MILK CONTAMINANTS

MILK PRODUCTION

MONS 038562

Milk
Contaminants

MONS 038563

MILK CONTAMINANTS

Fussion Products, ^{137}Cs ^{90}Sr ^{131}I 1

Compound 4072:
2-chloro-1-(2,4 - dichlorophenyl) vinyl diethylphosphate...2

3-hydroxycarbofuran.....3

Pentachloronitrobenzene.....4

Added ascorbic acid (inhibition of fat oxidation in milk).....5

Herbicide paraquat residue.....6
dichloride or the bis (methyl sulphate) salt
residue limit in milk: 0.01 ppm

Ferric ammonum citrate.....7

Pesticides: dicofol and aldren
chlordane:
heptachlor epoxide, 0.03 ppm
in milk legal action level in
Montana

DDT
dialifor, residue limit in milk,
0.06 ppm.....8

Antibiotic Residue and Enzymes.....9
Penicillinase - in milk is adulteration and
contrary to law

Miscellaneous.....10

Bacteria.....11

Library Search Cards.....12

MONS 038564

C.A. 75, 148236a

(1)

148236a Accumulation of cesium-137 and strontium-85 by Florida forages in a uniform environment. Garrett, A. R., Jr.; Cummings, S. L.; Regnier, J. E. (Southeast. Radiol. Health Lab., Public Health Sci., Montgomery, Ala.). *Health Phys.* 1971, 21(1), 67–70 (Eng). Expts. were performed to define the possible role of differences in root uptake of ^{85}Sr and ^{137}Cs among forage crops in explaining variable milk concns. of these radionuclides, particularly ^{137}Cs. Nine forage species commonly used in the Florida area were grown for 95 days under greenhouse conditions in soil contaminated with ^{85}Sr and ^{137}Cs. All species accumulated between 0.4 and 2.0 nCi ^{85}Sr/g; no statistically significant interspecies differences were obsd. Significant interspecies differences in ^{137}Cs accumulation were found, with white clover accumulating about 65 nCi/g, bahiagrass (*Paspalum notatum* var *saurae*) 48 nCi/g, pangolagrass (*Digitaria decumbens*) 28 nCi/g, and dallisgrass (*P. dilatatum*), oats, crabgrass (*D. sanguinalis*), and 3 Bermuda grass varieties about 35 nCi/g. Pangolagrass did not accumulate more ^{137}Cs than did the other forage species under the conditions of this study. The relation of these results to the previously established influence of pangolagrass on the high ^{137}Cs concns. in Tampa, Florida, milk is discussed.

MONS 038566

C.A.75. 105771d

105771d *Incorporation and control of fission products ingested by livestock.* Comar, Cyril L.; Wentworth, Richard A.; Lengemann, Frederick W. (Dep. Phys. Biol., New York State Vet. Coll., Ithaca, N.Y.). *U.S. Clearinghouse Fed. Sci. Tech. Inform., AD* 1970, No. 724190, 39 pp. (Eng). Avail. *NTIS.* From *Gov. Rep. Announce. (U.S.)* 1971, 71(14), 62. In feeding expts. with dairy cows, the influence of feed types upon the incorporation of fallout radionuclides into milk was examd. Observations furnished further verification of a method for the prediction of the total intake of ^{137}Cs, ^{90}Sr, and ^{131}I from milk by av. members of a human population following deposition of fallout on pasture. As a dietary countermeasure against ^{137}Cs, ferric ferrocyanide reduced contamination levels in cows' milk and in tissues of sheep and hogs by 91 to 98%. Na alginate reduced the retention of ^{90}Sr by sheep and hogs whereas a crude seaweed meal did not reduce ^{90}Sr incorporation into milk.

MONS 038567

C.A.74. 107877w

107877w Biological indicators of environmental radioactivity. Harvey, Raymond S. (Savannah River Lab., E. I. du Pont de Nemours and Co., Aiken, S.C.). *Environ. Surveillance Vicinity Nucl. Facil., Proc. Symp.* 1968 (Pub. 1970), 130-9 (Eng). Edited by Reinig, William C. Thomas: Springfield, Ill. Environmental radioactivity was investigated in the areas adjacent to the Savannah River plant with emphasis on the pollution of the atm. by fission products, liq. waste from the reactor, and streams into which the reactor effluent emptied. The program of monitoring included sampling of aquatic plants and fish, migratory birds, and terrestrial animals. Species selected included those which had a max. accumulation of radioisotopes as the bluegill sunfish for ^{65}Zn and $^{89,90}Sr$, grain for $^{134,137}Cs$, $^{89,90}Sr$, and milk for ^{131}I and ^{90}Sr. Samples were wet-ashed with HNO_3 and H_2O_2 and counts taken for 10 min, using a well crystal. The continuing surveillance program was greatly simplified by the selection of appropriate specific organisms for monitoring.

MONS 038568

C.A. 74. 72405m

72405m Comparison of the cesium-137 content of milk and people from 19 dairy farms in Utah. Lloyd, Ray D.; Mayr, Charles W.; Pendleton, Robert C.; Clark, D. O. (Dep. of Anat., Univ. of Utah, Salt Lake City, Utah). *Radiol. Health Data Rep.* 1969, 10(10), 427–33 (Eng). ^{137}Cs concns. were measured in milk from 19 Utah dairy farms and in residents from these farms from 1962 through 1966. When ^{137}Cs levels in the milk increased (1962–64), the $^{137}Cs/K$ ratios in people were similar to the ratios found in milk on the same dairy farm. When the ^{137}Cs levels in milk decreased (1965–66), the ratios found in humans were 2.5–4-times higher than that in the milk. This is due to differences in biol. half-times of ^{137}Cs for men, women, and children. Preliminary anal. of the relation between ^{137}Cs levels in milk and body concn. indicates that milk ^{137}Cs data can be used with appropriate human biol. half-times to est. the shape of human $^{137}Cs/K$ curves for the same period.

MONS 038569

12 P 2087

2087

12 P 2087
2-sec-butyl-4,6-dinitrophenol and 2-amino-6-sec-butyl-4-nitrophenol in milk and cream from cows fed 2-sec-butyl-4,6-dinitrophenol.
McKellar, R. L.
Journal of Agricultural and Food Chemistry 19 (4) 758-760 (1971) [2 ref. En] [Agric. Dept., The Dow Chem. Co., Midland, Michigan 48640, USA]

Holstein-Friesian cows were fed rations containing 2-sec-butyl-4,6- dinitrophenol (DNBP) at 1, 3, 10, 30, and 100 ppm levels. Milk samples were collected and analysed for DNBP and a possible metabolite, 2-amino-6-sec-butyl-4-nitrophenol (2-ABNP). The methods used included an acid hydrolysis step to liberate DNBP and 2-ABNP if they were present as glucuronides. Both compounds were determined by GLC employing electron capture detection, with DNBP as its methyl ether and 2-ABNP as its trimethylsilyl ether derivative. No residue of DNBP was found by the methods capable of detecting 0.01 ppm in milk and 0.05 ppm in cream. No 2-ABNP was found using methods sensitive to 0.1 ppm in milk and 0.1 ppm in cream. AS

Dairy products (P)

12 P 2088
Milk surveillance, December 1970.
Anon.
Radiological Health Data and Reports 12 (4) 199-208 (1971) [8 ref. En]

Monthly and annual average concn. of ^{90}Sr, ^{137}Cs and ^{131}I in raw or pasteurized milk are tabulated for 162 locations in the USA, 16 in Canada and 7 in Central and South America. Concn. of ^{131}I were all below the practical reporting level (10 pCi/l.) except for one (40 pCi/l.) from central Indiana. Monthly averages for ^{90}Sr ranged from 0 to 14 pCi/l. in the USA in Dec. 1970; highest 12-month average was 17 pCi/l. in Del Norte, California, equivalent to 8.5% of the Federal Radiation Council's radiation protection guide. Corresponding ^{137}Cs concn. were within the range 0-53 pCi/l.; highest 12-month average was 73 pCi/l. in S.E. Florida, representing 2.1% of the Council's guide for this nuclide. Levels of ^{137}Cs remained higher in Florida and Jamaica than at other locations. ^{89}Sr was detected in milk at 4 locations in the USA. Results are given of studies of assessment of accuracy of the determinations. [See FSTA (1970) 2 10P1403 for 1969 values.] BEPC

MONS 038570

465

3 P 465
Caesium-137 and strontium-90 in Florida milk - A five-year study of distribution and levels.
Roessler, C. E.; Williams, E. G.; Nettles, E. D.
Health Physics 16 (6) 681-89 (1969) [10 ref. En]
[Univ., Gainesville, Florida 32601, USA]

Data on ^{137}Cs and ^{90}Sr contents of milk from throughout Florida in 1963-1967 were analysed. Significant geographical variations were found, with highest ^{90}Sr contents in NW Florida and the highest ^{137}Cs contents in the central part of the state. These ^{137}Cs levels were the highest found in the USA and appear to be due to an unusual mechanism concentrating ^{137}Cs in the environment, including cattle feed. JMD

MONS 038571

J. D. Sci 44 (1961)

METHOD FOR REMOVING CATIONIC RADIONUCLIDES FROM MILK

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AND

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Dairy Products Division, USDA, Beltsville, Maryland

SUMMARY

A new method for the removal of radioactive strontium, barium, and cesium from milk has been developed. Fresh samples of raw whole milk with added Sr^{90}, Ba^{140}, and Cs^{137} were stored at 4° C. for at least 72 hr. The samples were then adjusted to a pH of 5.4 or 5.3 with 0.1 or 0.5 *M* citric acid and passed through a column containing Dowex 50W-X8 cationic resin in the CaMgKNa cycle. The resin was previously charged with a mixed salt solution containing Ca, Mg, K, and Na chlorides in approximately the same relative proportions as in the milk, but at five times their concentrations, and at the same pH of acidified milk. After treatment, the milk was mixed with Dowex 2-X8 anionic resin in the OH^- cycle, by the batch process, and the pH was brought to 6.6. The milk was filtered through a cheese cloth to remove the spent resin. Analysis of treated milk indicated that approximately 90-95% of Sr^{90}, 85-95% of Ba^{140}, and 75% of Cs^{137} were removed by this treatment from 25 resin-bed volumes of milk. The removal of radionuclides did not vary with flow rates of 5-7 ml. per minute and the cationic composition of the milk was essentially unchanged. Although the milk was not coagulable by rennin, addition of 2-3 ml. of 1 *M* $CaCl_2$ solution per liter of milk yielded coagulum comparable to that obtained with untreated milk. Further treatment of the final product with a CaMgKNa resin at pH 6.6 resulted in an additional removal of approximately 45, 30, and 90% of residual Sr^{90}, Ba^{140}, and Cs^{137} remaining after the initial treatment without further change in the gross cationic composition of the milk. Results obtained at pH 5.2-5.3 with milk labeled in vivo and in vitro were similar.

Since the advent of nuclear weapons testing, the radionuclide contamination of foods has been of concern. Surveillance studies have indicated significant amounts of biologically important radionuclides such as strontium[90] (Sr^{90}), strontium[90] (Sr^{90}), iodine[131] (I^{131}), barium[140] (Ba^{140}), and cesium[137] (Cs^{137}) in milk (2). Because of the health hazards associated with some of these contaminants, particularly Sr^{90}, methods have been sought to minimize their levels in marketed dairy products.

This problem may be approached either at the point of production on the dairy farm (6, 11) or at the processing plants before the product reaches the consumer. Control at the dairy farm may require modification of farm and animal husbandry practices. Although this approach might accomplish an over-all reduction in the concentration of radionuclides thus far observed in milk, it would not be effective in an emergency situation involving higher exposures. Under such circumstances, treatment of milk would be necessary to reduce contamination to safe levels. This treatment must be simple, economical,

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MONS 038572

MONS 038573

C.A. 75. 87435r

have orig. (2)

87435r **Residues of compound 4072 in milk and meat of cattle held in barns treated with residual sprays.** Escole, James L.; Mann, H. D.; Oehler, D. D. (Entomol. Res. Div., Agric. Res. Serv., Kerrville, Tex.). *J. Econ. Entomol.* 1971, 64(4), 890-7 (Eng). Beef calves and lactating dairy cows were held in rooms treated with 0.5, 2.5, or 5% Compound 4072 (2-chloro-1-(2,4-dichlorophenyl)vinyl diethyl phosphate) at a rate of 1 gal 50 ft^2. No residues of Compound 4072 were found in fat or tissue samples of animals exposed to the 0.5% spray or in the milk of cows held in any of the sprayed rooms. The small residues in the omental fat of calves exposed to the 2.5 and 5% sprays had disappeared at 32 days posttreatment.

MONS 038574

J. Econ. Ent. 64 (1971)

Residues of Compound 4072 in Milk and Meat of Cattle Held in Barns Treated with Residual Sprays[1,2]

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Entomology Research Division, Agr. Res. Serv., USDA, Kerrville, Texas 78028

ABSTRACT

Beef calves and lactating dairy cows were held in rooms treated with 0.5, 2.5, or 5% Compound 4072 (2-chloro-1-(2,4-dichlorophenyl) vinyl diethyl phosphate) at a rate of 1 gal/500 ft.². No residues of Compound 4072 were found in fat or tissue samples of animals exposed to the 0.5% spray or in the milk of cows held in any of the sprayed rooms. The small residues in the omental fat of calves exposed to the 2.5 and 5% sprays had disappeared at 32 days posttreatment.

Kilpatrick and Schoof (1963) and Mathis and Schoof (1964) reported that Compound 4072 (2-chloro-1-(2,4-dichlorophenyl) vinyl diethyl phosphate) was highly effective for control of the house fly, *Musca domestica* L., when it was applied to the interior surfaces of structures in and around dairies. Roberts et al. (1961) determined the residues in the milk of dairy cows sprayed with Compound 4072, and Ivey et al. (1966) determined the accumulation of residue in body tissues of sprayed beef cattle. However, it was not known whether residues would occur in the tissues of beef cattle or in the milk of lactating dairy cows held continuously in barns treated with residual sprays of Compound 4072. A study was made during 1968 at Kerrville, Texas, to obtain this information.

METHODS AND MATERIALS.—*Holding Enclosures.*—Six holding pens ranging from 28 to 65 m² each were modified to simulate fully enclosed barns by enclosing the sides and ends with new unpainted plywood panels. Rafters were also covered with plywood panels to form ceilings. An opening about 50–60 cm wide was left around the top and/or bottom of each room for ventilation. Each room was equipped with automatic waterers and feed troughs. All floors were concrete.

Treatments and Procedures.—Nine lactating Holstein dairy cows and 12 Hereford beef calves (weight about 204 kg each) were used in the test. Cows received about 4.5 kg of ground grain and mineral ration each day, and alfalfa hay was fed free choice. Calves received 2.7–3.6 kg of a ground grain and mineral mixture each day and about 2.2 kg of alfalfa hay and 11.3 kg sorghum. Cows were milked with mechanical milkers at 7:30 AM and 6 PM daily.

Three dairy cows each were held in each of 3 of the rooms, and 3 beef calves each were held in each of the other 3 rooms for 1 week before treatment. Then all the animals were held outside the building while the rooms were being sprayed. They were returned 5 hr posttreatment.

The treatments were residual sprays of Compound 4072 applied to the interior walls and ceiling of each room with a Hudson hand sprayer (5-gal, pump-up, compressed-air type) equipped with a flat-spray pattern nozzle that operated at a pressure of about 30–50 psi. Sprays were prepared by diluting a 24.1% xe with water. Feed troughs and waterers were covered carefully with polyethylene sheets before treatment and were not uncovered until after the spray had dried (5 hr). Two rooms were treated at the rate and concentration indicated on the label for control of house flies (1 gal of 0.5% spray/500 ft² surface area); 2 were sprayed with 5 times this concentration (1 gal of 2.5%/500 ft²); and 2 were treated with 10 times this concentration (1 gal of 5%/500 ft²). Each of the 3 treatments was applied to 1 room that contained 3 milk cows and 1 that contained 3 beef calves. In addition, 3 beef calves were held outdoors as untreated controls.

The animals were held in the rooms continuously throughout the test period except when the rooms were cleaned (twice daily) and when the cows were being milked. The total estimated time the cows were outside the rooms was 1 hr/day (28-day test); that for the calves was 20–30 min/day (32-day test period).

Sampling.—Samples were taken from the milk of each cow at 1 day pretreatment and at 1, 4, 8, 12, 20, and 28 days posttreatment. Morning and evening milk obtained the same day was combined in proportion to the quantity of milk obtained at each milking, and a sample from the combined milk was taken for residue analysis and butterfat determination.

Samples of omental fat taken by omentectomy were obtained from 1 calf from each treatment group and 1 control calf at 4, 8, and 16 days posttreatment. In addition, at 32 days posttreatment, 2 calves from each treatment group and 2 untreated calves were killed at a commercial abattoir, and samples of omental and renal fat, liver, heart, kidney, and muscle were taken from each. All samples were placed in polyethylene bags, frozen, and held for analysis.

Analytical Methods.—Extraction and cleanup of the tissue samples was done by the method of Claborn and Ivey (1965). Extraction and cleanup of the milk samples was done by using a modification of the method of Langlois et al. (1961) as follows: a 10-ml sample of milk was mixed with 20 g of Florisil™ (dried at 140°C for 16 hr and 5% water added). The 20 g of Florisil were placed in a chromatographic column (Shell design), and the milk-Florisil mixture was transferred to it by using 50 ml of a solvent mixture (50% methylene chloride-hexane) to make the transfer. The column was washed with 150 ml of the same solvent and then with 100 ml of methylene chloride. Compound 4072 was then eluted with 100 ml of 50% acetone in hexane, the solvent was concentrated to 5–10 ml by distillation through

Nine sulfon and 2 related acetates by a confirmatio (mode) abou ter three and directly inse solution.

The sulfon (= sulfide) and acetates *Anopli*

[1] Received for publication Aug. 10, 1970.
[2] Mention of a pesticide or a proprietary product does not constitute recommendation or endorsement by the USDA.
[3] The authors gratefully acknowledge the technical assistance of Joe Mowery and Billy Hogan of the Entomology Research Division, and they thank L. S. Palmer, Animal Disease and Parasite Research Division, Agr. Res. Serv., USDA, for performing the omentectomies.

MONS 038575

a Snyder column, and the remaining solvent was evaporated with a jet of clean dry air. The residue was dissolved in 5 ml of distilled hexane, and 10 aliters of the final solution were injected into the gas chromatograph.

Gas chromatography was accomplished with a Jarrell-Ash chromatograph equipped with a Melpar flame photometric detector using the phosphorous filter. The glass column, 6 mm od × 1.22 m, packed with 80- to 100-mesh Gas Chrom Q® coated with 5% DC-200®, was heated isothermally at 205°C, the detector at 170°, and the injector at 265°C. The carrier gas was prepurified nitrogen that flowed through the column at a rate of 120 ml/min. The flow rate for hydrogen was 200 ml/min and for oxygen 18 ml/min. The retention time for Compound 4072 was 2 min, and 0.2 ng gave a recorder response of 30% full scale. In a 10-ml sample of milk, the method would detect as little as 0.002 ppm Compound 4072 and gave recoveries of 97% at a level of 0.01 ppm. In a 20-g sample of tissues, it would detect as little as 0.001 ppm and gave recoveries of 84–100% at a level of 0.025 ppm.

RESULTS.—No residues of Compound 4072 were detected in any milk samples. No residues were found in the fat or other tissue taken from animals held in rooms treated with the standard 0.5% spray. The only residues found were in samples of the omental fat of beef calves held in rooms treated with 5 and 10 times the concentration indicated on the label (Table 1). When beef calves treated at each of the 3 levels were slaughtered at 32 days posttreatment, all fat and other tissue samples were free of any detectable residues of the insecticide.

These data indicate that if Compound 4072 is applied, as recommended on the label, at a rate and concentration of 1 gal of 0.5% spray/500 ft² of surface area to the inside surfaces of dairy and beef barns for fly control, residues of the chemical will not accumulate in milk, fat, and other tissues of animals held in the treated barns.

Table 1.—Residues of Compound 4072 in samples of omental fat taken by omentectomy from beef calves confined in rooms sprayed with 3 concentrations of the insecticide (1 sample from each treatment level at each sampling date).

% concn spray	Amount (ppm) of Compound 4072 in extracted fat at indicated days posttreatment		
	4	8	16
Untreated	0.0*	0.0	0.0
0.5	.0	.0	.0
2.5	.007	.007	.002
5.0	.020	.007	.007

* 0 = <0.001 ppm.

REFERENCES CITED

Clatborn, H. V., and M. C. Ivey. 1965. Determination of 2-chloro-1-(2,4-dichlorophenyl) vinyl diethyl phosphate and 2,2',4'-trichloroacetophenone in animal tissues and milk. J. Agr. Food Chem. 13(4): 354–6.

Ivey, M. C., H. V. Clatborn, R. A. Hoffman, O. H. Graham, J. S. Palmer, and R. D. Radeleff. 1966. Residues of Shell Compound 4072 in the body tissue of sprayed cattle. J. Econ. Entomol. 59: 579–82.

Kilpatrick, J. W., and H. F. Schoof. 1963. Adult house fly control with residual treatments of six organophosphorous compounds. Ibid. 56: 79–81.

Langlois, B. E., A. R. Stemp, and B. J. Liska. 1964. Rapid cleanup of dairy products for analysis of chlorinated insecticide residue by electron capture gas chromatography. J. Agr. Food Chem. 12(3): 243–5.

Mathis, W., and H. F. Schoof. 1964. Field tests of dichlorvos, General Chemical 4072, Hooker Compound 1422, and synergized DDT against *Musca domestica*. J. Econ. Entomol. 57: 256–8.

Roberts, R. H., R. D. Radeleff, and H. V. Clatborn. 1961. Residues in the milk of dairy cows sprayed with P³²-labeled General Chemical 4072. Ibid. 54: 1053–4.

The Insecticidal Action of Some Sulfonamides[1,2]

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ABSTRACT

Nine sulfonamides of medical and veterinary importance and 2 related compounds were examined for insecticidal activity by a tarsal contact technique. Four compounds sulfadiazine, sulfaquinoxaline, sulfadiazine, and sulfacetamide showed activity on filter paper at 5–10 g/m². The ester sulfamethoxine (= sulfadoxine) were also weakly insecticidal when fed to mosquitoes in sugar solution.

Wettable-powder formulations of the insecticidal sulfonamides, with talc and sodium lauryl sulfate, also had good insecticidal activity, and as such may be useful in the treatment of wall surfaces in malaria control programs or as substitutes for chlorinated hydrocarbon, organophosphorous, or carbamate insecticides.

The sulfonamides sulfaquinoxaline, sulfamethoxine (sulfadoxine), and sulfadiazine show both direct and systemic insecticidal activity against the mosquitoes *Anopheles stephensi* Liston and *Aedes aegypti* (L.), with *A. stephensi* being rather more susceptible (Beesley and Peters 1968, Peters and Beesley 1970). Larvicidal activity also was demonstrated (Beesley 1971).

It has been suggested (Peters et al. 1968, Ramkaran and Peters 1969) that certain sulfonamides may fulfill the triple role of (1) killing malarial parasites in the vertebrate host, (2) preventing development to the

[1] J. of Common cultures and communities.

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[2] Senior Lecturer, Veterinary Parasitology, and Professor of Parasitology, respectively.

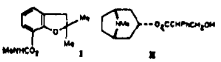
MONS 038576

MONS 038577

c A.74.140013j

(3)

140013j Effect of feeding carbofuran on the physiology of the dairy cow and on pesticide residues in milk. Miles, J. T.; Pernott, W. J.; Hinton, S. A.; Montgomery, M. J.; Bennett, S. R. (Dep. Dairying, Univ. Tennessee, Knoxville, Tenn.) *J. Dairy Sci.* 1971, 54(4), 478-80 (Eng). Oral administration of 5



g carbofuran (I) to cows caused acute symptoms of toxicity within 30 min, but the cows recovered following atropine (II) administration. The addn. of 0.5–1.0 g I to silage caused some minor nervous symptoms in cows immediately following initial feedings. At subsequent feedings, silage consumption was slower and no clin. symptoms were obsd. There was a significant depression of 0.03 kg of silage intake for every increase of 1 ppm I added over the exptl. range (12–147 ppm). An av. of 0.05% of the amt. of I consumed was excreted in the milk as the only metabolite, 3-hydroxycarbofuran.

MONS 038578

MONS 038579

C.A. 74. 123982g

(4)

123982g Toxicologic and metabolic studies on pentachloronitrobenzene. Borzelleca, Joseph F.; Larson, Paul Stanley; Crawford, E. M.; Hennigar, Gordon R., Jr.; Kuchar, Edward J.; Klein, H. Harvey (Dep. Pharmacol., Med. Coll. Virginia, Richmond, Va.) *Toxicol. Appl. Pharmacol.* 1971, 18(3), 522–34 (Eng). In studies on pentachloronitrobenzene (I), in a



I

3-generation reproduction study on rats, no adverse effect on any parameter appeared from diet levels through 500 ppm. Two-year feeding to beagle dogs established 30 ppm as the highest no-effect level tested; cholestatic hepatosis with secondary bile nephrosis was found in min. degree on 180 ppm and in moderate degree on 1080 ppm, but was considered to be a reversible lesion. Study of I did not occur in tissue of the rat, dog, and cow, but traces of apparent I was found in milk from treated cows. Pentachloroaniline and methyl pentachlorophenyl sulfide, metabolites of I, were found in tissue of treated animals in all 3 species, which together with absence of I indicated rapidly metabolism of the latter. In contrast, tissue storage of hexachlorobenzene and pentachlorobenzene, contaminants of technical I, were found in all 3 species, in degrees paralleling their content in the I, indicative of a slower rate of metabolism of these compds. When I was combined with 5-ethoxy-3-trichloromethyl-1,2,4-thiadiazole (Terrazole), no potentiation of toxicity was found in acute oral test on rats. In acute (24 hr) percutaneous toxicity test in rabbits, no sign of intoxication resulted from application of 4 g I/ml as a 30% soln. in corn oil.

MONS 038580

6T 289.

(5)

6 T 289
Food processing with added ascorbic acid. [A review]
Bauernfeind, J. C.; Pinkert, D. M.
Advances in Food Research 18 : 219-315 (1970) [406 ref. En] [Chem. Res. Dep., Hoffmann-LaRoche Inc., Nutley, New Jersey, USA]

Addition of L-ascorbic acid (AA) to foods and drinks is reviewed under these headings; metods of addition; AA reactions; and AA as an added nutrient, synergist in protection of fats and oils, preventive of fruit browning and vegetable discoloration, inhibitor of oxidative rancidity in fish, stabilizer of meat colour, flour and bread improver, O_2 acceptor in beer processing, reducing agent in wine, and inhibitor of fat oxidation in milk, butter, yoghurt and cheese. The regulations on the use of AA in foods in the USA, Canada and other countries are outlined. SJR

MONS 038582

MONS 038583

1P 53

(2)

1 U 64

Paraquat; tolerances for residues.

USA, *Environment Protection Agency*

Federal Register 37 (208, Oct. 27) 22 983-22 984 (1972) [En] [Washington, DC, USA]

Tolerances are established under the Federal Food, Drug and Cosmetic Act for residues of the herbicide paraquat derived from application of either the dichloride or the bis(methyl sulphate) salt as follows: alfalfa, birdsfoot trefoil, clover, pasture grass and range grass, 5 ppm; meat, fat and meat by-products of cattle, goats, horses and sheep, and in milk, 0.01 (negligible residue). CAS

1 U 62

Dialifor; tolerances for residues.

USA, Environment Protection Agency

Federal Register 37 (208, Oct. 27) 22 982 (1972) [En] [Washington DC, USA]

Tolerances are established under the Federal Food, Drug and Cosmetic Act for the combined residues of the insecticide dialifor (S-(2-chloro-1-phthali- midoethyl) O,O-diethyl phosphorodithioate) and its O analogue S-(2-chloro-1-phthalimidoethyl) O,O-diethyl phosphorothioate as follows; citrus fruits, 3 ppm; meat, fat, and meat by-products of cattle and milk fat (reflecting negligible residues in whole milk) 0.06. CAS

MONS 038584



MONS 038585

1P18

(7)

1 P 18
A chemical-organoleptic study of iron-fortified milk and the biological availability of the iron.
Wang, C.-F.
Dissertation Abstracts International, B 33 (1) 300: Order no. 72-20 794 (1972)
[En] [Univ. of Maryland, College Park, USA]

Raw milk was fortified with ferric ammonium sulphate, ferric ammonium citrate, ferric choline citrate or $FeSO_4$ before pasteurization and homogenization. The fortified milks were tested, after 2 or 7 days at 5°C, for oxidized flavour (by the 2-thiobarbituric acid test) and for fat, iron, tocopherols, vitamin A and carotene. Organoleptic tests with expert and consumer panels were also made. The milk containing ferric ammonium citrate (up to 30 ppm of Fe) could not be distinguished from control milk by the taste panels, and no lipid oxidation was apparent from the chemical tests. Milk containing 10 ppm of Fe supplied by any of the 3 other salts developed detectable lipid oxidation which was accompanied by losses of tocopherol, vitamin A and carotene. 13-day-old Hampshire × Yorkshire pigs were given a ration of cows' milk fortified with cream, vitamins, aureomycin and ^{59}Fe-labelled ferric ammonium citrate (to give 20 ppm of Fe). After 15 days on the diet, Fe absorption was estimated at approx 30%. The results indicate that milk fortified with ferric ammonium citrate is an effective source of Fe supplementation. About ½ pint of fortified milk would provide the average daily requirement of Fe in the human diet. MEG

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are also acknowledged

committee. 1959. Beri-Chemistry. The deter-ol in oils, foods and ;ost, 64: 356.
bee, and R. A. Chap-ol content of Cana-its use in detecting ry Sci., 38: 333.
Vitamin E content of human and animal tis-Agr. Exp. Sta., Bull.
W. M. Balding, H. S. Miller. 1949. Seasonal amin A content of Vic-Australian J. Sci. Res.,
37. Nutritional investi-during the war, 1939-Soc., 5: 255.
Anderson. 1965. Det. ts V ih A—Vérde.
964. The protection of during saponification J. Agr. Food Chem.,
R. A. Chapman. 1954. ration of butter with -cans of the tocopherol n., 26: 2195.
and F. H. McDowall. ary of New Zealand es., 20: 76.
M. Nesbitt. 1961. The in Manitoba. Depart-ce, University of Mani-
J. G. Armstrong. 1968. the Emmerie-Engel pre-mination of vitamin E Inst. Food Technol. J.,
D. Snow. 1947. The vitamin A with acti-chlorohydrin. J. Biol.
Agriculture. 1947. But-vitamin A in the diet he United States. U.S. ubl. 626. 47 pp.
Pharmacopeia. 1965. Mack Publishing Co.,
T. vitamin A and E ... H. Seasonal 64: 17.

Relationship Between Some Chlorinated Hydrocarbon Insecticides and Lactic Culture Organisms in Milk[1]

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Abstract

Portions of sterile milk containing 1 ppm of aldrin, DDT, or lindane were inoculated with strains of *Streptococcus lactis, Streptococcus cremoris, Streptococcus diacetilactis,* and *Lactobacillus casei* and incubated at 32 C for 14 days. When the insecticides were extracted from the milks and the extracts analyzed by gas-liquid chromatography there was no perceptible evidence of degradation or chemical alteration of the insecticides by the lactic culture organisms.

L. casei cells grown in trpyticase soy broth containing 0.01 and 0.02 ppm of ^{14}C-dieldrin showed 353 and 830%, respectively, higher radioactive counts than corresponding cells grown in the absence of ^{14}C-dieldrin, suggesting that a small amount of dieldrin was either adsorbed or incorporated by the cells.

Introduction

Insecticides designed to poison target organisms have become ubiquitous, frequently contaminating useful biological systems. The presence of chlorinated hydrocarbons in milk has caused some workers to consider the effect of these insecticides on the metabolic activity of lactic culture organisms. Kim and Harmon (4) showed that several insecticides had no adverse effect on the growth or fermenting ability of various strains of lactic culture organisms important in dairy product fermentations. On the contrary, Bradley and Li (2) reported that milk containing 2.15 to 2.37 ppm of dieldrin and made into Cheddar cheese showed slightly less acid development during manufacture and higher pH after ripening for ten days, than corresponding cheese made from milk containing no dieldrin.

Some investigators (5, 7, 8, 12) found that certain organisms, particularly coliforms and a few miscellaneous gram-negative bacteria, convert dichlorodiphenyltrichloroethane (DDT) to dichlorodiphenyldichloroethane (*DDD*); other investigators (1, 6) reported no degradation of chlorinated hydrocarbons by several organisms indigenous to soil. Stenersen (11) observed the conversion of DDT to *DDD* by cultures of *Escherichia coli* and *Serratia marcescens*.

Since organisms vary in their ability to alter or degrade chlorinated hydrocarbons, the purpose of this investigation was to determine whether certain lactic organisms commonly present in cultured dairy products could change aldrin, DDT, or lindane, and attempt to determine whether a typical chlorinated hydrocarbon (dieldrin) was incorporated into a representative organism (*Lactobacillus casei*) during growth of the organism.

Materials and Methods

Effect of lactic culture organisms on aldrin, DDT, and lindane in milk. Erlenmeyer flasks containing 25 ml of sterile milk and 25 μg of aldrin, DDT, or lindane dissolved in acetone were inoculated with 0.25 ml of active 18-hour litmus milk cultures of *Streptococcus lactis* A 254, *Streptococcus lactis* A 62, *Streptococcus cremoris* E 8, *Streptococcus diacetilactis* 18-16, *Streptococcus diacetilactis* DRCI, and *L. casei*. Noninoculated samples containing the insecticide were used as controls. Before addition of the insecticide, the original milks usually contained less than 0.01 ppm and always less than 0.05 ppm of the insecticide when tested by gas-liquid chromatography (GLC).

After incubation at 32 C for 14 days the insecticides were extracted from the milk and cleaned by recommended procedures (3, 10). The cleaned samples dissolved in hexane were analyzed by a gas-liquid chromatograph, equipped with an electron capture detector. The chromatograms of the extracts from the inoculated and noninoculated samples were compared, to determine whether the organisms had altered the chemical structure of the insecticides. The analytical technique was sensitive to 0.01 μg of the insecticides and related analogs per milliliter of substrate.

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Determining incorporation of dieldrin into L. casei. In work previously reported (4), several lactic culture organisms were grown in milk containing dieldrin, heptachlor, methoxychlor, and malathion. The only perceptible evidence of inhibition was a slight decrease in growth rate when *L. casei* was grown in milk containing 100 ppm of dieldrin.

An experiment was designed to determine if dieldrin was incorporated into *L. casei* cells when it was a component of the substrate. One milliliter of an active culture of *L. casei* was inoculated into 100-ml quantities of Trypticase Soy Broth (TSB) containing approximately 0.01 and 0.02 ppm of ^{14}C-dieldrin[2] with a specific activity of 72.4 mCi/mg, and incubated for 18 hours at 32 C. Similar cultures containing no dieldrin were used as controls. Viable cells were enumerated on plate count agar. One-half milliliter of ^{14}C-dieldrin, 14.5 ml of scintillator solution, and enough Cab-o-sil[4] to form a stable homogenous gel were shaken vigorously and the radioactivity measured using a Packard-Tri-Carb Liquid Scintillation Spectrophotometer Model 3310.[5] The scintillation solution contained 6 g/liter of 2,5-diphenyloxazole and 0.2 g/liter of 1,4-*bis*-2-4-methyl-5-*phenyloxnzole* in toluene. Twenty-five milliliters of the 18-hour cultures in TSB, with and without ^{14}C-*dieldrin*, were washed with 25 ml of hexane by shaking for 30 seconds in a stainless steel centrifuge bottle. Then the cells were harvested by centrifuging at 10,100 × *g* for 20 minutes in a Sorvall Model RS-2 automatic refrigerated centrifuge. The harvested cells were washed twice with 50 ml of 0.8% NaCl, transferred to a liquid scintillation vial using 0.5 ml of TSB, and the radioactivity measured. The results are reported as counts per minute per milliliter.

Results and Discussion

Stability of aldrin, DDT, and lindane in milk inoculated with lactic culture organisms. The chromatogram of aldrin extracted from milk containing 1 ppm of aldrin, inoculated with *S. lactis* A 62 and incubated for 14 days at 32 C is shown in Figure 1A. A chromatogram of corresponding noninoculated milk is shown in Figure 1B. When aldrin degrades to dieldrin

[2] ^{14}C-dieldrin, Amersham/Searle Corp., Des Plaines, Illinois.

[4] Cab-o-sil, New England Nuclear Corp., Pilot Chemicals Div., Boston, Massachusetts.

[5] Packard Tri-Carb Liquid Scintillation Spectrophotometer Model 3310, Packard Instrument Co., Inc., Downers Grove, Illinois.

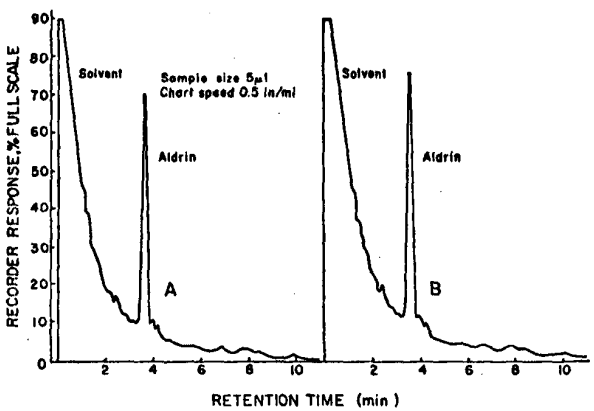


FIG. 1. Gas liquid chromatogram of extract from milk containing 1 ppm of aldrin and incubated at 32 C for 14 days (A, inoculated with *S. lactis* A 62), (B, noninoculated).

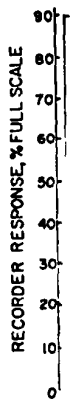


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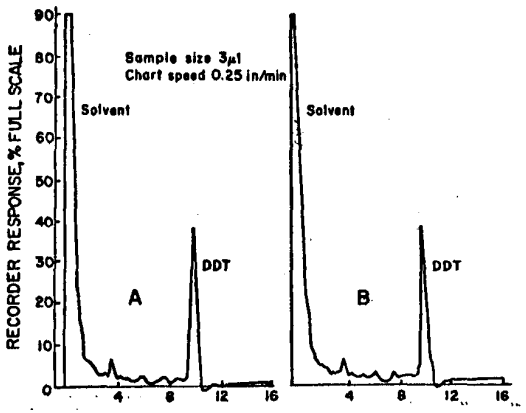


FIG. 2. Gas-liquid chromatogram of extract from milk containing 1 ppm of DDT and incubated at 32 C for 14 days (A, inoculated with *S. lactis* A-62), (B, noninoculated).

or any other analog, the peak representing aldrin on the chromatogram diminishes and a new peak indicating dieldrin or other analog will be present. Alteration in the chemical structure of any chlorinated hydrocarbon would be similarly indicated when analyzed by gas-liquid chromatography.

Figure 2A shows the chromatogram of DDT extracted from milk containing 1 ppm of DDT and inoculated with *S. lactis* A 62, whereas Figure 2B shows the chromatogram of the extract from the corresponding noninoculated milk.

The chromatogram of lindane extracted from milk containing 1 ppm of lindane and inoculated with *S. lactis* A 62 is shown in Figure 3A; the chromatogram of the extract from corresponding noninoculated milk is shown in Figure 3B.

Except for a slight quantitative difference between Figures 1A and 1B, attributable to differences in efficiency of extraction, a comparison of Figures 1A with 1B, 2A with 2B, 3A with 3B reveals that the two figures in each pair are virtually identical, indicating that none of the insecticides was altered in structure when present in milk inoculated with *S. lactis* A 62 and incubated for 14 days at 32 C.

Chromatograms of extracts from milks containing 1 ppm of aldrin, DDT, or lindane and inoculated with *S. lactis* A 254, *S. diacetilactis* 18-16, *S. diacetilactis* DRCI, *S. cremoris* E 8, and *L. casei* were also compared with chromatograms of extracts from similar noninoculated milks. Figures representing these data are omitted to conserve space, but the configurations of all of the chromatograms were identical to the corresponding control, indicating that none of the aforementioned organisms altered the structure of any of the insecticides when incubated in milk at 32 C for 14 days.

The mechanism of the toxicity of the chlorinated hydrocarbons is not clearly elucidated, but the insecticides are nerve poisons. Bacteria are not known to possess a nerve system, and there is little experimental evidence to indicate that insecticides have anti-bacterial activity.

Aldrin, DDT, and lindane are among the few chlorinated hydrocarbon insecticides susceptible to biodegradation by some microorganisms. In normal degradation, aldrin converts to dieldrin, which is an epoxide and more toxic than aldrin. DDT may convert to DDD by reductive dechlorination, to dichlorodiphenylethene (DDE) by dehydrodechlorination, or to dichlorodiphenylacetic acid (DDA) by oxidative dechlorina-

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tion. Lindane converts to pentachlorocyclohexane. The degradation of DDT and lindane are detoxication processes.

Most investigations of the modification of insecticides by microorganisms have involved DDT in synthetic broth media rather than in food substrates. Langlois (5) demonstrated the ability of *E. coli* to dechlorinate DDT to DDD in TSB, but when *E. coli* was inoculated into skimmilk containing DDT there was little conversion of DDT to DDD, suggesting that milk protects the chlorinated hydrocarbon from the action of the bacteria.

The results of our research, together with observations of other investigators, suggest that lactic cultures are not apt to modify or degrade chlorinated hydrocarbon insecticides in milk.

Uptake of carbon[1] *by L. casei grown in a medium containing* ^{14}*C-dieldrin.* Data in Table 1 show the results when *L. casei* was grown for 18 hours at 32 C in TSB containing ^{14}C-dieldrin in amounts calculated to approximate 0.01 and 0.02 ppm in Trials I and II, respectively.

When the amounts of ^{14}C-dieldrin incorporated by the cells are calculated as percentages of the amount of ^{14}C-dieldrin available, the percentages are 0.20 and 0.18 in Trials I and II, respectively (Table 1). These percentages are relatively small. This method of calculating uptake is used frequently but is not logical when there is a surplus of nutrients, because cells do not utilize all of the nutrients in the substrate, and there is no reason to assume they selectively utilize the radioactive component. Approximately 0.009 cc of cells were harvested from 25 ml of TSB. If the uptake of ^{14}C-dieldrin by the cells was proportional to the amount of ^{14}C-dieldrin in the TSB, then the counts per minute should be approximately 49 in Trial I and 81 in Trial II, as indicated by calculations in Table 1. Data in Table 1 also show that the radioactive counts per minute of TSB containing 0.01 and 0.02 ppm of ^{14}C-dieldrin were 353 and 830% higher, respectively, than the counts per minute of corresponding cells grown in TSB containing no ^{14}C-dieldrin.

The aforementioned data suggest that some ^{14}C-dieldrin was either adsorbed on, or incorporated in, the cells of *L. casei*, but there is insufficient evidence to conclude that the cells are metabolizing dieldrin. Obviously, the amount involved is small, as tions. Certain factor of measuring the r results vary with t organisms are differe completely eliminate may adsorb, but di should have been rem the cell by the hexan activity is less effic solutions, and errors tion of low counts cells.

If the uptake of ^{1} determined in milk, t been more useful, method of harvestin lated milk and there believe the results w

Salton (9) stated gram-positive bacte organic solvents in acetone. He stated of *Streptococcus l* insoluble, and that (gram-negative) wa nol. Since the chlo cules are fat-solubl incorporated and

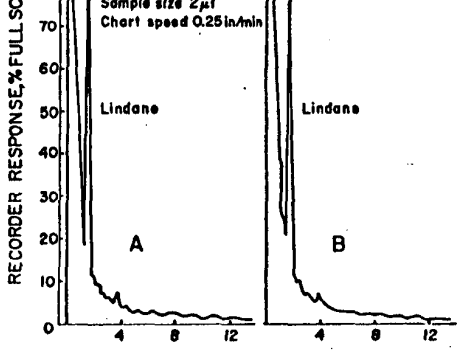


FIG. 3. Gas-liquid chromatogram of extract from milk containing 1 ppm of lindane and incubated at 32 C for 14 days (*A*, inoculated with *S. lactis A-62*), (*B*, noninoculated).

TABLE 1. Uptake of ^{14} 18 hours at 32 C.

a) Viable cell cou
b)[2] Approximate v harvested from
c)[3] CPM of 1 ml
d) CPM of washe no ^{14}C-dieldri
e) CPM of washe ^{14}C-dieldrin.
f) Per cent of i ing ^{14}C-dieldr dieldrin (e ÷
g) Anticipated (TSB containi
h) Per cent of a ÷ (e − d) ×

[1] The TSB in Tri respectively.

[2] Assuming an *L.* applying the formula $10^9 x^3$, or 0.000 cc.

[3] CPM = Counts

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TABLE 1. Uptake of ^{14}C-dieldrin by *Lactobacillus casei* cells in trypticase soy broth incubated 19 hours at 32 C.

	Trial[1] I	Trial[1] II
a) Viable cell count per milliliter.	24×10^7	22×10^7
b)[2] Approximate volume in milliliters of washed and packed cells harvested from 25 ml of TSB.	0.009	0.009
c)[3] CPM of 1 ml of inoculated TSB containing ^{14}C-dieldrin.	2,118	5,070
d) CPM of washed cells harvested from 25 ml of TSB containing no ^{14}C-dieldrin (background count).	30	30
e) CPM of washed cells harvested from 25 ml of TSB containing ^{14}C-dieldrin.	136	279
f) Per cent of increase in CPM of cells grown in TSB containing ^{14}C-dieldrin compared to cells grown in TSB without ^{14}C-dieldrin ($e \div d \times 100$)	353	830
g) Anticipated CPM of washed cells harvested from 25 ml of TSB containing ^{14}C-dieldrin [$(b \times c) + d$].	49	81
h) Per cent of available ^{14}C-dieldrin taken up by cells [$(e - d) \div (c - d) \times 25$].	0.20	0.18

[1] The TSB in Trials I and II contained approximately 0.01 and 0.02 ppm of ^{14}C-dieldrin, respectively.

[2] Assuming an *L. casei* population of 24×10^7 with an average dimension of $0.8 \times 3\ \mu$ and applying the formula $\pi r^2 \times$ length, the volume of cells in 25 ml of broth is approximately $9 \times 10^9 \mu^3$, or 0.009 cc.

[3] CPM = Counts per minute.

involved is small, as indicated by the calculations. Certain factors influence the accuracy of measuring the radioactivity of cells and results vary with the methods used. Microorganisms are difficult to wash sufficiently to completely eliminate material which the cells may adsorb, but dieldrin is fat-soluble and should have been removed from the surface of the cell by the hexane rinse. Measuring radioactivity is less efficient with cells than with solutions, and errors are apt to be in the direction of low counts in suspensions containing cells.

If the uptake of ^{14}C-dieldrin could have been determined in milk, the information might have been more useful, but there is no practical method of harvesting *L. casei* cells from coagulated milk and there is no apparent reason to believe the results would differ.

Sutton (9) stated that the cell walls of most gram-positive bacteria are insoluble in many organic solvents including alcohols, ethers, and acetone. He stated that the isolated cell wall of *Streptococcus faecalis* (gram-positive) was insoluble, and that the cell wall of *E. coli* (gram-negative) was soluble in 90% w/w phenol. Since the chlorinated hydrocarbon insecticides are fat-soluble, they are more apt to be incorporated and probably more apt to be chemically altered by gram-negative organisms which contain up to 20% lipid, than by gram-positive organisms containing a maximum of 2% lipid. When hexane was used as a solvent to extract chlorinated hydrocarbons from TSB cultures of *S. lactis* and *L. casei* (gram-positive), no organisms or cellular fragments could be detected in the hexane layer when subjected to microscopic examination.

Conclusion

Data reported herein indicate that the gram-positive lactic cultures were unable to cause any measurable alteration (biodegradation) in the chemical configuration of aldrin, DDT, or lindane.

References

(1) Bartha, R., R. P. Lanzilotta, and D. Pramer. 1967. Stability and effects of some pesticides in soil. Appl. Microbiol., 15: 67.

(2) Bradley, R. L., and C. F. Jd. 1968. The effect of dieldrin on acid development during manufacture of Cheddar cheese. J. Milk Food Technol., 31: 202.

(3) Food and Drug Administration, U.S. Department of Health, Education, and Welfare.

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Residues in Milk Resulting from Ultra-Low-Volume Sprays of Malathion, Methoxychlor, Coumaphos, Ronnel, or Gardona® for Control of the Horn Fly[1,2,3]

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ABSTRACT

No residues were found in samples of milk from dairy cows treated twice daily for 21 days with 1 ml of a mist spray of either of 2 concentrations of malathion, coumaphos, or Gardona® (2-chloro-1-(2,4,5-trichlorophenyl)-vinyl dimethyl phosphate). The maximum residues of methoxychlor found were 0.005 ppm from applications of the low concentration (1%) and 0.010 ppm from applications of the high concentration (2%). The maximum residues of ronnel found were 0.014 ppm for the low concentration (5%) and 0.037 for the high concentration (10%). The lower concentrations of insecticides were about the minimum required to control the horn fly, *Haematobia irritans* (L.), and the higher concentration was twice this minimum amount.

Residues of insecticides in the milk of dairy cows after a single application of conventional sprays and those resulting after daily applications of low-volume sprays have been compared (Claborn et al. 1965). That work showed that daily applications of 80–120 ml of 0.05% DDT, 0.10% Compound 4072 (2-chloro-1-(2,4-dichlorophenyl) vinyl diethyl phosphate), and 0.20% ronnel for 14 days caused maximum residues of only 4, 1, and 3 parts/billion, respectively. Subsequently (Miller and Eschle 1967) an improved sprayer was developed that automatically and accurately delivered 1 ml of pesticide in a xylene solution as a mist spray and was used (Eschle and Miller 1968) to study control of horn flies, *Haematobia irritans* (L.), achieved with several insecticides. To supplement the encouraging results, the present tests were made to determine whether 1 ml/animal mist sprays of malathion, methoxychlor, coumaphos, ronnel, or Gardona® (2-chloro-1-(2,4,5-trichlorophenyl) vinyl dimethyl phosphate) would cause residues in the milk of dairy cows when the pesticides were applied daily in concentrations that would produce effective control of horn flies.

Materials and Methods.—Two concentrations of the technical materials dissolved in xylene were used for the tests as follows: malathion 1 and 2%, methoxychlor 1 and 2%, coumaphos 0.5 and 1%, ronnel 5 and 10%, and Gardona 0.5 and 1%. The lower concentration was about the minimum required to maintain control of horn flies with this method of application, the higher concentration was about double that amount.

Two dairy cows were used in the test of each pesticide. One cow was sprayed twice daily, immediately after each milking, with the lower concentration; the other was treated in the same manner with the higher concentration. The pesticide was applied with the single-nozzle automatic sprayer (Miller and Eschle 1967) adjusted to deliver 1 ml of the xylene solution just below the back line on 1 side of the cow over an area about 30 cm wide that extended from the withers to the loins. Four pesticides were applied for 21 days, but the ronnel spray was applied for 28 days.

Samples of milk (controls) were taken from the cows for at least a week before the 1st treatment. Thereafter, at 1, 3, 5, 7, 10, 14, and 21 days, the morning and evening milk from each cow was combined, and a 600-ml sample (in a proportion equal to the quantity of milk obtained at each milking) was taken for analysis. Part of each sample was used for a butterfat determination; the remaining portion was divided into duplicate samples that were kept in glass bottles at a temperature of 0–5°C until analyzed. All samples were analyzed within 7 days after collection. The cows were milked by machine, and care was taken to avoid mechanical contamination. Samples were collected at 28 days from the cows sprayed with ronnel and taken at 24 and 26 days (2 and 5 days after the spraying ceased) from the cows sprayed with methoxychlor.

Analytical Methods.—Gas chromatographic methods were used to analyze for residues of all 5 pesticides. The extraction and cleanup methods used for methoxychlor, coumaphos, ronnel, and Gardona were similar to the method reported by Langlois et al. (1964), but the amount of water added to deactivate the Florisil* and the concentration of dichloromethane in the hexane elution solvent were varied. Also, the 10-ml sample of milk was mixed with 20 g of Florisil, and 20 g more Florisil were used in the lower portion of the cleanup column for all pesticides except Gardona (only 15 g). An electron capture detector using a helium glow discharge as the electron source was used in the analysis of all pesticides except malathion; a flame photometric detector was used for malathion.

Methoxychlor.—For analysis of methoxychlor, the Florisil used in the lower portion of the cleanup column was dried for 16 hr at 145°C and deactivated with 10% water. The column was washed with 50 ml of 15% dichloromethane in hexane, and the methoxychlor was eluted with 100 ml of this same solvent. The eluate was evaporated to dryness, the residue was dissolved in 5 ml of double-distilled hexane (diluted more if necessary), and a 5-µliter aliquot was injected into the gas chromatograph. A Beckman GC-5 gas chromatograph equipped with an electron capture detector was used for the analysis. The glass column, 122 cm × 6 mm od, was filled with 80–100 mesh Gas Chrom Q treated with 5% DC 200. Helium gas at a flow rate of 80 ml/min was used as the carrier gas. The temperatures of the column, detector, and injector were 220°, 250°, and 270°C, respectively. With a range setting of 2.5×10^{-9} amp,

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[1] Diptera: Muscidae.

[2] Received for publication Apr. 17, 1969.

[3] Mention of a proprietary product does not necessarily imply its endorsement by the USDA.

[4] Chemist, Entomology Research Division.

[5] Research Entomologist, Entomology Research Division.

[6] Agricultural Engineer, Agricultural Engineering Research Division.

[7] The authors gratefully acknowledge the assistance of R. E. Boggs, Entomology Research Division, for collection of milk samples and butterfat determinations, and of M. O. Perkins, Agricultural Engineering Research Division, for maintaining and checking the spraying equipment.

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a 5-μliter injection of a methoxychlor solution containing 0.04 ng/μliter gave a response of 45% full scale. The retention time was 4.8 min with these conditions.

Coumaphos.—For analysis of coumaphos, the Florisil used in the lower portion of the column was deactivated with 10% water from undried material. The milk-Florisil mixture was transferred to the column with five 20-ml portions of 15% dichloromethane in hexane, the column was washed with 150 ml of 50% dichloromethane in hexane, and the coumaphos was eluted with 175 ml more of the same solvent. The eluate was concentrated to 2 ml by evaporation on a steam bath, the remainder of the solvent was removed with a jet of clean dry air, and the residue was dissolved in 10 ml of double-distilled hexane. The samples were analyzed with a Beckman GC-5 gas chromatograph as for methoxychlor, except that the column temperature was 230°C. With a range setting of 5× 10^{-9} amp, 0.5 ng of coumaphos in 5 μliter of hexane gave a response of 35% full scale and had a retention time of 5.5 min. With the method, 0.01 ppm of coumaphos was readily detected, and 0.1 ppm gave recoveries of 100%.

Ronnel.—For analysis of ronnel, the Florisil used in the lower portion of the cleanup column was dried for 16 hr at 190°C and partially deactivated with 5% water. It was packed in the column and washed with 100 ml of 25% dichloromethane in hexane. The milk-Florisil mixture was then added to the column, and the ronnel was eluted with 200 ml of the same solvent. The eluate was concentrated to 5 ml on a steam bath, and the extract was transferred with hexane to a glass-stoppered centrifuge tube. The volume was reduced to 1 ml with a jet of clean dry air, and 10 μliter were injected into the gas chromatograph. The sample was then diluted if necessary.

The samples were analyzed with a Jarrell-Ash gas chromatograph equipped with an electron capture detector. The glass column, 122 cm × 6 mm od, was filled with 80–100 mesh Chromosorb® W treated with 5% SF-96. The carrier gas was prepurified nitrogen with a flow rate of 275 ml/min. The column was heated isothermally at 180°C, the injector at 190°C, and the detector at 200°C. With a range setting of 10^{-9} amp, 1 ng of ronnel in 10 μliter gave a response of 25–40% full scale depending upon the sensitivity of the detector. With these conditions, the retention time was 2.7 min. The method readily detected 0.001 ppm of ronnel and gave recoveries of 87%.

Gardona.—For analyses of Gardona, undried Florisil deactivated with 10% water was used in the bottom portion of the cleanup column. The milk-Florisil mixture was added to the top portion of the column and washed with 100 ml of hexane. The Gardona was then eluted with 250 ml of 50% dichloromethane in hexane, and the eluate was concentrated to 2 ml by evaporation on a steam bath. The remaining solvent was removed with a jet of clean dry air. The residue was dissolved in 10 ml of double-distilled hexane, and a 5-μliter aliquot was injected into the gas chromatograph. The sample was then diluted to a convenient volume, judged by the response.

The samples were analyzed with a Beckman GC-5 gas chromatograph with the same glass column and helium gas flow as used for methoxychlor. The temperature of the column was 210°C; the injector and detector were each held at 260°C. With a range setting of 5×10^{-9} amp, 0.05 ng of Gardona in 5 μliter of hexane gave a response of 10–15% full scale and had a retention time of 2.6 min. With 0.01 ppm, the method gave recoveries of 85% and readily detected 0.001 ppm of Gardona in a 10-ml sample of milk.

Malathion.—For analyses of malathion, a 20-ml sample of milk was measured with a pipette into a 500-ml Erlenmeyer flask, and 150 ml of acetonitrile, 20 g of sodium sulfate, and 6 drops of acetic acid were added. The mixture was heated to boiling, and the lumps were broken up by stirring with a spatula. After the flask was cooled for 10 min in an ice bath, the mixture was filtered into a 500-ml separatory funnel, and the filter was washed with 50 ml of acetonitrile. The solution was extracted with four 50-ml portions of hexane, and the hexane extracts were back-extracted with 25 ml of acetonitrile and discarded. The acetonitrile was added to the main extract and concentrated to 20 ml by distillation through a Snyder column. The concentrate was transferred to a separatory funnel, diluted with 80 ml of water, and extracted with one 50-ml portion and three 30-ml portions of hexane. The combined hexane extracts were washed with two 35-ml portions of water and then dried by filtration through a plug of anhydrous sodium sulfate into a 300-ml Erlenmeyer flask. The solvent was concentrated to 5 ml by distillation through a Snyder column, the extract was transferred to a 10-ml glass-stoppered centrifuge tube with hexane, the volume was reduced to 2 ml with a jet of clean dry air, and 10 μliter were injected into the gas chromatograph (diluted further if necessary).

A Jarrell-Ash Model 700 gas chromatograph equipped with a Melpar flame photometric detector with the phosphorous filter was used for the analysis. The 240 cm × 6.3-mm od stainless-steel column was filled with 80–100 mesh Chromosorb W treated with 5% SF-96. Prepurified nitrogen at a flow rate of 160 ml/min was used as the carrier gas. The flow rate of oxygen was 25 ml/min, and that of hydrogen was 200 ml/min. The column temperature was 210°C, the injector temperature was 250°C, and the detector temperature was 100°C. The range setting was 10^{-9} amp. A 10-μliter injection of 1 ng of malathion in hexane gave a response of 12–15% full scale and had a retention time of 3.5 min. With 0.01 ppm, the

Table 1.—Residues[a] of methoxychlor and ronnel in milk of dairy cows sprayed twice daily with 1 ml of xylene solutions of the insecticides.

Days after spraying started	Methoxychlor in milk (ppm)		Ronnel in milk (ppm)	
	1% spray	2% spray	5% spray	10% spray
0	<0.001	<0.001	<0.001	<0.001
1	0.001	0.001	0.002	0.005
3	.003	.006	.005	.010
5	.003	.007	.008	.012
7	.006	.007	.010	.015
10	.005	.008	.009	.020
14	.006	.007	.011	.021
21	.005[b]	.010[b]	.011	.035
24	.003	.005		
26	<.001	.001		
28			.011[c]	.022[c]

[a] All results adjusted to 4% butterfat.
[b] Spraying stopped at 21 days.
[c] Spraying continued 28 days.

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of 10–15% full scale and
min. With 0.01 ppm, the
85% and readily detected
a 10 ml sample of milk.
s of malathion, a 20-ml
ared with a pipette into a
ml 150 ml of acetonitrile,
ml 6 drops of acetic acid
was heated to boiling, and
by stirring with a spatula,
for 10 min in an ice bath,
into a 500-ml separatory
as washed with 50 ml of
e was extracted with four
, and the hexane extracts
25 ml of acetonitrile and
e was added to the main
to 20 ml by distillation
The concentrate was trans-
ml, diluted with 80 ml of
% urea 50-ml portion and
same. The combined hexane
ch two 35-ml portions of
ydration through a plug of
into a 100-ml Erlenmeyer
oncentrated to 5 ml by dis-
n column, the extract was
stoppered centrifuge tube
was reduced to 2 ml with a
he plunger were injected into
diluted further if necessary).
700 gas chromatograph
flame photometric detector
er was used for the analysis.
e stainless-steel column was
Chromosorb W treated with
nitrogen at a flow rate of 160
carrier gas. The flow rate of
and that of hydrogen was
ion temperature was 210°C,
was 250°C, and the detector
The range setting was 10
ion of 1 ng of malathion in
d 12–15% full scale and had
min. With 0.01 ppm, the

ethoxychlor and ronnel in milk
ere daily with 1 ml of xylene
ch.

Dose in milk (ppm)	Found in milk (ppm)		
	2% spray	5% spray	10% spray
0.001	< 0.001	< 0.001	< 0.001
0.003	0.002	0.005	0.005
0.006	.005	.006	.016
0.007	.008	.008	.012
0.007	.010	.011	.015
0.016	.007	.009	.028
0.015	.013	.013	.024
0.016	.011	.011	.035
0.015			
0.015			
	0.11*		0.022

method gave recoveries of 92–98%, and the lower limit of detection was 0.001 ppm.

RESULTS AND DISCUSSION.—No residues of malathion, coumaphos, or Gardona were detected in any milk samples taken during the 21-day test. The lower limit of detection for the methods used were: malathion 0.001 ppm, coumaphos 0.01 ppm, and Gardona 0.001 ppm. Table 1 shows the low residues found in milk from the cows sprayed with methoxychlor and ronnel.

REFERENCES CITED

Claborn, H. V., H. D. Mann, I. L. Berry, and R. A. Hoffman. 1965. Comparisons of residues in milk resulting from two types of spray applications of DDT, Shell Compound 4072, and ronnel. J. Econ. Entomol. 58 (5) : 922–3.

Eschle, J. L., and J. A. Miller. 1968. Ultra-low-volume application of insecticides to cattle for control of the horn fly. Ibid 61 (6) : 1617–21.

Langlois, B. E., A. R. Stemp, and B. J. Liska. 1964. Cleanup of dairy products for analysis of chlorinated insecticide residues by electron capture chromatography. J. Agr. Food. Chem. 12: 243.

Miller, J. A., and J. L. Eschle. 1967. An automatic cattle sprayer for ultra-low-volume applications. USDA ARS 42-125, 5 p.

An Improved Larval Medium for Colonized *Culicoides variipennis*[1,2]

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ABSTRACT

The laboratory colony of *Culicoides variipennis* (Coquillett) was made more uniform, and production was increased by using a standardized larval medium composed of an inert substrate and a broth-microorganism system developed from commercially available products rather than from cow manure. A standard inoculum was used to initiate bacterial growth in larval pans, and a standard photoperiod of 15 hr of light was adopted for the larval colony.

Since 1962, when this laboratory was moved to Denver, we have been engaged full time in cooperative research with the Denver Animal Disease Research Laboratory (of the Animal Disease and Parasite Research Division, Agricultural Research Service, U.S. Department of Agriculture) on bluetongue, a viral disease of sheep, cattle, and ruminant wildlife. A colony of the biting midge *Culicoides variipennis* (Coquillett) (Jones 1957, 1960, 1964, 1966) is being maintained at this laboratory. The colony was established in December 1957 at the Kerrville, Tex., Laboratory of the Entomology Research Division and was relocated at Denver in 1962; it has been maintained without the addition of wild flies.

Because this species of biting fly has been shown to be a biological vector of bluetongue (Foster et al. 1963), and because it is known to be a pest of livestock, as well as common throughout the United States (Jones 1961), *C. variipennis* has been used almost exclusively as the vector in our transmission studies. Although there is an obvious need to check other species of flies as possible vectors and to include some of these in future studies, the need has also become evident to develop a more standard fly to represent the single species that we are using. The interpretation of results of research involving the transmissibility of viruses by arthropods may well prove to be dependent on the physiological condition of the vector. The virus logically is influenced by the environment in which it develops, and in light of known differences that do occur—for example the dramatic physiological change that accompanies the ingestion of a blood meal (Bowne and Jones 1966; Bowne, unpublished data)—the milieu of the virus in the insect becomes extremely important.

The standard fly for our studies at Denver on the transmission of bluetongue by *C. variipennis* is a colonized fly 24–48 hr old that has been maintained for the preceding 24 hr on water only. Because the conditions of light, relative humidity, and temperature for maintenance of adults and pupae can be made constant with relative ease, standardization of the recently emerged fly depends almost entirely on the conditions under which the larva has been reared. We therefore attempted to develop, as a more standard larval medium for the colony, an artificial microbial-broth system that would lend itself to complete standardization through quality-control techniques. This paper describes the development of such a larval medium, as well as some changes in methodology for handling the adult colony. (Some data on the improved medium were presented in a speech by one of us (R.H.J.) at the New York meeting of the Society in November 1967).

DEVELOPMENT OF A STANDARDIZED LARVAL MEDIUM.—An important step in the original colonization of *C. variipennis* was the use of a larval medium that closely resembled the natural one. Because the semi-aquatic larvae commonly occur in areas polluted by livestock, cow manure was selected as the main ingredient. Soil was added to provide a growth of microorganisms, and the substrate for the medium simulated the naturally occurring one of soft silty mud exposed to direct sunlight.

The most important major variable that had prevented the development of a standardized fly colony was the use of field-collected cow manure in the larval medium: besides being unsterilized and therefore containing various contaminating microorganisms, the manure was variable in nutritional content. In addition, "poor" manure sometimes resulted in conditions that adversely affected larval development. It was obvious as early as 1958 (when one of us (R.H.J.) tried limited experiments with a broth system for *Escherichia coli* as larval food) that the substitution for cow manure of an artificial nutrient broth system with a known flora would be advantageous. With an

[1] Diptera: Ceratopogonidae.
[2] Received for publication July 17, 1969.

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OUR INDUSTRY TODAY

PESTICIDE RESIDUES AND THE DAIRY INDUSTRY[1]

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Pet Milk Research Center, Greenville, Illinois

There has been increasing awareness and concern on the part of food and health officials and of the dairy industry about the presence in milk and milk products of pesticide residues. The problem is not peculiar to dairy products. All raw agricultural commodities have been undergoing a similar trend which parallels the tremendous increase during the past twenty-five years in the use of pesticides in this country. Agriculture, as we know it today, could not exist without them. More than 200 basic chemicals are now being produced and offered for sale and use on our farms. The upward trend is certain to continue as well as it should. Consumers have come to expect products with quality and sanitation standards never dreamed of in past generations. Pesticides offer the only economical means of maintaining not only this quality but also the adequacy and sufficiency of agricultural production.

IMPACT OF THE MILLER BILL

Milk production and manufacture became directly involved in the pesticide residue problem with the passage in 1954 of the Miller Bill, now known as the Pesticide Amendment to the Food, Drug, and Cosmetic Act, which provides Food and Drug Administration with authority to establish and enforce tolerances for pesticide chemicals in raw agricultural products. Since that time, more than 2,000 such tolerances or exemptions from the requirements of tolerances have been established for a wide variety of pesticide chemicals in basic agricultural products.

There is an interesting aspect to this amendment which may not be generally realized, which is that producers, processors, or manufacturers of agricultural products are not permitted to petition for tolerances for pesticide chemicals, for example, in milk or milk products. The law reserves this right to the manufacturers of the chemicals, which must already have been registered with the U. S. Department of Agriculture under the Federal Insecticide, Fungicide, and Rodenticide Act. However, the Food and Drug Administration at its discretion can establish tolerances in the absence of a petition and has done so on frequent occasions.

POLICY OF REGULATORY OFFICIALS

It has been the traditional policy of food and health officials, including the Federal Food and Drug Administration, to oppose the addition to milk in any amount of poisonous or deleterious substances. In the absence, therefore, of any established tolerances for milk and dairy products, Food and Drug Administration has followed an enforcement policy based on zero, i.e., that any residues found in milk are violative of the Pesticide Amendment. In consideration of these policies, manufacturers of agricultural chemicals have usually not included milk among the agricultural products for which they have applied for tolerances for their respective pesticides.

There has been one notable exception: The manufacturer of Methoxychlor did include in his petition a request for a tolerance in milk for this particular chemical. Scientific evidence of the type generally accepted as adequate for establishing safety of chemicals in foods was submitted. At the request of the Food and Drug Administration, a special committee was nominated by the National Research Council to consider this petition. After due consideration, the committee recommended against the requested tolerance for Methoxychlor in milk, even at the requested low level of 0.25 p.p.m., and the petition was denied.

The significant factor here is not the denial of the petition but, rather, is contained in the reasons given by the committee for its recommendation:

> ". . . that because of the unique position of milk in the diet of infants and normal and ill adults, a greater margin of safety must be established in a proposal for a pesticide tolerance petition than was demonstrated (in the petition for Methoxychlor) and, in fact, a greater margin of safety than would be the case for any other food item in the human diet."

Going beyond this statement, the committee recommended that FDA remove milk from its list of raw agricultural commodities under the Pesticide Amendment. This indicated the committee's belief that there should be no provision in law for the establishment of any tolerance for pesticide chemical residues in milk.

UNIQUE POSITION OF MILK

Most technical men would agree with part of the committee's conclusion, i.e., as to the unique position of milk in the diets of special segments of the population that milk enters the diet more frequently and in greater amounts than other foods for which tolerances have been granted that, therefore, a greater margin of safety should be allowed in regulating pesticide residues in milk as compared with most

[1] Presented at the 56th Annual Meeting of the American Dairy Science Association, University of Wisconsin, Madison, 1961.

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other foods. On the other hand, it is difficult to discern *any scientific basis for the committee's recommendation* that there be no provision in law for tolerances for these residues in milk. The reasons are simple. Pharmacologists agree that for every chemical registered for agricultural use, there is a safe level which can be scientifically determined. Moreover, even under the best agricultural practices, it is impossible to produce milk in today's environment which is completely free from pesticide residues. With present methodology, it may not always be possible to detect the presence of such residues, but they are there, nonetheless. A vast amount of data establishing this is now available.

PRACTICAL CONSIDERATIONS

In the intervening years, since the passage of the Pesticide Amendment, the dairy industry has taken a somewhat detached view of the pesticide residue problem. It has been common knowledge that residues are present in milk. But viewed in the light of the tolerances established for many other agricultural products, for example, 7 to 14 p.p.m. DDT in or on fruits, vegetables, the fat of meat, etc., residues in milk, according to the available data, are well within or below these levels. There are other factors which in recent years held back action programs to monitor or control the residue problem. There is no analytical method which can be used at the plant level for testing incoming milk for pesticide residue content. Even for the analysis of finished milk products, methodology is time-consuming and expensive and, up until very recently, the only available methods determined merely total organic chlorine which was, in fact, a measure of DDT and its homologues and provided no identification or quantitative measure of other compounds.

Moreover, there had not been general awareness in the dairy industry of the behavior of the chlorinated hydrocarbon group of chemicals, which have the unfortunate characteristic of being transmitted through the biological system of the cow into milk. They can enter the biological system through the skin, by inhalation, or by ingestion. They are stable in milk, unaffected by heat processing. In varying degrees, they are stored in the fat of the animal and above certain thresholds translocate into milk over prolonged periods of time. There are data which indicate, for example, that DDT continues to appear in the milk of a dairy cow for months after the source is removed, the time depending upon the rate of feeding or upon the rate of depletion of stores of body fat.

In the face of some of these obstacles, little progress was made in controlling pesticide residues in milk. Nevertheless, however mitigating these factors may be, the dairy industry must face up to and acknowledge negligence in its approach to the total problem.

The situation was changed radically when, in late 1959 and early 1960, FDA seized shipments of dairy products moving in interstate commerce on the basis of pesticide residue content. The amounts in the milk were small—approximately 0.2 p.p.m. on the fluid milk basis or 4 to 5 p.p.m. in the fat as determined by the Schecter-Haller-Method. This is the official method, with a reliability probably not below about 2.5 p.p.m. in milk fat. The method is probably adequate for enforcement purposes but not for a technical study of the incidence, types, levels, or sources of pesticide residues in milk.

AVAILABLE METHODS

Fortunately, a good screening method is now available, developed by Paul Mills of FDA and published in the *Journal of the Association of Official Agricultural Chemists* in November, 1959. It employs paper chromatography and can be used for the identification and semiquantitative estimation of chlorinated hydrocarbons. It will detect DDT, DDE, TDE, Heptachlor Epoxide, Lindane, Benzene Hexachloride, Methoxychlor, Chlordane, Perthane, Heptachlor, and Toxaphene. The Mills Method has been given first action by the A.O.A.C. for the first six pesticide residues listed above in dairy products. Although it was adopted as a method for identification only, it does have semiquantitative analytical value. In our laboratory, the method has sensitivity down to roughly 0.3 p.p.m. in the fat of dairy products.

In the wake of events described above, the dairy industry under the auspices of its Dairy Industry Committee appointed a Technical Advisory Committee to appraise the pesticide problem and to develop an action program. This committee is made up of 12 technical men representing leading corporate and cooperative manufacturers of dairy products in the United States. Here are some of the questions to which the committee undertook to find answers: What pesticide residues occur in milk? What is the incidence of these residues? What are the levels? What, if any, are the seasonal influences and geographical variations? What are the sources of these chemicals? Are the levels in milk such as to constitute a public health hazard? What is the best methodology for measuring residues? How sensitive are the methods? Is it possible or practical to produce residue-free milk? On what basis could the residue problem be resolved which would be mutually satisfactory to food and health officials and to the dairy industry? Such a basis would need, obviously, to integrate the objectives of both groups in terms of the residue levels in milk which (1) are biologically insignificant and (2) are the lowest which can be achieved under good agricultural practices.

COMMITTEE ORGANIZATION

The Technical Advisory Committee was organized into six subgroups:

(a) Methodology
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(c) Toxicology.
(d) Survey of the
(e) Liaison with
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(a) Methodology and collection of analytical data.
(b) Sources of pesticides in milk. It has been FDA's contention that the chief source is poor dairy-barn practices, i.e., the misuse of pesticides by the dairy farmer. It was necessary to find out if this were true or if, on the other hand, feeds and forage might be the major contributor.
(c) Toxicology.
(d) Survey of the scientific literature.
(e) Liaison with the feed industry.
(f) The Dairy Industry Committee itself acting to conduct a strong educational program for dairy farmers.

The committee held its first meeting in May, 1960, and thus has now completed a full year of work. It has been an inspiring experience to the writer to chairman this group of technical leaders in the industry, who have given so unstintingly of their time to develop and interpret information and to implement this research and educational program.

Twelve laboratories have collaborated in the collection of data. More than 20,000 analyses have been submitted, representing all types of dairy products and all geographic regions in the United States. A full year's cycle has been completed, which delineates seasonal variations. Sources of pesticide contamination have been studied. Data on balance studies in dairy cows are available which throw light on the ratio of intake of pesticides in feed to excretion in milk. A review of toxicologic data on the chlorinated hydrocarbons has been made and a report prepared on this important aspect. The survey of literature now being printed includes some 800 abstracts of pertinent technical articles.

DATA COLLECTED BY PET RESEARCH CENTER

A progress report is being prepared for presentation to FDA within the next few weeks. Therefore, I shall not pre-empt that report by presenting the committee's findings here. In lieu thereof, I should like to present a study from our own laboratory, which I believe reveals with some clarity the present status of the pesticide residue problem with respect to incidence of residues, levels, and sources of contamination.

This particular case study, although representing only a portion of the total data collected by the committee, nevertheless has certain advantages from the standpoint of reliable interpretation. It includes approximately 4,000 analyses of dairy products. All of the analyses were conducted in the same laboratory, by the same personnel, and by the same method. The Mills Paper Chromatography Method was strictly followed. The sampling is consistent, since the same plant locations were represented. The study covers a complete 12-month cycle. The local dairy farmers were subjected to the same educational program at all sampling locations.

In our laboratory, about 53 separate manipulations are necessary when the method is applied, for example, to evaporated milk. Quantities as low as 0.2 μg. can be identified, equivalent to 0.3 p.p.m. on the fat basis. Recovery

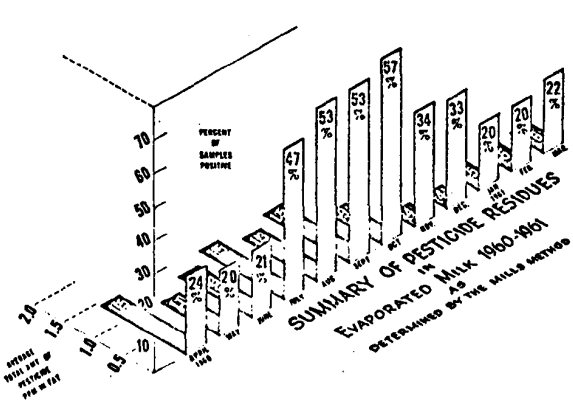


FIG. 1

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studies indicate that in our laboratory the method recovers between 60 and 80% of added pesticides. The data reported have been corrected, assuming an average recovery of 70%. Studies have been conducted to evaluate the minimum amount detectable. As might be expected, this value has changed over the year of study as personnel became more efficient in the techniques. This shifting of the lower limit of detectability causes some slight difficulty in interpretation of the year's data, but this will be explained as we view the following slides.

In all instances where levels of pesticides are shown, the level is the estimated total amount of residue in the fat. This is obtained by adding together all the residues found in each sample. Therefore, the values represent the aggregate of the chlorinated hydrocarbons in the particular milk product being analyzed.

RESULTS AND DISCUSSION

Figure 1 shows the level and incidence of pesticide residues on almost a country-wide basis month by month. The seasonal characteristics of the residue problem are shown in the marked increase in incidence from July through October. The average levels remained relatively high throughout the summer and fell off sharply in the fall. Levels found in March, 1961, are significantly lower than in the corresponding period of 1960.

Figures 2, 3, and 4 depict the same type of information as in Figure 1, but are grouped according to geographic sections of the United States. Figure 2 is the northern area—Wisconsin, Ohio, Illinois, Kansas, Missouri. Here both levels and incidence rose slowly throughout the summer months to a peak in October, then fell off sharply for the remainder of the months reported here. Figure 3 shows a comparable situation for the southern area—Virginia, Maryland, Tennessee, Kentucky, Mississippi, and Arkansas. It may be noted that a plateau was reached in July and maintained through October. Levels were relatively high during this period.

Figure 4 reveals a serious problem area in the United States, i.e., the Mountain and Pacific regions—Idaho, Utah, California. Incidence was significantly higher than in other geographic areas. The peak of incidence came somewhat earlier here. Levels after the month of April show a rather characteristic rise and fall, with the peak levels appearing slightly before the peak incidence.

Although one must use caution in drawing too narrow conclusions from these data, there is strong indication in all areas that incidence of pesticide residues in milk follows the pattern of the major growing seasons. It would follow that this would be the time of greatest activity in the spraying or dusting of agricultural crops.

It would appear that little progress has been made in reducing the incidence of contamination of milk with residues. However, it should be borne in mind that in this particular study, during the last six months, levels were being detected that might have been missed in April and May of the previous year, 1960.

Importantly, levels of residues found have definitely decreased when compared to results a year ago. A factor which may have some bearing upon the apparent lack of a lowering

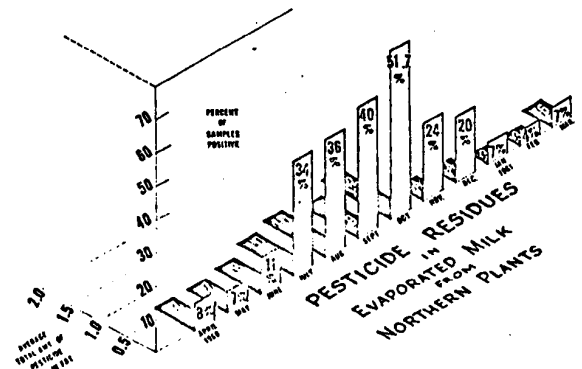


FIG. 2

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peak in October, remainder of the re 3 shows a com- southern area—Vir- Kentucky, Missis- ty be noted that a ly and maintained ere relatively high

as problem area in Mountain and Pacific California. Incidence than in other geo- of incidence came cle after the month aracteristic rise and appearing slightly

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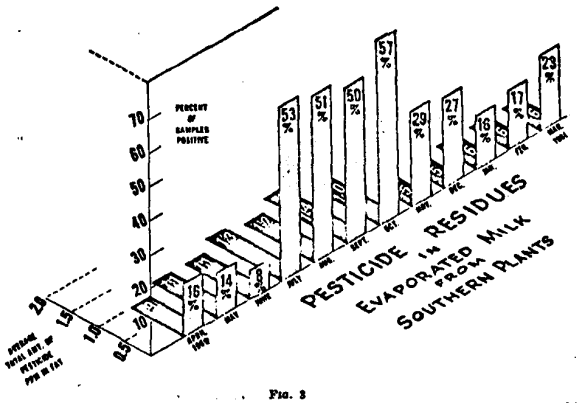


FIG. 3

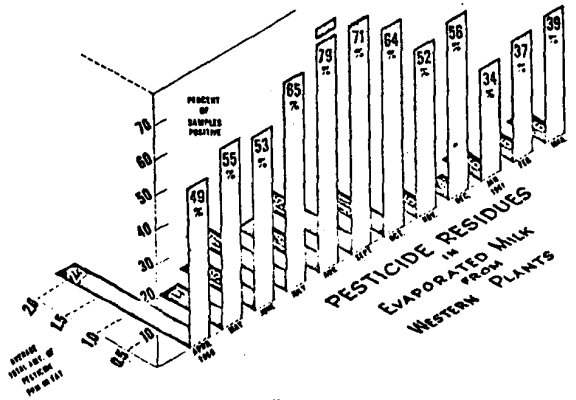


FIG. 4

incidence is the extreme persistence of these sidues in the biological system of the cow. dies reported in the literature show reten- times from 120 days up to a year in some stances. Our own study has shown a retention DDT up to ten months. Under such circum- stances, rapid elimination of detectable residues would not occur.

Figure 5 shows the specific residues found in these 4,000 samples. Approximately 90% of all positive samples contained DDT; 15% contained DDE, a homologue of DDT. This

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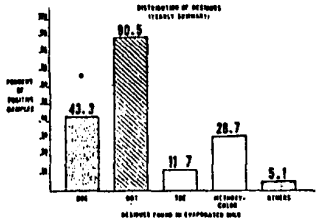


FIG. 5

is probably the result of the breakdown of DDT, either by weathering or metabolic systems. Twelve per cent of the samples contained TDE or DDD, which may be the result of direct application of these chemicals to crops or can also represent breakdown of DDT. The 29% of positive samples showing Methoxychlor will be discussed later. Only 5% of the positive samples contained residues other than the four mentioned above. A few of these were Lindane, some BHC, but the majority represented an unidentified residue appearing in cotton-growing areas. Efforts to identify this compound have failed. We know only that it is not one of the more commonly used chlorinated hydrocarbons. It can be postulated that it is a metabolite of a pesticide or herbicide used in the production of cotton.

Figure 6 shows the seasonal use of Methoxychlor. The first peak in July very likely coincides with the maximum fly-population season. The second peak in October is more difficult to explain. It may be the result of usage to protect cattle against other pests, such as face flies or gnats. Since Methoxychlor has a very short biological retention time, the sharp peaks are not unexpected. Of all the data gathered, those concerning Methoxychlor are the only indication of misuse of a pesticide on the dairy farm. Data in the literature, as well as our own experience indicate, however, that Methoxychlor can be used in such a manner that it will not appear in the milk. Continuing effort in educating the farmer in the proper use of Methoxychlor is needed.

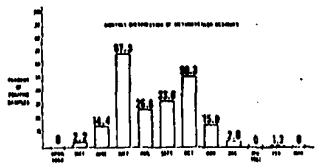


FIG. 6

Figure 7 clarifies the situation with respect to DDT residues. At least 90% of all positive samples contained detectable amounts, reflecting the widespread use in agriculture of DDT and its long biological retention. It is interesting, however, that extensive surveys indicate that the use of DDT on dairy animals and in dairy barns is negligible. These are highly significant findings, pointing directly to feeds and forage as being substantial contributors of DDT residues in milk.

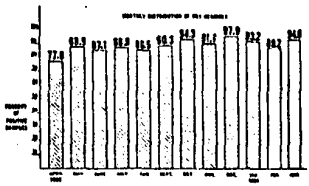


FIG. 7

Figure 8 shows the range of levels of total residues in the fat of dairy products. The rather sudden change appearing in November needs interpretation. It was during October that this laboratory recognized its ability to detect lower levels of contamination as techniques improved. At this point, we started carrying smaller standard amounts on papers than previously and were thus able to graph the papers down further than in the earlier work. When these smaller amounts were recognized, this obviously resulted in samples whose aggregate residue content was evaluated at lower levels. Although the accuracy of the chart is thus slightly impaired, as a result of the changing technique in the quantitative evaluation of the paper chromatograms, nevertheless the broader indication is clear, i.e., DD

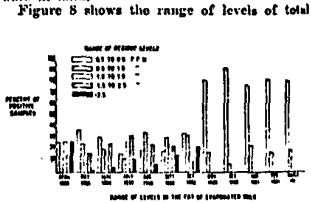


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during the period April, 1960, through March, 1961, aggregate residue content has been significantly reduced in all areas included in this study.

SUMMARY

Study of the data derived from this work indicates that progress in controlling the contamination of milk by pesticides has been made. Residue levels have been reduced in the year reported here. The fact that incidence of residues has not been materially reduced indicates the complexity of the problem. Biological retention of chlorinated hydrocarbons is an established fact and undoubtedly is contributing to this continued appearance of low-level residues in the milk supply. Personal contact by field men with producers supplying milk to the various plants sampled in this program reveals that actual in-barn and on-animal usage of chlorinated hydrocarbons, except for Methoxychlor, has virtually been eliminated. This leaves the relatively unknown area of the conditions of pastures and feeds as a route of continuing contamination. Many of these conditions are beyond the control of the dairy farmer. There is indication that more stringent control of the use of Methoxychlor should be exercised by the dairy farmer.

The results of the study point to the unrealistic nature of an absolute zero tolerance for pesticides on an agricultural product that is produced in an environment shared with other agricultural products upon which pesticide usage is permitted and necessary.

The contention of some food and health officials that, by and large, milk can be produced free of residue is not borne out. Moreover, the data indicate that probably no dairying area produces milk completely free of residue. When a residue is not found, it can be said only that the sample does not contain a sufficient amount to be detected. It is probable that if our methodology were consistently sensitive to lower levels, the incidence of contamination would be found higher than at present. There is no zero for the analytical chemist; there is only an amount below which he can not detect a substance.

It becomes increasingly clear that a strong educational program directed to dairy farmers on the proper use of pesticide chemicals, and on selection of feeds and forage on which pesticide application is controlled, in a comparatively brief time, i.e., twelve months, can produce significant reduction in levels of residues in milk. However, we do not have evidence that incidence of contamination is materially reduced.

It is apparent from these studies that under such a program, pesticide residues in milk and milk products can be controlled at levels sufficiently low as to constitute no hazard to public health.

The data show that feeds and forage are suspect as major contributors of pesticide contamination in milk and that action programs in the feed and related agricultural industries are probably necessary to bring about further improvements.

Above all, these studies indicate the necessity for a persistent, industry-wide action program to monitor and control pesticide residues from any source which may contaminate dairy products, so as to preserve the safety and reputation of milk and its products, as major components of the diets of all segments of the population.

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considerably greater protein synthesis than unfertilized eggs but less than those of normal fertilized eggs. The eggs of aziridinyl chemosterilized flies were reported to undergo one or more meiotic divisions before embryonic death occurs (Fahmy and Fahmy 1964, LaChance et al. 1968, Matolin 1969). Since mRNA is essential for ribosomal aggregate formation it is possible that insufficient or incorrect mRNA may be implicated in the limited protein synthesis and lack of DNA synthesis in the chemosterilized eggs.

ACKNOWLEDGMENT.—We express appreciation to Dr. Nasr Matei for helpful advice and to Elaine Tillman and Patricia Baker for technical assistance.

REFERENCES CITED

Borkovec, A. B. 1966. Insect Chemosterilants. Advances in Pest Control Research VII. Interscience, New York. 143 p.

Britten, R. J., and R. B. Roberts. 1960. High resolution density gradient sedimentation analysis. Science (Washington) 131: 32–33.

Campagnoni, T. A., and H. R. Mahler. 1967. Isolation and properties of polysomes from cerebral cortex. Biochemistry 6: 956–67.

Fahmy, O. G., and M. J. Fahmy. 1964. A Symposium on Chemosterilants. II. The chemistry and genetics of the alkylating chemosterilants. Trans. Roy. Soc. Trop. Med. Hyg. 58: 318–26.

Gadallah, A. I., W. W. Kilgore, and R. R. Painter. 1970a. Isolation and identification of housefly (*Musca domestica* L.) egg ribosomes. J. Insect Physiol. 16: 1245–8.

1970b. Metabolism of nucleic acids and proteins of normal and chemosterilized house flies during oögenesis and embryogenesis. J. Econ. Entomol. 63: 1777–83.

Kilgore, W. W. 1967. Chemosterilants, p. 197–239. *In* W. W. Kilgore and R. L. Doutt [ed.] Pest Control, Biological, Physical and Selected Chemical Methods. Academic Press, New York. 477 p.

Kilgore, W. W., and R. R. Painter. 1964. Effect of the chemosterilant apholate on the synthesis of cellular components in developing housefly eggs. Biochem. J. 92: 353–7.

Kilgore, W. W., R. R. Painter, and A. I. Gadallah. 1971. Characteristics of the nucleic acids of eggs from house flies fed aziridinyl compounds. J. Econ. Entomol. 64: 30–33.

LaChance, L. E., D. T. North, and W. Klassen. 1968. Cytogenic and cellular basis of chemically induced sterility in insects, p. 99–157. *In* G. C. LaBrecque and C. N. Smith [ed.] Principles of Insect Sterilization. Appleton-Century-Crofts, New York, 354 p.

Lowry, O. H., N. J. Rosebrough, A. L. Farr, and R. J. Randall. 1951. Protein measurement with the Folin phenol reagent. J. Biol. Chem. 193: 265–75.

MacKintosh, F. R., and E. Bell. 1969. Proteins synthesized before and after fertilization in sea urchin eggs. Science (Washington) 165: 901–3.

Matolin, S. 1969. The effect of chemosterilants on the embryonic development of *Musca domestica* L. Acta Entomol. Bohemoslov. 66: 65–69.

Mirkes, P. E. 1970. Protein synthesis before and after fertilization in the eggs of *Hyanassa obsoleta*. Exp. Cell. Res. 60: 115–8.

Painter, R. R., and W. W. Kilgore. 1967. The effect of apholate and thiotepa on nucleic acid synthesis and nucleotide ratios in housefly eggs. J. Insect Physiol. 13: 1105–8.

Tissières, A., J. D. Watson, D. Schlessinger, and B. R. Hollingsworth. 1959. Ribonucleoproteins from *Escherichia coli*. J. Mol. Biol. 1: 221–33.

Residues of Dichlorvos, Diazinon, and Dimetilan in Milk of Cows Fed PVC-Insecticide Feed Additives[1,2]

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ABSTRACT

Insecticides in polyvinyl chloride pellets were included in a commercial dairy protein supplement and fed to dairy cows at 1.4, 2.0, and 2.5 mg of diazinon/kg; 1.3, 1.8, and 2.6 mg of dichlorvos/kg; and 1.3, 2.2, and 2.6 mg of dimetilan/kg body weight for 2 weeks. No insecticidal residues were found in milk samples collected at 1, 3, 7, 10, or 14 days. A 2.5 mg/kg dosage would provide a 5 × margin of safety for PVC-dichlorvos or PVC-diazinon fed to cattle to control face fly, *Musca autumnalis* De Geer, larvae in manure.

Recent research on the use of feed additives for control of fly larvae in manure of cattle has emphasized the use of compounds and methods that result in minimal milk and meat residues (Lloyd and Matthysse 1970). Compounds that have received most attention are botanicals, *Bacillus thuringiensis* Berliner, inorganics, and organophosphates resistant to absorption from the alimentary canal. Our method (Lloyd and Matthysse 1966) which incorporates insecticides into polyvinyl chloride (PVC) showed promise against the face fly, *Musca autumnalis* De Geer. PVC-insecticide pellets, when fed to cattle, were extremely effective against face fly larvae at dosages that were totally ineffective when the insecticide was unprotected (Lloyd and Matthysse 1970). Though most of the insecticides presented little hazard of residue in milk, it was not known whether the increased stability imparted by polymer formulation would increase the hazard. The objective of this study was to determine whether residues appeared in the milk of dairy cows fed PVC formulations daily of 3 insecticides, diazinon, dichlorvos, and dimetilan, at a proposed dosage of 2.5 mg insecticide/kg.

MATERIALS AND METHODS.—Cylindrical PVC pellets ⅛ in. diam and ⅛ in. long, containing 25% diazinon, dichlorvos, or dimetilan were prepared as described earlier (Lloyd and Matthysse 1970). The pellets were added to a protein supplement that contained 18% ground oats, 20% ground corn, 20% corn distillers dried grains, 15% bran, 15% linseed oil meal, 10% cane molasses, 1% iodized salt, 1% dical

[1] Supported by a grant from Agway Corporation, Ithaca, N.Y. Received for publication Aug. 10, 1970.
[2] Geigy Research Laboratories, Ardsley, N.Y., analyzed the samples for dimetilan; Shell Development Company, Modesto, Calif., analyzed the samples for dichlorvos; Dr. D. L. Fink and Mr. W. H. Gutenmann analyzed the samples for diazinon at the Cornell University Pesticide Residue Laboratory.
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cium phosphate, and 0.1% cobalt salt. The pellets were first mixed with a small amount of feed in a laboratory "V" blender, then each treated feed was mixed in a ribbon blender. The 10% molasses was poured in while the feed was stirred in the blender.

Nine mature Jersey cows were used, and their average weight was 888 lb. The cows were milked and fed protein supplement twice daily.

Protein supplement which contained each different PVC feed additive larvicide was fed daily at the evening milking to 3 cows. Consumption of the protein supplement averaged 5.8 lb/½ day and ranged from 4.5 to 9.0 lb/cow and resulted in daily dosages of 1.4, 2.0, and 2.5 mg diazinon; 1.3, 1.8, and 2.6 mg dichlorvos; and 1.3, 2.2, and 2.6 mg dimetilan/kg body wt per day.

Milk samples were collected from the treated cows and 2 untreated cows on 3 pretreatment days, then 1, 3, 7, 10, and 14 days after the 1st feeding of treated protein supplement. Electric milking machines were used, and samples were removed from the machines into 1-qt polyethylene bottles after the machines were removed from the cows. The samples were frozen immediately and stored until residue analyses could be performed.

Recoveries of diazinon at the 0.1-ppm level were 50, 42, 41, and 41%. The method was sensitive to 0.05 ppm of diazinon in milk. Analysis was with a *Barber-Colman Model 10 gas chromatograph with a* battery-operated no. A-4071, 6-cc detector containing 50 μCi of radium 226. The detector was operated at 6 v. A 90,000 megohm resistor added to the electrometer gave an additional gain of 3000. A 0–50 mv Wheelco recorder running at 10 in./hr was used. The U-shaped borosilicate glass column, 5 mm od and 6 ft *long,* was *packed with 5% FFAP (Wilkins Instrument* and Research). The column, flash heater, and detector were 200, 265, and 235°C, respectively. Nitrogen at 60 cc/min was the carrier gas. The column was conditioned for 16 hr at 230°C before use. The milk sample was extracted into acetone then into benzene. After drying with 2% sodium sulfate, the benzene was injected into the FFAP column.

The enzyme inhibition-spectrophometric method (Anonymous 1964) was used for dichlorvos analysis. Recoveries of dichlorvos added to untreated milk at 0.1 ppm were 95, 95, and 100%. The limit of sensitivity was 0.01 ppm.

The analytical procedure for dimetilan consisted of determining dimethylamine and 3-methyl-5-pyrazolone. Milk used for dimethylamine determination was extracted with 10% 3A ethanol in chloroform. Fat was removed from the extract by acetonitrile-hexane partitioning. The acetonitrile solution was evaporated to dryness and the residue was subjected to column chromatography to remove other interfering materials. This column consisted of activated alumina (Woelm, basic) of Activity Grade V. Two eluants were used, first 10% ethyl ether in *n*-hexane, then 50% ethyl ether in *n*-hexane. The fraction from the 1st eluant was discarded, the second removed the dimetilan from the column. Final determination was by the method of Margot and Stammbach (1964).

The colorimetric analysis method of Zuhairi and Casida (1965) was used to determine 3-methyl-5-pyrazolone. The compound 3-methyl-5-pyrazolone forms a red dye when reacted with 4-aminoantipyrine and subsequently oxidized. This reaction was performed directly in the milk with no extraction. The red dye was then extracted into chloroform and measured spectrophometrically.

Recoveries of dimetilan added to milk were 62, 75, and 60% at 0.05 ppm; 82, 86, and 94% at 0.11 ppm; and 98, 119, and 115% at 0.22 ppm. Recoveries of 3-methyl-5-pyrazolone added to milk were 117 and 92% at 0.12 ppm; 117 and 100% at 0.24 ppm; and 96 and 92% at 0.48 ppm. The limits of sensitivity were 0.05 for dimetilan and 0.10 ppm for 3-methyl-5-pyrazolone. Recoveries of dimetilan from milk treated at 0.22 ppm and stored for 2 months were 86, 96, 82, and 82%.

RESULTS AND DISCUSSION.—Treated feed given to Jersey cows for determination of residues in milk was consumed readily with no apparent effect on production by all but 1 cow. This cow consumed dichlorvos-PVC-treated feed for 8 days then stopped eating entirely, and production decreased. By day 13 of the experiment, this cow was again eating treated and untreated food, and milk production was increasing.

There was evidence that the molasses added to the treated feed was not evenly distributed. Numerous balls of molasses, ca. ¼ in. diam and smaller, were observed in the finished feed.

No detectable residues of diazinon, dichlorvos, dimetilan, or 3-methyl-5-pyrazolone were found in any of the milk samples from the treated cows. Dorschyhire and Murphy (1962) reported no diazinon residues *in milk from cows fed 10 mg/kg for 7 days.* However, Robbins et al. (1957) found traces of radioactivity in a cow's milk 6 through 24 hr after a single oral dose of ^{32}P-labeled diazinon at 20 mg/kg. From 0.09 to 0.56 μg/ml of milk behaved like unchanged diazinon. Tracey et al. (1960) showed that orally administered dichlorvos is not likely to produce res*idues in milk of cows at 9 mg/kg.*

Diazinon-PVC and dichlorvos-PVC were both highly effective larvicides when fed at 0.5 mg insecticide/kg per day (Lloyd and Matthysse 1970). Therefore determining hazard of residue in milk at 2.5 mg/kg per day provided a 5 × margin of safety.

REFERENCES CITED

Anonymous. 1964. Determination of "Vapona"® insecticide in crops and animal products, enzyme inhibition-spectrophometric method. Shell Development Co. Modesto Method Series, Analytical Method MMS 30/64, 5 p.

Derbyshire, J. C., and R. T. Murphy. 1962. Diazinon residues in treated silage and milk of cows fed powdered diazinon. J. Agr. Food Chem. 10(5): 384–6.

Lloyd, J. E., and J. G. Matthysse. 1966. Polymer-insecticide systems for use as livestock feed additives. J. Econ. Entomol. 59: 363–367.

1970. Polyvinyl chloride insecticide pellets fed to cattle to control face fly larvae in manure. Bull. 63: 1271–81.

Margot, A., and K. Stammbach. 1964. Dimetilan. p 183–5. *In* G. Zweig [ed.] Analytical Methods for Pesticide Plant Growth Regulators and Food Additives. Vol. II, Insecticides. Academic Press, New York.

Robbins, W. E., T. L. Hopkins, and G. W. Eddy. 1957. Metabolism and excretion of phosphorus-32 labeled diazinon in a cow. J. Agr. Food Chem. 5(7): 500–1.

Tracey, R. L., J. G. Woodcock, and P. Chadhoff. 1960. Toxicological aspects of 2,2-dichlorovinyl dimethyl phosphate (DDVP) in cows, horses and white rats. J. Econ. Entomol. 53: 593–601.

Zuhairi, M. Y., and J. E. Casida. 1965. Detoxication of dimetilan in cockroaches and house flies. Biol. 58: 403–9.

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J. Dairy Sci. 49, 1488-(1966)

Milk Contamination From Low Levels of DDT In Dairy Rations

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Abstract

Five groups of lactating cows were fed rations containing low levels of DDT for 26 wk. Mean DDT concentrations of the rations were 0.09, 0.24, 0.39, 0.73, and 0.28 ppm. The first group served as control; solutions of crystalline DDT were added to the grain ration of the next three groups; and the 5th group received DDT from field-contaminated alfalfa hay. Maximum milk fat DDT concentrations determined by gas chromatography were 0.38, 0.45, 0.53, 0.92, and 0.53 for the groups of four, three, four, three, and four cows per group, respectively.

An equilibrium point in milk fat DDT concentration was observed. Maximum values were reached at 18 to 21 wk, but fell slightly thereafter, although intake continued through 26 wk.

The milk fat DDT concentration of cows fed field-contaminated forage did not differ significantly from that of cows receiving similar levels of supplemental DDT in their concentrate ration. It is concluded that lactating cows, continuously provided feed with a DDT concentration under 1.0 ppm, will produce milk fat of a DDT concentration similar to that in their feed. The continual feeding of field-contaminated alfalfa hay containing 0.5 ppm DDT will result in a milk fat concentration slightly above 0.5 ppm but well below 1.0 ppm.

Much of the feed and forage available today for dairy production contains very low but detectable amounts of DDT [1,1,1-trichloro-2,2-bis(4'-chlorophenyl)ethane] and related chlorinated hydrocarbon insecticides. Cows that receive DDT in their feed store part of it in their body fat and excrete small amounts in their milk (1, 3, 5). The greatest portion of the intake probably is passed from the cow's body in the feces; excretion in milk and urine accounts for only about 5% of the apparent total intake.

Gannon et al. (4) and Zweig et al. (10) reported analytical data on the transfer of dietary DDT to milk of cows fed in the low parts per million ranges. Although milk residues were present, the analytical methods then available did not permit accurate measurements at the lower levels. Williams et al. (9) recently examined the transfer of very low dietary levels of DDT into milk, their maximum feeding level being roughly 0.30 ppm.

In a number of instances, milk contaminated levels in California dairy herds have exceeded 1.25 ppm of DDT in the milk fat, and alfalfa hay has contained close to the presently accepted limit of 0.5 ppm (7). No published data show accurately the effects of feeding DDT this practical range on the milk fat DDT concentrations. The present experiment was undertaken to determine the pattern of DDT storage in the milk fat of cows receiving such a continual, low-level intake of the commercial insecticide in their feed during lactation.

Materials and Methods

Analysis. Blood, milk, and body fat samples were analyzed by the electron-capture gas-chromatographic procedure described by Crosby and Archer (2). The separate responses of the chlorinated hydrocarbon constituents were not totaled; the term DDT applied here to the analytical results should be interpreted as total DDT isomers, DDE [1,1-dichloro-2,2-bis(chlorophenyl)ethylene] isomers, and TDE [1,1-dichloro-2,2-bis(4'-chlorophenyl)ethane] isomers.

Animals and feed. Whole blood analyses for DDT, developed during a previous experiment (2, 6), provided a method for detection of contaminated animals under conditions where biopsy would be difficult or impossible. Blood samples were drawn from a group of mature, potentially high-producing Holstein cows available from a commercial dairy replacement source. Eighteen animals with whole blood DDT levels of 0.002 ppm or less were purchased for this experiment. They were delivered to the Station, where they received alfalfa hay and grain averaging less than 0.05 ppm of DDT. They were then distributed into five groups (Table 1) purposely balanced as closely as possible for body size, stage of lactation, and early milk yield. Calving dates ranged from August 8 to September 28, 1964. The trial commenced on September 28 and continued 26 wk, after which all groups were placed

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TABLE 1
Experimental groups and treatments applied over 29 wk of lactation

Group	Treatment	No. of cows	Age	Group means at start of experiment: Body weight	Daily milk yield	Day of lactation
			Months	(kg)		
1	Control	4	27	1,158	18.5	28
2	DDT added	3	28	1,095	16.6	23
3	DDT added	4	26	1,081	19.8	44
4	DDT added	3	27	1,023	18.7	31
5	Contaminated hay	4	27	1,071	18.5	34

the control ration. The heifer that calved last was placed in the control group.

Alfalfa hay from areas likely to be low in DDT contaminants was sampled, and a lot of 88 tons was purchased for the experiment. This lot was sampled five times between May and August, 1964, and DDT values ranged from 0.016 to 0.035 ppm (average 0.024 ppm). Monthly composite core samples of the bales fed as the experiment progressed showed a steady increase to 0.206 ppm over a five-month period during the experiment, then fell to 0.116 ppm during the last month; apparently, the center of the lot contained hay more heavily contaminated than the surface. Composite values for all bales at approximately monthly intervals were 0.021, 0.022, 0.063, 0.124, 0.206, 0.197, and 0.116 ppm. Estimated total DDT intakes were obtained from the levels in the hay actually fed.

Pesticide treatments. The grain to be fed was delivered to a storage tank at the milking barn in five- to eight-ton lots as needed. Each lot was thoroughly sampled with a grain-sampling tube and the DDT content included in the estimated DDT intake. Grain values ranged from 0.005 to 0.085 ppm and averaged 0.034 ppm for the 11 lots delivered during the experiment. Technical-grade DDT (77% p,p'-isomer) dissolved in acetone was given to the cows in Groups 2, 3, and 4 by thoroughly mixing the solution with their individual morning grain ration. Daily dosage levels were 3.3 to 3.4 mg for Group 2, 6.0 to 6.8 mg for Group 3, and 12.5 to 14.5 mg for Group 4. The means and ranges of the total DDT intakes are shown in Table 2 and Figure 1. Actual individual grain allowance and estimated hay intake, based on the total amount of hay fed the group and proportioned to individuals by body weight, provided an estimate of individual feed intakes. Groups 1, 2, 3, and 4 were kept in the same

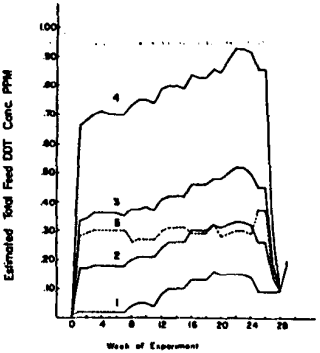


FIG. 1. Estimated DDT intake expressed as parts per million of the total feed. 1 in the control group of four cows. Groups 2, 3, and 4 had supplemental DDT added in their grain ration; cow numbers were 3, 4, and 3, respectively. Group 5 consists of four cows fed field-contaminated alfalfa hay.

TABLE 2
Estimated concentrations and amounts of DDT in total feed intake of experimental groups

Group	No. of cows	Est. total feed levels of DDT during expt. (ppm) Mean	Range	Est. daily intake of DDT (mg) Mean	Range	Est. daily intake in γ/kg body weight Mean	Range
1	4	0.09	0.02 to 0.16	1.8	0.3 to 3.5	3.3	0.7 to 6.4
2	3	0.24	0.17 to 0.35	5.1	3.7 to 6.7	9.5	6.8 to 12.5
3	4	0.39	0.33 to 0.52	8.4	7.0 to 10.0	16.4	13.8 to 19.1
4	3	0.73	0.66 to 0.93	15.2	13.9 to 16.7	31.3	29.0 to 34.2
5	4	0.28	0.26 to 0.37	5.6	4.9 to 6.3	10.9	9.1 to 12.6

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corral and fed the same hay; Group 5 was fed grain from the common supply, but was kept separate and fed from a lot of field-contaminated hay purchased for the experiment. Composite samples of bales fed this group had values of 0.500, 0.443, 0.488, 0.478, 0.423, and 0.544 as the experiment progressed. Their estimated total feed concentration was very close to 0.280 ppm throughout the experiment (Table 2 and Figure 1). One of the early feed samplings was made by the Yolo County Agricultural Commissioner and portions of three later samplings analyzed by the Division of Chemistry of the California Department of Agriculture. Results agreed closely with those of the Station.

Milk samples were composited at each milking and the composites analyzed weekly for DDT and milk fat (Babcock test). Blood samples were drawn every 2 wk and analysis is still pending. Body fat samples were taken before the start of the experiment and again at irregular intervals (Table 3). The method of sampling was described previously (6).

Results and Discussion

The selection of animals on the basis of very low whole blood concentrations of DDT proved successful, in that all of the animals started lactation with very low milk fat concentrations of the insecticide. Values for the first wk of lactation of the individual cows ranged from 0.020 to 0.160 ppm and averaged 0.107 ppm. These values tended to drop, as indicated in Figure 2; for the 2 wk immediately prior to the start of the experiment, DDT ranged from 0.029 to 0.145 ppm (average 0.070 ppm) in the milk fat. The correlation between the prepartum whole blood levels and mean milk fat concentrations for the first 2 wk of lactation was −0.5[illegible]. Eleven cows with whole blood levels < 0.001[illegible] ppm had milk fat concentrations averaging 0.109 ppm and seven cows with whole blood levels between 0.0015 and 0.0020 ppm had milk concentrations averaging 0.106 ppm for their first 2 wk. Thus, while the whole blood analyses may detect heavily contaminated cows, there appears to be a low correlation between the two measures where the contamination is slight. Blood samples taken throughout this experiment are under investigation and results will be reported later.

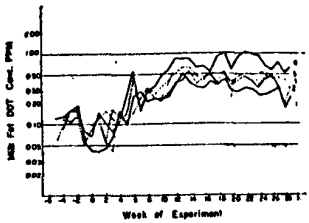


FIG. 2. Mean concentration of DDT in the milk fat of cows of the groups, as designated in Figure 1.

The relationship between body fat and milk fat concentrations of DDT observed in this experiment is revealed in Table 3 and Figure 3. The circular cluster of points between values of 0.15 ppm for body fat and 0.16 ppm for milk fat represents the data of all groups from the samples taken the week before the experiment

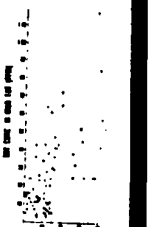


FIG. 3. Distribution in relation to

started and at the only a single poi fat 0.24 ppm) f this limit. In the 8, 12, and 18), 0.11 ppm. milk group. At body there were no mil ppm. There was values as body fa 1.40 ppm. The may be obtained The 95% confide predicted from a range between zero would appear that concentrations in milk fat at these l but extremely vari

As shown above appeared to incre end of the experim 0.016 ppm as pu over a period of 0.206 ppm, then accumulation of the weeks an identical cent, total control ppm, increased to closed to 0.020 pp the ready collecti from the surface would give values existing in the tech repeated volatiliza the stock of bala proportion of the relatively cooler Cottonmen may h take in many pa

TABLE 3

Average body fat and milk fat concentrations of DDT, their correlations and regressions

Group	No. of cows	Week of experiment: 0 Body fat	0 Milk fat	4 Body fat	4 Milk fat	8 Body fat	8 Milk fat	12 Body fat	12 Milk fat	18 Body fat	18 Milk fat
		(ppm)									
1	4	0.11[a]	0.04[a]	0.02	0.15	0.11	0.21	0.15	0.35	0.30[a,b]	0.28
2	3	0.11	0.08	0.01	0.13	0.16	0.33	0.13	0.38	0.38[c]	0.42[c]
3	4	0.10	0.10	0.04	0.14	0.10	0.26	0.15	0.59	0.71	0.50
4	3	0.10	0.07	0.13	0.10	0.10	0.31	0.37	0.85	1.25	0.91
5	4	0.10	0.09	0.05	0.10	0.52	0.26	0.29	0.53	0.83	0.36

Weeks	Pairs of observations	Correlation	Regression of milk fat on body fat
0 and 4	35	−0.52	−0.53 ± 0.15
0, 4, 8, 12, and 18	86	0.02	0.49 ± 0.07
8, 12, and 18	53	0.46	0.31 ± 0.08

[a] One sample missing.
[b] Two samples taken week 22.
[c] One sample taken week 22.

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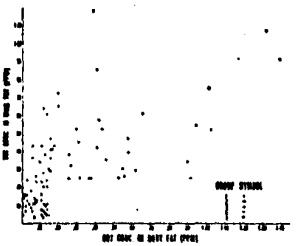


FIG. 3. Distribution of milk fat DDT concentration in relation to body fat DDT concentration.

started and at the 4th wk. Of the 35 analyses, only a single point (body fat 0.03 ppm, milk fat 0.24 ppm) for a control cow fell outside this limit. In the next three samplings (weeks 8, 12, and 18), only a single point (body fat 0.11 ppm, milk fat 0.16 ppm) fell into this group. At body fat values of over 0.15 ppm, there were no milk fat values of less than 0.25 ppm. There was a wide scattering of milk fat values as body fat values ranged from 0.15 to 1.40 ppm. The equation $Y = 0.17 + 0.50\ X$ may be obtained from the 88 points of Figure 3. The 95% confidence limits for milk fat values predicted from a body fat value of 0.25 ppm range between zero and 0.57 ppm. Therefore, it would appear that the association between DDT concentrations in body fat, as sampled here, and milk fat at these low levels of intake is positive but extremely variable.

As shown above, the level of DDT in hay appeared to increase steadily until almost the end of the experiment. The 88-ton lot contained 0.016 ppm as purchased; this value increased over a period of five months to a maximum of 8.206 ppm, then declined to 0.116 ppm. Examination of the data of Williams et al (9) reveals an identical circumstance. In their experiment, total control feed content started at 0.011 ppm, increased to 0.066 ppm at 8 wk, then declined to 0.026 ppm. The effect may be due to the ready codistillation of DDT with water from the surface of a stack of bales, which would give values lower than those originally existing in the field. It also could be due to a repeated volatilization and condensation within the stack of bales, resulting in an increasing proportion of the total DDT concentrated at the relatively cooler center. Unfortunately, this phenomenon may have obscured the actual DDT intake in many previous investigations; for example, although the low-level feeding by Williams et al. (9) was placed at a value of 0.052 ppm, the control intake at 8 wk was 0.066 ppm. Simple dehydration of the stored hay also may account for fluctuation of pesticide levels in the bales. In our experience, newly cured hay may contain as much as 18 to 20% moisture, whereas hay stored in stacked bales in warm climates could contain as little as 8 to 12% moisture.

While the amount of ingested DDT increased due to progressively increased concentrations in the hay of Groups 1 through 4, the intake per kilogram of body weight remained more stable, due to increasing body weight as lactation progressed (Table 2). Intakes of Groups 2, 3, and 5 were very similar (Table 2) and their milk fat outputs (Figures 2, 5, 6, 8) not greatly different from the standpoint of statistical significance. From the standpoint of mean intake,

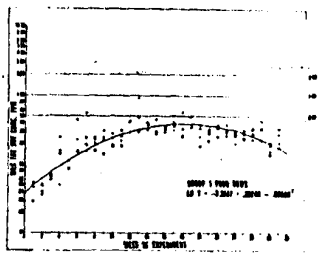


FIG. 4. Milk fat DDT values of individual cows of the control group. Mean DDT concentration of feed 0.09 ppm.

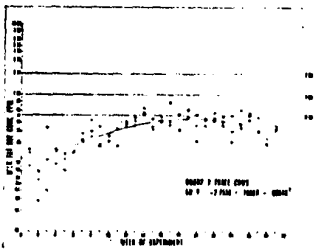


FIG. 5. Milk fat DDT values of individual cows receiving supplemental DDT. Mean feed concentration 0.24 ppm.

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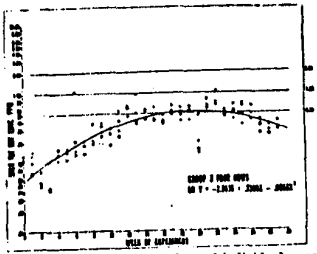


FIG. 6. Milk fat DDT values of individual cows receiving supplemental DDT. Mean feed concentration 0.39 ppm.

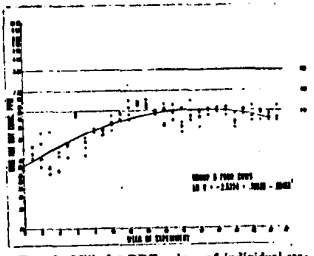


FIG. 8. Milk fat DDT values of individual cows receiving alfalfa hay with a field-contamination level of approximately 0.5 ppm of DDT.

Group 2 (the lowest supplement group) and Group 5, which received field-contaminated hay, are very similar (mean feed concentrations 0.24 and 0.28 ppm, mean milligrams DDT/cow/day 5.1 and 5.6, and mean γ/kg of body weight 9.5 and 10.9, respectively; Table 2). The mean intake of Group 3 was 0.39 ppm (8.4 mg/day, and 10.4 γ/kg of body weight), distinctly above the intakes of Groups 2 and 5. Results of the milk analyses are presented in Table 4 and Figures 2 (the group mean concentrations of DDT in milk fat) and 4 through 8 (individual values observed for each cow). It was impossible, in the early weeks, to distinguish between the control group mean and the means of groups receiving additional DDT in their feed. Milk fat DDT of Group 4 which received 13 mg DDT/cow/day was greater than that of the others in the 5th and 6th wk, but not until the 8th wk of supplemental DDT intake did it remain clearly and distinctly above the groups receiving supplemental DDT intakes of 3 to 7 mg/cow/day. The milk fat DDT concentration of the control group increased with the increasing background DDT in the control hay, and only after the 8th wk did it remain distinctly below that of Groups 3 and 5. Treatment continued beyond the 13th wk before the control and Group 2 became clearly separated in their milk fat concentrations of DDT. Analyses of variance indicate that the mean milk fat DDT concentration of Group 1 is significantly ($P < .05$) below that of Group 2; Group 4 is significantly ($P < .01$) higher than any of the other groups, and differences between Groups 2, 3, and 5 fail to reach the 0.05 level of significance. It is noted that whereas the

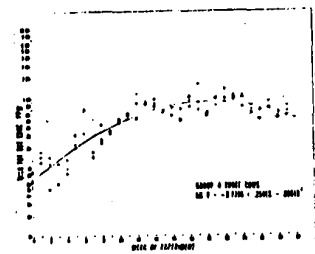


FIG. 7. Milk fat DDT values of individual cows receiving supplemental DDT. Mean feed concentration 0.75 ppm.

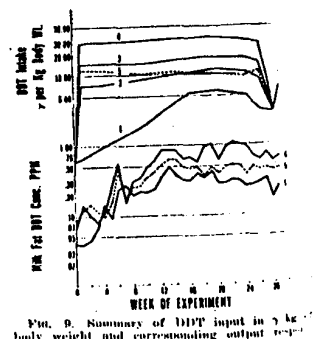


FIG. 9. Summary of DDT input in γ kg body weight and corresponding output ... of three of the groups.

Mean and maximu

Group	No. of cows
1	4
2	3
3	4
4	3
5	4

DDT intake of Grou
Group 2, the mean
Group 5 was closer
of Group 2 (Table
though the commonly
tical significance was
of the values does sugg
tainment of the rough
effective in raising
the supplementary D
ration (3).

Maximum milk fat
take level, as calculat
Figures 4–8, are 0.4
0.53 ppm for Group
single week maximum
0.56 ppm for Group
and 0.64 ppm for Gr
contaminated hay; t
equation probably p
tory description of
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individual cows appe
ppm in the milk fat, b
3 fell in this range (1

The response of Gro
double the DDT dosa
in Figures 2, 4, and
was close to 1.0 ppm.
cows exceeded this le
and the group mean
(Figure 2).

The relation betwee
DDT concentration w

Total DDT intake

Group	
1	
2	
3	
4	
5	

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TABLE 4
Mean and maximum values of milk fat DDT concentrations and times of reaching maximum values

Group	No. of cows	26-wk Mean ppm	26-wk S.D. ppm	Equation maximum ppm	Equation maximum Week	Observed maximum (Figure 2) ppm	Observed maximum (Figure 2) Week
1	4	0.205	0.138	0.384	18	0.490	13
2	3	0.330	0.103	0.451	20	0.564	14
3	4	0.502	0.237	0.526	20	0.673	22
4	3	0.590	0.340	0.921	21	1.071	22
5	4	0.377	0.174	0.528	20	0.644	13

DDT intake of Group 5 was close to that of Group 2, the mean milk fat concentration of Group 5 was closer to that of Group 3 than of Group 2 (Table 4, Figures 5 ,6, 8). Although the commonly accepted level of statistical significance was not reached, the order of the values does suggest that DDT fed as a contaminant of the roughage appears slightly more effective in raising milk fat DDT levels than the supplementary DDT mixed with the grain ration (3).

Maximum milk fat concentrations at each intake level, as calculated from the equations of Figures 4–8, are 0.45 ppm for Group 2 and 0.53 ppm for Groups 3 and 5. The observed single week maximum values (Figure 2) are 0.56 ppm for Group 2, 0.87 ppm for Group 3, and 0.64 ppm for Group 5, which received the contaminated hay; the smoothed line of the equation probably provides the most satisfactory description of the observations. There were no instances in Groups 2 or 5 where the weekly composite samples (14 milkings) of individual cows approached or exceeded 1.0 ppm in the milk fat, but four samples of Group 3 fell in this range (Figures 5, 6, 8).

The response of Group 4, which received about double the DDT dosage of Group 3, is shown in Figures 2, 4, and 9. Milk fat concentration was close to 1.0 ppm; samples from individual cows exceeded this level nine times (Figure 7), and the group mean exceeded 1.0 ppm twice (Figure 2).

The relation between milk yield and milk fat DDT concentration was systematically investigated and no definite trends of association were found in these data. Milk fat yield from daily milk weights and the Babcock tests of the weekly composite samples averaged 253 lb for the 203-day lactation period, including 1 wk before and 2 wk after the DDT feeding period. The five group means ranged from 232 to 296 lb, and individual cows ranged from 164 to 352 lb of milk fat in the 203 days. In Groups 1 and 5, the highest producer tended to have a higher milk fat DDT concentration than the lowest. The opposite was true of Groups 2 and 3; the lowest producer tended to have milk fat concentrations above the highest producer. There was no difference in the milk fat DDT concentration between the lowest producer, 164 lb, and the highest, 282 lb, in Group 4.

Feed and milk fat concentrations show a very close association. As previously observed (6), there is a greater relative amount of the feed DDT accounted for in the milk fat at low than at higher feed concentrations. The mean weekly ratios of milligrams DDT in feed to milligrams DDT in milk are shown in Table 5; they range from 13.0 for the control group to 1.8 for Group 4, which received the greatest amount of DDT. Although not statistically significant, it is notable that this ratio for Group 5 is slightly above that of Group 2, which had a lower estimated intake.

The most significant finding of this experiment is the evidence of an equilibrium point in the milk fat levels of DDT. Although this phenomenon was observed with other pesticides by Williams et al. (9), they obtained DDT

TABLE 5
Total DDT intake in the feed, output in the milk, and mean weekly ratios of milligrams in feed to milligrams in milk

Group	No. of cows	Estimated total DDT intake/cow (MG)	Estimated total DDT output/cow in milk (MG)	Mean weekly ratio of milligrams in feed to milligrams in milk
1	4	320	30.8	13.0
2	3	912	30.4	3.3
3	4	1,503	36.8	2.4
4	3	2,724	52.2	1.8
5	4	1,009	34.9	3.5

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values too low to provide a significant measure. Examination of their data, however, suggests that the total of DDT and related compounds had not approached a maximum after the 5 wk of their experiment. The very low DDT levels encountered by these investigators may reflect the fact that DDT was fed as a mixture with four other insecticides; it is known that the presence of one insecticide may drastically alter the body retention of another (8).

In our experiment, the times at which the equilibrium point was attained were calculated from the maxima of the equations shown in Figures 4 through 8 (Table 4). At higher intake levels, equilibrium is attained more slowly; the equation for the control group peaked at 18.3 wk; Groups 2 and 3 peaked at 19.6 wk, and Group 4 at 20.8 wk. Group 5 was very close to Group 3 in this characteristic. It is important to note that this equilibrium point, whether determined by a smoothing equation or by inspection of group means, occurred while feed concentration was still rising. Concentration of DDT in the feed reached its maximum about the 24th wk; milk fat concentration, however, had leveled off or actually started to decline slightly well before this time.

The cyclic nature of DDT concentration in milk fat is shown in the present as well as in the previous experiment (6), although sampling errors were greatly reduced by the composite technique. These unexplained but sometimes violent variations from the ideal curve would be of utmost significance in any attempt to determine long-term levels of contamination by analysis of a single sample.

Acknowledgment

The authors gratefully acknowledge the technical assistance of Eugene Whitehead and James Stokes of the Agricultural Toxicology and Residue Research Laboratory, John Kincheloe and Charles Stiers of the Department of Animal Husbandry, and the Department of Food Science and Technology for conducting the Babcock tests for milk fat.

References

(1) Allen, N. N., Lardy, A. A., and Wilson, H. F. 1946. The Effect of Ingestion of DDT upon Dairy Cows. J. Dairy Sci., 29: 530.

(2) Crosby, D. G., and Archer, T. E. 1966. A Rapid Analytical Method for Persistent Pesticides in Proteinaceous Samples. Bull. Environ. Contam. and Toxicol., 1: 16.

(3) Ely, R. E., Moore, L. A., Carter, R. H., Mann, H. D., and Poos, F. W. 1952. The Effect of Dosage Level and Various Methods of Administration on the Concentration of DDT in Milk. J. Dairy Sci., 35: 266.

(4) Gunnon, N., Link, R. P., and Decker, G. C. 1959. Insecticide Residues in the Milk of Dairy Cows Fed Insecticides in Their Ration. J. Agr. Food Chem., 7: 829.

(5) Gyrisco, G. G., Norton, L. B., Trimberger, G. W., Holland, R. W., McEnerney, P. J. and Muka, A. A. 1959. Effects of Feeding Low Levels of Insecticide Residues on Hay to Dairy Cattle on Flavor and Residues in Milk. J. Agr. Food Chem., 7: 707.

(6) Laben, R. C., Archer, T. E., Crosby, D. G. and Peoples, S. A. 1965. Lactational Output of DDT Fed Preparatum to Dairy Cattle. J. Dairy Sci., 48: 701.

(7) Rollins, R. Z. 1965. Division of Chemistry, California Department of Agriculture. Private communication.

(8) Street, J. C. 1964. DDT Antagonism to Dieldrin Storage in Adipose Tissue of Rats. Science, 146: 1580.

(9) Williams, S., Mills, P. A. and McDowell, L. E. 1964. Residues in Milk of Cows Fed Rations Containing Low Concentrations of Five Chlorinated Hydrocarbon Pesticides. J. Assoc. Offic. Agr. Chemists, 47: 1124.

(10) Zweig, G., Smith, L. M., Peoples, S. A., Cox, R. 1961. DDT Residues in Milk from Dairy Cows Fed Low Levels of DDT in Their Daily Rations. J. Agr. Food Chem. 25: 219.

Secretion of Hep

b. . .

Abstra

Twelve cows, fed alf 0.08 or 0.29 ppm hep chlor epoxide for 3 their milk an average the intake, respectivel of the epoxide. A log-l a correlation coefficient between the amount its epoxide consumed tion of the epoxide in in early lactation secret their intake into the in late lactation. How lactation produced milk a slightly higher co epoxide than cows Jersey cows had a high the epoxide per kilogra Holsteins, but the Jer lower concentration tha fat.

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The amount of hepta... into the milk as the epox... several investigators ... up to about 25%, of the ... the epoxide to cows ...ationship between the ...ide in the diet and ... ...

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J. Dairy Sci. 49 (1966)

Contamination of Milk from Different Routes of Animal Exposure to DDT [1, 2]

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Abstract

The level of DDT [2,2-bis(p-chlorophenyl)-1,1,1-trichloroethane] and its metabolites was determined in milk of cows treated at the same dosage both for one day and for six consecutive days in the following manner: 1) intratracheal infusion of p,p'-DDT; 2) alimentary exposure of a corn oil solution of p,p'-DDT in a capsule; 3) an aged residue of technical-grade DDT on alfalfa hay which had been pelleted; and 4) an intravenous infusion of p,p'-DDT. It was found that respiratory exposure of cows to DDT produces a lower... rather than higher level of DDT and its metabolic products in the milk than alimentary exposures. Administration of DDT in the form of aged residues on alfalfa results in a higher residue level than when DDT is administered in solution in oil. Different routes of exposure to DDT result in different ratios of DDT, DDE (2,2-bis(p-chlorophenyl)-1,1-dichloroethylene), and DDD (2,2-bis(p-chlorophenyl)-1,1-dichloroethane) in the milk. The predominant product resulting from intratracheal and intravenous (I.V.) exposure, which bypass the rumen, is DDT, but some DDE and DDD are produced from the longer-term I.V. exposure. Alimentary exposure by means of DDT in oil solution produces predominantly DDT and DDD in the milk. Alimentary exposure of DDT as an aged residue produces DDT, DDE, and DDD.

Pesticides are frequently found as residues in milk from commercial herds at levels higher than would be predicted from those found in the feed (27). A correlation between actual and predicted amounts must be successful, to effectively establish permissible levels of pesticide in animal feed. This discrepancy between actual and predicted levels of pesticide in milk could occur because a) there was an unmonitored intake of pesticide prior to time of testing or b) the experimental data on which the predictions are based are inadequate for this purpose.

In relation to the possible inspiration of pesticide by cows, it has been shown that aerial applications of pesticides can result in drift for extremely long distances, in amounts sufficient to cause significant contamination of forage crops (26). It was hypothesized that such airborne drifting pesticides may provide an unmonitored respiratory exposure significantly reflected in the contamination level of the milk. Although such exposures would be brief and intermittent, they could be significant if such pulmonary exposure resulted in a more efficient absorption than a similar degree of alimentary exposure.

The propensity for DDT to be secreted in the milk of dairy cows as a result of consumption of DDT in the feed has been well established (1-4, 6-9, 13, 19, 22-25, 28). Only the work of Ely et al. (6) compared the effect of different routes of administration. A study of Claborn et al. (5) noted that treatment of the barn with DDT resulted in accumulation of DDT in the milk of cows using the barn, but this was not the result of inhalation of DDT.

No previous study measured the degree of response of a cow to a known respiratory dose of DDT, or compared this response to the effect of comparable exposures by other routes of administration. To measure the response efficiency of pulmonary exposure, the level of DDT and its metabolites was determined in the milk of cows treated at the same dosage by 1) intratracheal infusion of p,p'-DDT; 2) alimentary exposure of a corn oil solution of p,p'-DDT in a capsule; 3) an aged-residue of technical-grade

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[3] Present address: Department of Dairy Science, University of Arizona, Tucson.

Average valu

Treatment	
(One-day)	
Intratracheal	
Rumen-capsul	
Aged-residue	
Intravenous	
(Six-day)	
Intratracheal	
Rumen-capsul	
Intravenous	

DDT on alfalfa and 4) an int p,p'-DDT.

Experimental Pro

Holstein cows dairy herd were Table 1 describ milk were fed to Morrison's st and production. animals were k fed individually age and cover good-quality al was the normal sic barley-cotto mixture.

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The dose wa

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TABLE 1

Average values describing characteristics of the three experimental cows on each treatment

Treatment	Body wt	Lactation no.	Days in lactation	Daily milk production	Fat production	Daily feed intake	Dose of DDT per day	Amt of dose secreted in milk
	(kg)			(kg)	(%)	(kg)	(mg)	(%)
(One-day)								
Intratracheal	565	1.3	251	12.3	3.7	10.43	43.5	1.31
Rumen-capsule	577	2.0	210	12.3	3.4	14.28	56.1	3.53
Aged-residue	522	1.0	305	12.9	3.8	13.95	55.0	7.68
Intravenous	644	1.7	317	8.8	3.8	12.13	48.5	5.36
(Six-day)								
Intratracheal	538	1.3	112	19.7	2.9	13.07	52.3	3.31
Rumen-capsule	601	2.3	210	15.4	3.6	13.65	54.5	3.21
Intravenous	633	2.7	65	26.0	2.7	14.08	57.4	32.07

DDT on alfalfa hay which had been pelleted; and 4) an intravenous infusion (I.V.) on p,p'-DDT.

Experimental Procedure

Holstein cows from the University of Arizona dairy herd were used as experimental animals. Table 1 describes their characteristics. All animals were fed in a normal manner, according to Morrison's standards (18) for maintenance and production, and in a healthful state. The animals were kept in a single corral but were fed individually weighed portions of both roughage and concentrate. Roughage consisted of good-quality alfalfa hay and the concentrate was the normal herd-grain consisting of a basic barley–cottonseed meal–beet pulp–mineral mixture.

The hay was sampled in 18 sections prior to feeding to ascertain that the pesticide level was below 0.1 ppm of chlorinated hydrocarbon pesticides and that the bales were uniform in this regard. Every bale fed was cored and each week's samples composited for analysis. Values for the weekly analyses for total pesticide ranged from 0.0035 to 0.0416 ppm (average 0.0223) in roughage and 0.0203 to 0.0942 (average 0.0199) in the concentrate.

Four routes of administration (intratracheal, intravenous, rumen capsule, and aged residue in pelleted alfalfa) of DDT were studied. Three cows were assigned to each route in a manner to assure an even distribution according to production. Four to ten pretreatment samples of milk were taken, to establish a normal baseline for each cow. Baseline values for a single cow were continued throughout the experiment, to determine the validity of using only a few samples to determine the stability of the level of contamination with time.

The dose was administered only once to each cow during the first trial. During the second trial, the dose was administered once a day for six consecutive days. In all cases, the dose was based on the weight of feed consumed (which in turn was based on production) and calculated to be equivalent to 4.0 ppm of the feed.

The intratracheal infusion was carried out by a technique whereby a 13-gauge, 5.25-cm hypodermic needle was inserted into the trachea and a section of polyethylene tubing, previously loaded with a weighed amount of a 50% p,p'-DDT[1]/celite mixture, was inserted 15-25 cm into the trachea by way of the 13-gauge needle. A 100-ml syringe was then used to blow air through the tube and expel the DDT. The tube was later extracted and analyzed for DDT, to determine the net amount of DDT administered.

The intravenous infusion was accomplished by dissolving the appropriate amount of p,p'-DDT in a detergent (polyoxyethylene sorbital esters of mixed fatty acids, Atlox® 1045-A) and injecting this solution of DDT directly into the jugular vein. The injection was accomplished by inserting a 13-gauge needle into the jugular vein and feeding a section of polyethylene tubing through the needle. The tubing was connected to an aspiration-type syringe which pulled the solution of DDT from a test tube and rinsed it into the vein.

The rumen-capsule method of administration was conducted by placing an appropriate amount of a solution of p,p'-DDT in corn oil (about 5 ml of a commercial salad oil previously analyzed and shown to be free of DDT) in a gelatin capsule, and the cow induced to swallow the capsule.

The aged-residue-in-pelleted-alfalfa method

[1] 99.3% p,p'-DDT. We wish to express our appreciation to the Geigy Chemical Corporation for supplying the DDT for this study.

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was carried out with commercial alfalfa hay which, prior to harvesting, had been subjected to drift from an application of technical-grade DDT to an adjacent crop. This hay was harvested, baled, ground, and pelleted, with thorough mixing at both the grinding and pelleting stages, to ensure an even distribution of DDT in the pelleted ration. The pelleted feed contained 5.25 ppm of DDT. The pelleted feed was substituted for the normal hay ration in an amount which allowed the animals 4.0 ppm DDT for the entire diet.

During the month prior to the trials, milk samples were collected at one milking each day for six days per week (three morning and three evening milkings) and three contiguous samples were composited to form a single sample for analysis. Two to four days prior to the dosing and for 1 to 2 wk following (before, during, and after a period where the DDT content of the milk could be expected to change rapidly) the milk was sampled at both daily milkings and each sample analyzed individually. In all cases, milk yield was recorded and per cent fat in the milk determined (Babcock method).

Extraction and clean-up of the milk samples was accomplished by a slight modification of previously published methods (15, 17). Feed samples were ground in a Wiley mill with a 2-mm-mesh screen. After thorough mixing, a 25-g subsample was extracted in 250 ml of hexane for 15 min in a high-speed omnimixer. An aliquot of the extract equivalent to 5 g of feed was partitioned into acetonitrile from hexane, the acetonitrile driven off by evaporation, the sample taken up in pentane, then further purified on a florisil column, as with the milk samples.

The purified, or cleaned-up, samples of milk or feed were adjusted to an appropriate volume in hexane and analyzed by gas chromatography with an electron capture detector. A Microtek 2SS-102 and Aerograph 350-B with E. C. detectors were used. The column was 5% Dow 11 precipitated from ethylacetate on double (11.7 N HCl) washed 60/80-mesh chromasorb W. The columns were 3-mm by 100-cm pyrex glass. Carrier gas was nitrogen passed through a molecular sieve at a flow rate of 31 ml/minute. The operating temperatures were: injection port, 185 C; column, 175 C; detector, 195 C. The sample injected for detection represented 0.3 to 0.5 mg of initial milk fat, or 4 to 7 mg of initial feed.

The fact that the three compounds detected (DDT, DDD, DDE) were present in amounts different from each other by a factor of 10, and that the levels of DDT and DDD in the milk

TABLE 3

Average net accumulation and depletion of DDT and its metabolites in parts per million in milk fat

Treatment	Maximum response			From max. resp. to 5 days			From 5.5 to 10 days			From 10.5 to 15 days			From 15.5 to 20 days				
	DDT	DDE	DDD	DDT	DDE	DDD	DDT	DDE	DDD	DDT	DDE	DDD	DDT	DDE	DDD	DDT	DDE	DDD
(One-day)																		
Intratracheal	0.68	0.06	0.0	0.18	0.0	0.0	0.10	0.03	0.0	0.03	0.15	0.0	0.0	0.07	0.0	.....	.....	.....
Rumen-capsule	0.59	0.0	0.28	0.16	0.0	0.10	0.08	0.04	0.0	0.25	0.04	0.0	0.27	0.11	0.01	.....	.....	.....
Aged-residue	0.38	0.90	0.56	0.07	0.32	0.05	0.05	0.24	0.01	0.06	0.02	0.02	.....	.....	.....	.....	.....	.....
Intravenous	3.00	0.12	0.12	0.37	0.0	0.0	0.30	0.0	0.0	0.45	0.09	0.0	0.22	0.01	0.0	.....	.....	.....
	Maximum response			From max. resp. to 10 days			From 10.5 to 15 days			From 15.5 to 30 days			From 30.5 to 45 days			From 45.5 to 60 days		
(Six-day)																		
Intratracheal	1.54	0.01	0.08	0.49	0.0	0.02	0.26	0.0	0.02	0.24	0.02	0.0	0.07	0.0	0.0	0.07	0.01	0.0
Rumen-capsule	0.49	0.04	1.18	0.05	0.05	0.26	0.03	0.03	0.07	0.0	0.04	0.0	0.0	0.0	0.0	.....	.....	.....
Intravenous	7.00	0.25	0.69	3.90	0.15	0.17	2.27	0.09	0.06	1.52	0.05	0.04	1.15	0.13	0.0	0.95	0.08	0.0

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fat of control animals were near 0.05 ppm (0.002 ppm in whole milk), made the quantitative analysis difficult. Responses from the very low levels of these products in the control animals were near those obtained from reagent blanks, which also made accurate analysis difficult. The per cent recoveries of standards at these low levels were: DDT, 109%; DDD, 55.5%; and DDE, 77.5%. The tenfold difference in concentration of the products detected, and consequent difficulty in adjustment of detector amplification in order to remain on scale when the products are not widely separated on the column (retention time DDT, 8.5 min; DDD, 7.0 min; DDE, 5.25 min), contributed to the error, as expressed in the recovery values. Careful control of the operating conditions was required to prevent the breakdown of DDT to DDD and DDE in the injection block of the Microtek instrument. Although glass liners were used in the injection block of the Microtek (glass liners were not necessary in the Aerograph instrument), they were not sufficient to prevent this degradation. It was necessary to install a special on-column injection system (which precluded the use of the dual column system normally available in the instrument) to reduce the degradation of DDT to less than 10% of the amount injected. This difficulty also reduced the lower limit of sensitivity and increased the variance of the results.

Results and Discussion

Average responses of the cows as a result of the four types of one-day exposures and three types of six-day exposures are summarized in Table 3. The dose/response relationships for each of the seven exposures are shown in Figures 1 through 7. The figures represent average values obtained from the three cows used in each trial, except for the one-day rumen-pellet exposure, in which only two cows were averaged because one cow consumed only 12 lb of the DDT-treated pellets (equivalent to 2.4 ppm of DDT intake for a normal day's intake).

The basic diet of hay and grain contained an average of 0.033 ppm of DDT and its metabolic products. This level of unavoidable contamination produced a baseline level of pesticide in the milk which was low and quite uniform. The groups used in the one-dose experiments had average values of 0.07 ppm DDT, 0.50 ppm DDE, and 0.02 ppm DDD. The question of whether there are idiosyncratic cows which excrete much greater quantities of pesticide than similarly exposed cows was not settled by this study, but it was noted that two of the cows consistently responded to the treatments with a higher level of excretion of pesticide in the milk through several exposures. Corresponding values for the animals in the six-dose experiments were 0.21 ppm, 0.56 ppm, and 0.05 ppm, respectively. It is of interest to note that in no case does the amount of pesticide in the basic diet account for the amount found in any of the pretreatment milk. This apparent anomaly is based on the common assumption that the approximate 1:1 ratio of pesticide in milk fat and in feed can be correctly extrapolated to this low-level contamination.

All four dosing methods produced definite accumulations of DDT or its metabolites in the milk. It was not previously known whether there would be a measurable response from a single low-level dose (0.05 to 0.10 mg/kg). The intratracheal or respiratory exposures did not produce a uniquely high accumulation of DDT in the milk. Under conditions of this experiment pulmonary absorption of pesticide, or at least secretion of pesticide in the milk following pulmonary absorption, occurs at a lower rather than higher rate than either method of

TABLE 3

Average half-life values of the insecticide residue in milk fat

	Rapid decline			Slow decline		
Treatment	DDT at start of decline	Time to baseline	Half-life	DDT at start of decline	Time to baseline	Half-life
(One-day)	(ppm)	(days)	(days)	(ppm)	(days)	(days)
Intratracheal	0.8	7.0	2.1	....	....	....
Rumen-capsule	0.6	5.0	1.0	....	....	....
Rumen-pellets	1.83	4.3	2.2	....	....	....
Intravenous	0.6	....	0.5	0.5	....	18
(Six-day)						
Intratracheal	1.7	....	1.5	0.7	57	24
Rumen capsule	0.9	....	1.3	0.3	21	23
Intravenous (DDT)	7.8	....	4.3	3.0	....	23

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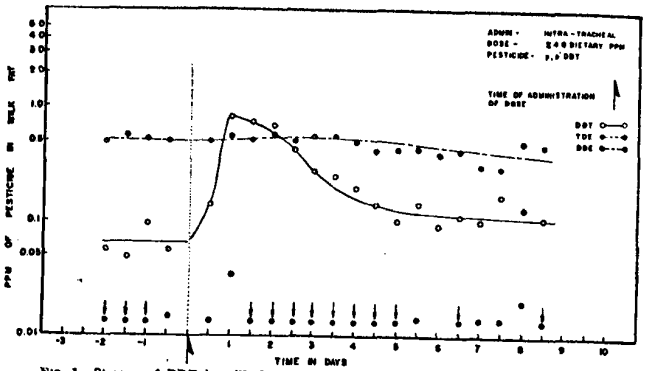


FIG. 1. Storage of DDT in milk fat in response to a single respiratory dose of DDT.

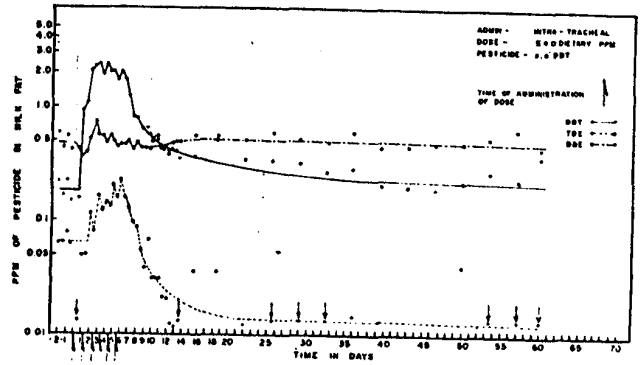


FIG. 2. Storage of DDT in milk fat in response to six daily respiratory doses of DDT.

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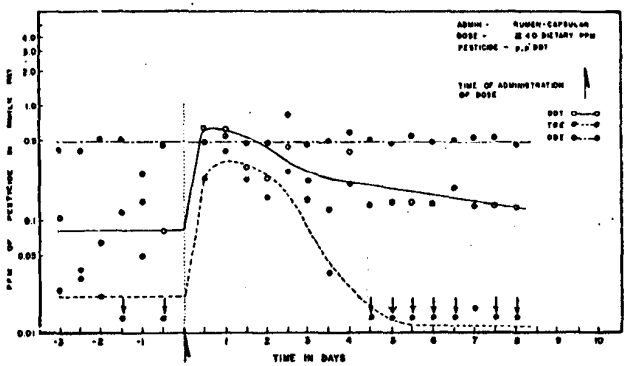


FIG. 3. Storage of DDT in milk fat in response to a single rumen-capsular dose of DDT.

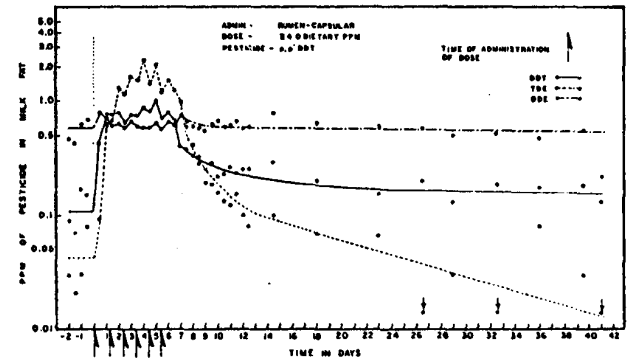


FIG. 4. Storage of DDT in milk fat in response to six daily rumen-capsular doses of DDT.

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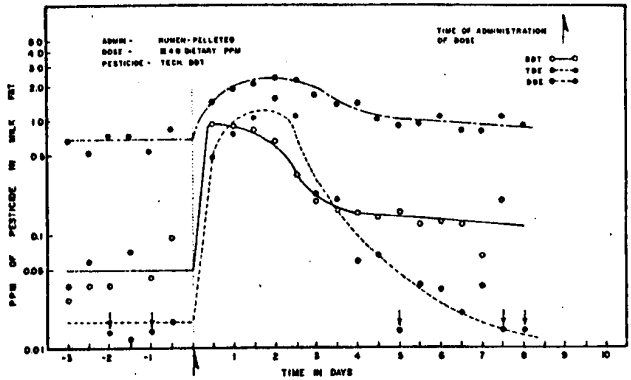


FIG. 5. Storage of DDT in milk fat in response to a single pelleted dose of DDT.

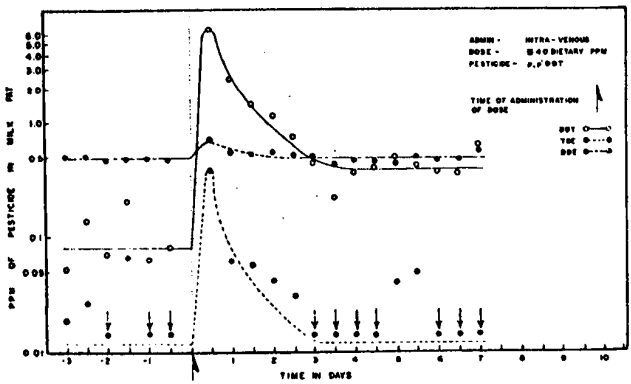


FIG. 6. Storage of DDT in milk fat in response to a single intravenous dose of DDT.

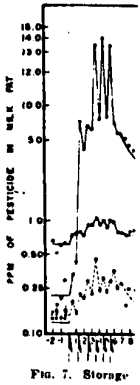


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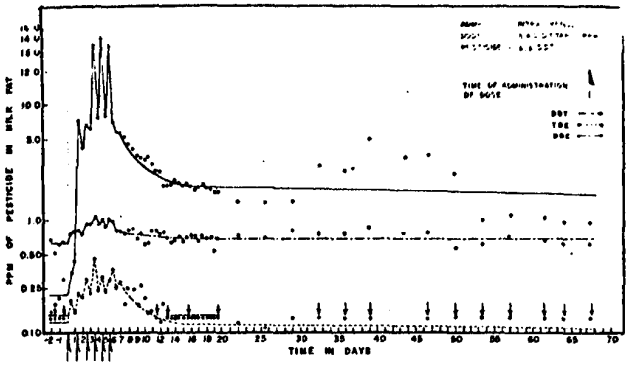


FIG. 7. Storage of DDT in milk fat in response to six daily intravenous doses of DDT.

alimentary administration. The concentration of DDT and its metabolites in the milk fat during the period of maximum response to the dose(s) was 0.74 ppm for the intratracheal single dose and 0.87 and 1.84 ppm for the single rumen-capsular and aged-residue, respectively.

The six-dose intratracheal exposure produced a mean maximum response, 93% of the response produced by the six-dose rumen-capsular exposure (1.63 ppm in the milk fat versus 1.75 ppm). This represents an increase from 85% for the same ratio in response to the one-dose exposure. These six-dose exposures could not be compared to a six-dose rumen-pellet exposure, because the cows were unwilling to consume the aged-residue for the entire six days.

If comparisons based solely on a single exposure are valid, it may be concluded that absorption of DDT from aged residues on alfalfa are about twice as efficient as absorption of DDT from an oil solution. This phenomenon has also been observed by Ely et al. (6). The increased absorption of DDT from an aged-residue on alfalfa may be due to a longer rumen exposure time for the alfalfa as compared to the oil. Whether the common experimental practice of administering a dose of insecticide by pipetting an acetone solution of the insecticide on to the grain ration just prior to feeding is similar to administration in an oil solution or is similar to an aged-residue, depends on whether the solution of insecticide penetrates the grain and remains in the rumen or whether it is washed from the surface of the grain and passes rapidly from the rumen. This important distinction cannot be made here and awaits further experimentation.

Intravenous administration of DDT was included, on the basis that maximum response would be observed only after a given dose was first absorbed into the blood. Both the one-dose and six-dose intravenous exposures produced much larger amounts of DDT (and its metabolites) in the milk fat than any other method tested. The one-dose exposure produced a total of 3.24 ppm of DDT product(s) in the milk fat during the time of maximum response and the six-dose exposure produced 8.53 ppm. These responses are 102 to 525% of those obtained by comparable doses by other routes of administration.

Hayes (10) states that intravenous administration of an insecticide may not produce a true maximum response (death) because, if administered as an emulsion of an oil solution, the oil droplets may be blocked from passage in small capillaries or taken up by phagocytic cells and the fraction of the dose immediately available for distribution to critical tissues is unknown (as in other routes of administration) *and probably small. In the method of administration* used in the present work, infusion of DDT in solution with an effective emulsifier would not necessarily form oil droplets, but the actual particle size is not known. Whether

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absorption of the intravenous dose was restricted due to the nature of the dispersion of the DDT cannot be determined, but 33% of the intravenous dose was excreted in the milk in contrast to only 3 to 5% from other methods of administration.

The depletion rate of the pesticide was uniform for low-level accumulations, but there were two rates for higher levels of storage and for storage resulting from all six-day exposures, whether or not they reached high levels (Table 3). After the start of depletion, there was an initial rapid decline for three to eight days. If this rapid decline did not return the level of contamination to the initial baseline values, it was followed by a slow decline which returned to the initial baseline in from 0.5 to more than 90 days. Half-life values for the rapid decline were 0.5 to 4.3 days and for the slow decline, 18 to 24 days. These two distinctly different dissipation rates suggest a two-compartment storage with different rates of exchange. Perhaps there is an *immediate storage in* a site with a rapid depletion potential, and with longer exposure there is storage in a less active site. Loss rates in most previous studies have not been sufficiently detailed or extensive to permit *deduction* of half-life values or to distinguish between rapid and slow decline rates. The most recent previous work (13) presents decline rates of 9 to 11%/wk, equivalent to a *half-life of* 6 wk, which is in agreement with data presented here.

However, Bruce et al. (4) found a half-life of about 300 days for DDT in cows receiving 100 ppm *of DDT in their feed for* 84 days. The method of administration employed by Bruce et al. (4) seems to be similar to that employed by Laben et al. (13). Level of dose administered and length of time of administration were also similar. Bruce et al. (4) used cows of the Shorthorn breed rather than Holstein or Jersey, but it is difficult to see that this factor should cause such a *difference* in retention of DDT. Factors which affect the length of time of retention of pesticide by cows must be defined, if rate of decline studies are to contribute to decisions by producers as to whether to retain *or cull contaminated* animals.

The per cent of the dose of insecticide excreted in the milk may help to understand variations in rate of loss. Zweig et al. (28) reported finding about 0.3 to 2.2% of the dose in the milk and Laben et al. (13) calculated that 3.0% of the dose was excreted in the milk and that an additional 14 to 16% was excreted in the *urine*. Other workers have been cited (14) as recovering 5 to 30% of the dose of DDT in the milk. In the present work, the amount of the administered DDT which could be accounted for in the milk varied from 0.78% in one of the intratracheal one-dose experiments to 32.2% of the dose in one of the *intravenous six-dose* experiments. The per cent of the dose recovered in the milk does not seem to be correlated with milk production, lactation number, stage of lactation, or weight of the cow; there is, of course, a correlation of the per cent recovery with level of residue in the milk and length of time the decline can be followed.

This work has shown for the first time that various routes of administration of the DDT change the ratio of the metabolic products of DDT detected in the milk. Studies on the accumulation of DDT in milk conducted by total chloride analysis (1, 25), *and studies using* alcoholic hydrolysis as a clean-up step prior to detection by electron capture gas chromatography (13), would not have distinguished between DDT and DDE. Studies using the Schechter-Haller colorimetric analysis (23, 28) could not have identified DDD, but could have distinguished the presence of DDE had a full spectral analysis been conducted. All of these and other early studies reported their results in terms of DDT. Williams et al. (24) analyzed milk samples from feeding experiments by gas chromatography methods which distinguished between DDT, DDE, and DDD, but the levels involved were so low that the data were not presented. Intratracheal administration of DDT increases the amount of DDT in milk, but increases in level of DDE and DDD are not significant. Alimentary administration of DDT in corn oil solution increases the amount of both DDD and DDT in the milk. During six-dose exposure, the increase in the amount of DDD was greater than the increase in DDT. Administration of the dose of DDT as an aged residue in alfalfa pellets increases the level in the milk of both DDE and DDD as well as unchanged DDT. The increase in DDE exceeded the increase in the other products. Intravenous administration of DDT produced a large increase in the level of DDT in the milk and slight increases in the level of DDE and DDD as a result of the one-dose experiments, but produced significant increases in the DDE and DDD levels during the six-dose experiments. It is apparent that doses of DDT administered by way of the rumen—and subject to metabolism by the rumen flora—are metabolized to a much greater extent than doses which bypass the rumen. The question as to whether the cow—as distinct from her symbiotic flora—is capable of producing DDE or DDD may have been answered

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...curred by the six-dose intravenous ad-...ation of DDT, during which small but ...ant amounts of these products seem to ...l. Peterson et al. (21) found DDD ...from DDT in the liver of the rat, but ...l DDD in the body fat. It is impor-... that detection by gas chromatog-... amounts of DDD in the presence ...

...ficult and ... conditions, ... sensitivity. In addition, an error of 0.5%, in the amount of degradation of DDT to DDD, caused by the injection block of the chromatograph, would cause an apparent production of DDD by the cow if there were 10 ppm DDT in the milk fat.

The extensive transformation of DDT to DDD by alimentary administration is consistent with the work of Kallman et al. (12), which showed that microorganisms form DDD from DDT, and the work of Miskus et al. (16), which revealed transformation of DDT to DDD by rumen fluid. However, both these studies also showed that there was no transformation to DDE by microorganisms. An increase in the level of DDE as a result of administration of DDT in the form of an aged residue, and the lack of this metabolic step when DDT is administered in oil solution, are difficult to explain. Perhaps a longer exposure of the DDT in the rumen when administered on alfalfa than when dosed by means of an oil solution permits a longer action by rumen flora and an additional transformation of the DDT. Surveys of pesticides of milk in the United States (11, 20, 27) have revealed the presence of considerable DDE in relation to the amount of DDT in milk. This extensive transformation of DDT to DDE has been presumed to be accomplished by metabolic systems of the cow. These short-term studies do not support this hypothesis, though longer-term exposure and depletion times may effect such a change.

Acknowledgment

The authors gratefully acknowledge the assistance of the late Mrs. Nancy Lord.

References

(1) Allen, N. N., Lardy, H. A., and Wilson, H. F. 1946. The Effect of Ingestion of DDT upon Dairy Cows. J. Dairy Sci., 29: 530.

(2) Bache, C. A., Gyrisco, G. G., Fertig, S. N., Huddleston, E. W., Link, D. J., Fox, F. H., Trimberger, G. W., and Holland, R. F. 1960. Effects of Feeding Low Levels of Heptachlor Epoxide to Dairy Cows of Residues and Off-Flavors in Milk. J. Agr. Food Chem., 8: 408.

(3) Biddulph, C., Bateman, G. Q., Bryson, M. J., Harris, J. R., Greenwood, D. A., Binns, W., Menor, M. L., Harris, L. E., and Madsen, L. L. 1950. DDT in Milk and Tissues of Dairy Cows Fed DDT-Dusted Alfalfa Hay. Advances in Chem. Ser., no. 1, 237.

(4) Bruce, W. N., Link, R. P., and Decker, G. C. ... Agr. Food Chem., ...

(5) Claborn, H. V., Beckman, H. F., and Wells, R. W. 1950. Contamination of Milk from DDT Sprays Applied to Dairy Barns. J. Econ. Entomol., 43: 723.

(6) Ely, R. E., Moore, L. A., Carter, R. H., Mann, H. D., and Poos, R. W. 1952. The Effect of Dosage Level and Various Methods of Administration on the Concentration of DDT in the Milk. J. Dairy Sci., 35: 266.

(7) Gannon, N., and Decker, G. C. 1960. The Excretion of Dieldrin, DDT, and Heptachlor Epoxide in Milk of Dairy Cows Fed on Pastures Treated with Dieldrin, DDT, and Heptachlor. J. Econ. Entomol., 53: 411.

(8) Gannon, N., Link, R. P., and Decker, G. C. 1959. Insecticide Residues in the Milk of Dairy Cows Fed Insecticides in Their Daily Ration. J. Agr. Food Chem., 7: 829.

(9) Gyrisco, G. G., Norton, L. B., Trimberger, G. W., Holland, R. F., McEnerney, P. J., and Muka, A. A. 1959. Effects of Feeding Low Levels of Insecticide Residues on Hay to Dairy Cattle on Flavor and Residues in Milk. J. Agr. Food Chem., 7: 707.

(10) Hayes, W. J. 1965. Review of the Metabolism of Chlorinated Hydrocarbon Insecticides Especially in Mammals. Ann. Rev. Pharmacol., 5: 27.

(11) Helmuth, H. E. O., and Miller, C. B. 1961. Pesticide Residues and the Dairy Industry. J. Dairy Sci., 44: 1775.

(12) Kallman, B. J., and Andrews, A. K. 1963. Reductive Dechlorination of DDT to DDD by Yeast. Science, 141: 1050.

(13) Labou, R. C., Archer, T. E., Crosby, D. G., and Peoples, S. A. 1965. Lactational Output of DDT Fed Prepartum to Dairy Cattle. J. Dairy Sci., 48: 701.

(14) Marth, E. H. 1962. Chlorinated Hydrocarbons Deposited in Biological Material. II. Animal and Animal Products. J. Milk Food Technol., 25: 72.

(15) Mills, P. A. 1959. Detection and Semiquantitative Estimation of Chlorinated Organic Pesticide Residues in Food by Paper Chromatography. J.A.O.A.C., 42: 734.

(16) Miskus, R. P., Blair, D. P., and Casida, J. E. 1965. Conversion of DDT to DDD by Bovine Rumen Fluid, Lake Water, and Reduced Porphyrins. J. Agr. Food Chem., 13: 481.

(17) Moffit, R. A. 1963. Residue Analysis in the Dairy Industry. *In* Analytical Methods for

MONS 038620

Pesticides, Plant Growth Regulators, and Food Additives. Vol. I, p. 545. G. Zweig, ed.

(18) Morrison, F. B. 1950. Feeds and Feeding. 22nd ed. Morrison Publishing Company, Ithaca, New York.

(19) Orr, L. W., and Mott, L. O. 1945. The Effects of DDT Administered Orally to Cows, Horses, and Sheep. J. Econ. Entomol., 38: 428.

(20) Paul, C., and Merrill, M. H. 1965. Pesticide Chemicals DDT, DDD, DDE in Fluid Milk Products Resulting from Common Use in Pest Control on Many Agricultural Crops. Petition to the Food and Drug Administration, March 1.

(21) Peterson, J. E., and Robinson, W. H. 1964. Metabolic Products of p,p'-DDT in the Rat. Toxicol. Appl. Pharmacol., 6: 321.

(22) Shepherd, J. B., Moore, L. A., Carter, R. H., and Poos, F. W. 1949. The Effect of Feeding Alfalfa Hay Containing DDT Residue on the DDT Content of Cow's Milk. J. Dairy Sci., 32: 549.

(23) Smith, Ray F., Haskins, W. M., and Fullmer, O. H. 1948. Secretion of DDT in Milk of Dairy Cows Fed Low-Residue Alfalfa Hay. J. Econ. Entomol., 41: 759.

(24) Williams, S., Mills, P. A., and Melbourn, R. E. 1964. Residues in Milk of Cows Fed Rations Containing Low Concentrations of Five Chlorinated Hydrocarbon Pesticides. J.A.O.A.C., 47: 1124.

(25) Wingo, C. W., and Crigler, O. S. 1948. Effect of DDT on Dairy Cattle and Milk. J. Econ. Entomol., 41: 105.

(26) Witt, J. M., and Gerhardt, P. D. 1965. Comparison of Pesticide Drift Resulting from Aerial Dust and Spray Application. Unpublished data.

(27) Witt, J. M., Whiting, F. M., Brown, W. H., and Stull, J. W. 1965. Epidemiology of DDT on Dairy Farms. Unpublished data.

(28) Zweig, G., Smith, L. M., Peoples, S. A., and Cox, R. 1961. DDT Residues in Milk from Dairy Cows Fed Low Levels of DDT in Their Daily Rations. J. Agr. Food Chem., 9: 481.

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J. Dairy Sci. 50 (1967)

DDT Contamination in Milk Following a Single Feeding Exposure

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Abstract

Feeding a single large dose (about 14 mg/kg) of 1,1,1-trichloro-2,2-bis(4'-chlorophenyl)ethane (DDT) to dairy cows caused a very large but transient increase in blood and milk levels of the insecticide. After 8 wk, milk fat levels had declined to a near-plateau of about 6 ppm, and the total time required for attainment of a 2.5-ppm level was calculated to be at least 15 wk.

Numerous studies have been made of the transfer of chlorinated hydrocarbon insecticides from the feed into the milk of dairy cows. Such experiments generally have involved the feeding of known, relatively low insecticide levels over periods of weeks or months, accompanied by the determination of milk residues (3, 4).

We recently reported (2) the effects of feeding high levels of DDT [1,1,1-tricloro-2,2-bis (4'-chlorophenyl)ethane] to dry cows on the subsequent contamination of their milk. Even after a 30-day withdrawal from the insecticide prior to calving, the milk fat DDT level of cows which had received 300 ppm in their diet was found to be roughly 200 ppm 1 wk after onset of lactation, and to average 5.3 ppm after 37 wk.

The above experiments were carried out from a range-finding viewpoint and with the realization that continued ingestion of such high levels of insecticide would be highly improbable. However, single incidents of accidental high-level exposure may be expected as long as such pesticides are applied to crops. Consequently, the present investigation was aimed at evaluation of the milk fat residues of DDT following a single oral dose of the insecticide.

Materials and Methods

Animal feeding. Technical-grade DDT (77% p, p'-isomer) was dissolved in acetone and thoroughly mixed with approximately 10 lb of grain ration immediately prior to feeding. Two Holstein cows were treated: No. 154 was 34 months of age, in her eighth month of lactation, and weighed 630.5 kg; no. 155 was 33 months of age, in her eighth month of lactation, and weighed 594.2 kg. No. 154 received a single dose of 8.5 g DDT (13.5 mg/kg body weight) and no. 155 received 8.9 g (15.0 mg/kg). During the sampling period, the cows were fed approximately 18 kg of alfalfa hay (0.1 ppm DDT) and 7 kg of grain ration (0.05 ppm DDT) per day.

Sampling. The cows were milked dry twice daily (4:15 AM and 2:15 PM), and a two-day (four-milking) composite was taken immediately prior to DDT treatment. Subsequently samples from each milking were taken for 6 days, followed by AM-PM composite samples taken on the dates indicated in Table 1. Milk samples were held at 4 C until annlysis, warmed to 40 C, thoroughly mixed, and divided for butterfat analysis (Babcock test) and DDT analysis.

A blood sample was drawn from the jugular vein shortly before administration of the DDT, heparinized, and held at 4 C until analysis. Subsequent blood samples, taken at 9:30 AM on the dates shown in Table 2, were handled in the same way.

Analysis. The samples were analyzed by the electron-capture gas chromatographic procedure described by Crosby and Archer (1). Separate values for the chlorinated hydrocarbon constituents were totalled and represent the sum of DDT isomers, DDE [1,1-dichloro-2,2-bis(4'chlorophenyl)ethylene] isomers, and TDE [1,1-dichloro-2,2-bis(4'-chlorophenyl)ethane] isomers.

Results and Discussion

Detailed results of the experiment are compiled in Tables 1 and 2, and the gross trends in milk fat levels of DDT is shown in Figure 1. Sampling of milk and blood in the pretreatment period established a DDT baseline for each cow; in addition, the mean levels of the insecticide in the feed and milk fat of bovines before and after this experiment are shown in Table 3. These figures indicate the background levels of DDT on the premises, and it is apparent that the DDT levels in both the blood and the milk normally were low.

At the time of administering the oral dose of insecticide, milk and blood DDT levels remained unchanged. During the next 11

Date (1965)	Sample
4/28–4/29	P + A
4/29–4/30	P + A
4/30	P*
5/1	A
5/1	P
5/2	A
5/2	P
5/3	A
5/3	P
5/4	A
5/7	P
5/10	A + P
5/13	A + P
5/17	A + P
5/19	A + P
5/26	A + P
6/2	A + P
6/9	A + P

* Total isomers of D
* A = 4:15 AM; P =
* DDT fed immediate

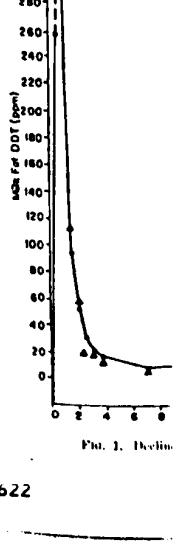


FIG. 1. Declin

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University of California, Davis

h month of lactation, and
No. 154 received a single
T (13.5 mg/kg body weight)
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ained. During the next 14-hr

TABLE 3
Milk fat levels of DDT[a]

Date (1965)	Sample	Cow 154 Milk	Cow 154 Fat	Cow 154 DDT	Cow 155 Milk	Cow 155 Fat	Cow 155 DDT
		(lb)	(%)	(ppm)	(lb)	(%)	(ppm)
4/28–4/29	P + A[b]	59.7	3.2	0.38	58.5	3.7	0.35
4/29–4/30	P + A[b]				12.0	4.2	0.30
4/30	P[c]	13.3	3.1	0.34	17.0	3.6	313.9
5/1	A	17.4	3.9	259.0	12.8	3.9	328.2
5/1	P	11.8	3.7	289.2	16.7	3.5	113.4
5/2	A	17.5	3.9	94.1	12.0	4.1	57.6
5/2	P	13.7	3.7	52.7	16.1	3.4	20.9
5/3	A	17.0	3.7	30.0	11.0	3.7	21.1
5/3	P	13.2	3.8	23.3	16.3	3.6	10.8
5/4	A	18.5	3.8	17.6	10.5	4.7	7.1
5/7	P	13.8	4.0	8.5	20.4	3.6	12.4
5/10	A + P	27.3	3.5	11.3	27.3	4.1	10.1
5/13	A + P	28.0	3.8	9.7	26.6	3.8	5.8
5/17	A + P	25.0	3.6	4.2	20.6	3.8	7.2
5/19	A + P	28.3	3.9	4.7	20.9	3.6	5.7
5/26	A + P	31.5	4.0	5.4	27.7	3.9	6.6
6/2	A + P	28.1	3.8	4.6	27.6	3.8	6.7
6/9	A + P	29.0	3.8	5.4			

[a] Total isomers of DDT, TDE, and DDE.
[b] A = 4:15 AM; P = 2.15 PM.
[c] DDT fed immediately prior to this sampling.

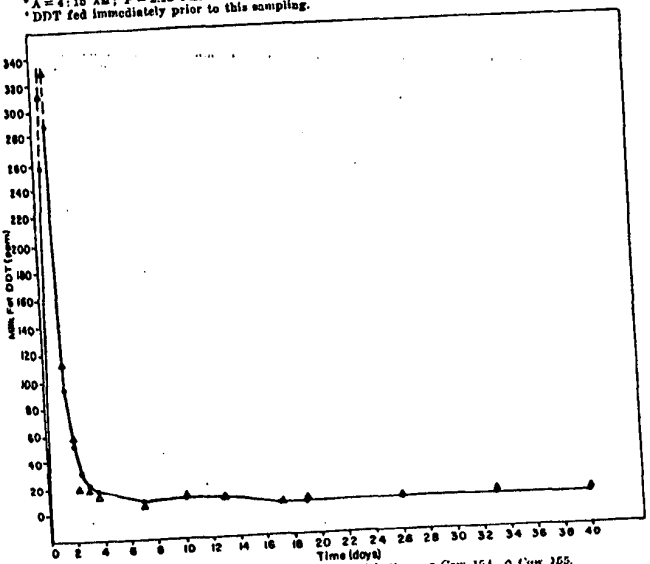


FIG. 1. Decline of DDT milk fat residues with time. ● Cow 154, △ Cow 155.

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TABLE 3
Whole blood levels of DDT[a]

Date (1965)	Hr after exposure	Cow 154 DDT	Cow 165 DDT
		(ppb)	
4/30	−5	11.3	7.8
4/30	2	15.5	22.0
5/1	17	75.4	68.0
5/2	41	28.1	15.2
5/3	65	14.9	13.0
5/13	305	7.8	4.7
5/17	400	5.8	9.6
5/19	448	6.3	9.6
5/26	616	14.8	4.2
6/2	784	8.4	9.0

[a] Total isomers of DDT, TDE, and DDE.

period, however, the DDT level suddenly approached its maximum value and at an undetermined time during the next 12 hr (dashed line of Figure 1) peaked at over 300 ppm. Blood DDT increased sharply within the first 2 hr after feeding, then paralleled the milk values. The levels diminished rapidly after the peak, then continued to decline asymptotically. After 3 wk, a near-plateau was established and the trial was terminated after 6 wk; no attempt was made to extend the feed-off period to the point where milk fat DDT and related compounds reached the presently enforced 2.5 ppm applicable in this instance, but it was obvious that an extended period would be required. Analysis of the data obtained between May 10 and June 9 indicated that, as in our previous experiments (2, 3), the rate of decline stabilized at approximately 10% per week. At this rate, at least 13 wk on the plateau would be required for milk fat DDT levels to reach 2.5 ppm, and 20 wk would result in 1.25 ppm according to the equation derived from the slope of the regression curve (2):

$$\text{Weeks} = \frac{2.303 - \ln (\text{ppm})}{0.105}$$

Consistent with our past experience, blood DDT levels below 2 ppb indicate that the milk fat will contain less than 2 ppm total DDT and related chlorinated hydrocarbons. However, both blood and milk data from single samplings are subject to violent fluctuations presently unexplained, which make a precise mathematical correlation highly improbable.

Our data show clearly that a dairy cow will become severely contaminated by a single large dose of DDT. The rate of decline following the single exposure is so slow that serious economic loss would result before milk DDT declined to an acceptable level. Although ingestion of the amount of insecticide employed in this experiment (roughly 350 ppm in the feed) may not be commonplace, it is to be expected that similar levels encountered in the inadvertent feeding of certain agricultural byproducts or the accidental exposure to freshly sprayed crops will lead to milk insecticide levels which are, practically, of equal consequence.

TABLE 4
Milk fat and feed background DDT[a]

Cow	Treatment	DDT level: Prior feed[b]	DDT level: Pre-experiment milk fat[c]	DDT level: Post-experiment milk fat[d]
			(ppm)	
154	Treated	0.09	0.21	5.40
155	Treated	0.24	0.36	6.70
152	Untreated	0.09	0.27	0.44
161	Untreated	0.39	0.32	0.27
162	Untreated	0.73	0.76	0.42
168	Untreated	0.28	0.36	0.36

[a] Total isomers of DDT, TDE, and DDE.
[b] Mean level for prior 20 wk.
[c] Composite (14-milking) sample for week ending 4/17/65.
[d] Sample of 6/9/65.

Acknowledgment

We gratefully acknowledge the assistance of Charles Stiers with the milk blood samples, Eugene Whitehead and James Stokes with laboratory analyses, and the Department of Food Science and Technology for Babcock analyses. This work was supported in part by special research funds from the Director, California Agricultural Experiment Station.

References

(1) Crosby, D. G., and Archer, T. E. 1966. Rapid Analytical Method for Persistent Pesticides in Proteinaceous Samples. Bull. Environ. Contam. Toxicol., 1: 10.

(2) Laben, R. C., Archer, T. E., Crosby, D. G., and Peoples, S. A. 1965. Lactational Output of DDT Fed Prepartum to Dairy Cattle. Davis. J. Dairy Sci., 48: 701.

(3) Laben, R. C., Archer, T. E., Crosby, D. G., and Peoples, S. A. 1966. Milk Contamination From Low Levels of DDT in Rations. J. Dairy Sci., 49: 1488.

(4) Williams, S., Mills, P. A., and Mehrle, R. E. 1961. Residues in Milk of Cows on Rations Containing Low Concentrations of Five Chlorinated Hydrocarbon Pesticides. J. Assoc. Offic. Agr. Chemists, 47: 1124.

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J. Dairy Sci. 52(1969)

Comparative Excretion and Retention of DDT Analogs by Dairy Cows

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Abstract

Three groups of three cows each were fed 25 mg of *p,p'*-DDT, *p,p'*-DDD, or *p,p'*-DDE per day for 60 days. Concentrations of the compounds in milk fat approached, but did not reach, equilibrium during the feeding period. From 40 to 60 days, 25.8% of the *p,p'*-DDE, 7.6% of the *p,p'*-DDD, and 5.1% of the *p,p'*-DDT as *p,p'*-DDT (2.1%) and *p,p'*-DDD (3.0%) were excreted in the milk. When the feeding of the compounds ended at 60 days, the decline in milk fat concentrations of all compounds could be described as the sum of two first-order terms. The initial partial concentrations of the first term were 0.41, 0.91, and 0.41 with rates of decline of 67, 41, and 31% per day for *p,p'*-DDT, *p,p'*-DDD, and *p,p'*-DDE, respectively. The initial partial concentrations of the second term were 0.59, 0.09, and 0.59, with rates of decline of 1.3, 2.6, and 1.3% per day, respectively.

Introduction

Technical grade DDT contains a number of analogs in addition to the major component, *p,p'*-DDT. The composition of the residue from DDT use may also change in the environment due to reactions such as the dechlorination of *p,p'*-DDT to *p,p'*-DDD and *p,p'*-DDE. As a consequence, these three analogs are usually found in varying quantities in environmental situations involving the DDT contamination of milk.

Many aspects of the uptake of DDT and related organochlorine compounds (DDT-ROC) from feeds by dairy cows and the subsequent appearance of the compounds in milk have been studied. The studies have employed technical grade DDT (4, 8, 9), pure *p,p'*-DDT (11, 12), or environmentally contaminated feed (3, 9, 12). The dehydrochlorination analytical method (4, 8, 9), or reporting the residue as the total DDT-ROC (3, 12), does not allow one to assess the differences in the residue composition of either the material fed or in the milk produced. Generalizing these results to situations involving DDT residues includes the assumption that all of the analogs are transferred from feed to milk at similar rates. However, there are suggestions (5, 6) that the behavior of the compounds are markedly different. Thus the results of individual studies may be misleading when applied to situations involving environmental contamination.

The purpose of this study was to compare the body retention and the milk excretion of the three environmentally important analogs *p,p'*-DDT, *p,p'*-DDD, and *p,p'*-DDE, when fed as pure compounds.

Experimental Procedures

Nine cows similar in production level, stage of lactation, and body weight were randomly assigned to three groups of three cows each. The cows were fed orchardgrass silage *ad libitum* and concentrate. Average daily dry matter intake during the study was 10.1 kg silage and 7.4 kg concentrate. The intakes of *p,p'*-DDT, *p,p'*-DDD, and *p,p'*-DDE from feeds averaged 0.19, 0.05, and 0.07 mg/day respectively.

The study was conducted for 120 days. During the first 60 days the three groups were fed 25 mg/day of either *p,p'*-DDT, *p,p'*-DDD, or *p,p'*-DDE. The compounds dissolved in acetone were fed by adding appropriate amounts to a portion of the concentrate and allowing the acetone to evaporate before mixing with the remaining concentrate. Milk samples were collected as frequently as daily immediately after the beginning and end of compound intake, and as infrequently as every ten days when concentrations of the compounds were relatively stable. Body fat biopsy samples from the tail head area were obtained at 20-day intervals throughout the study. Milk samples were taken before the beginning of the study, as well as from other cows fed the same diet during the study, to determine background levels.

Extraction and cleanup of all samples were performed by established methods (1). The concentrations of the compounds were determined by electron capture gas chromatography

Fat determinations on ... made by the Babcock m...

Results and Discussion

When *p,p'*-DDD or *p,p'*-DDE, only compound found in ... fations above backgro... that was fed. Both *p,p'*-... were present in the m... was fed, but the concent... did change significantly ... observation agrees with ... which *p,p'*-DDT was ...

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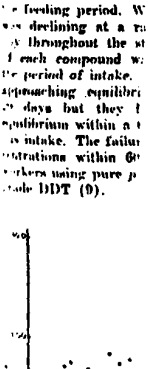


FIG. 1. Mean re... of DDD in the m... *p,p'*-DDT.

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Fat determinations on all milk samples were made by the Babcock method.

Results and Discussion

When *p,p'*-DDD or *p,p'*-DDE was fed, the only compound found in the milk fat at concentrations above background was the compound that was fed. Both *p,p'*-DDT and *p,p'*-DDD were present in the milk fat when *p,p'*-DDT was fed, but the concentration of *p,p'*-DDE did not change significantly from background. This observation agrees with other work (11, 12) in which *p,p'*-DDT was used.

The general shape of the milk fat concentration curve was similar for all of the compounds (Fig. 1, 2, 3). The concentrations of the compounds increased rapidly after the start of feeding. At about 20 days the concentration began to level off, but the milk fat concentration continued to increase slowly throughout the feeding period. While milk fat production was declining at a rate of about 0.23% per day throughout the study, the total excretion of each compound was increasing throughout the period of intake. The cows may have been approaching equilibrium in the period after 20 days but they had not reached a true equilibrium within a 60-day period of continuous intake. The failure to reach maximum concentrations within 60 days agrees with other workers using pure *p,p'*-DDT (11) or technical grade DDT (9).

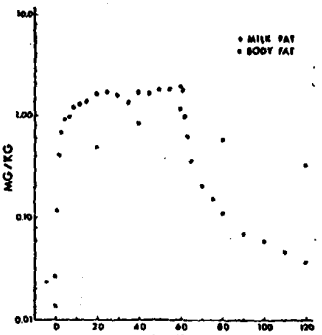


FIG. 2. Mean concentration of *p,p'*-DDD in milk fat and body fat of cows fed *p,p'*-DDD.

The large quantitative differences among the compounds in their excretion into milk, as well as the variability of individual cows within treatments, are presented in Table 1. These values are for the period of 40 to 60 days of the continuous intake. While the cows were not strictly at equilibrium, the values are probably a close approximation of this state, especially in the case of total amount of compound excreted daily into milk.

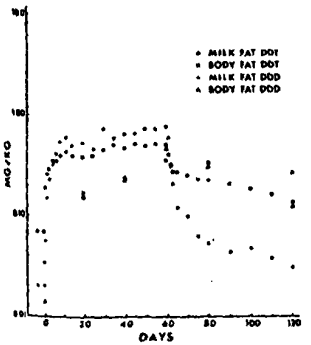


FIG. 1. Mean concentration of *p,p'*-DDT and *p,p'*-DDD in the milk fat and body fat of cows fed *p,p'*-DDT.

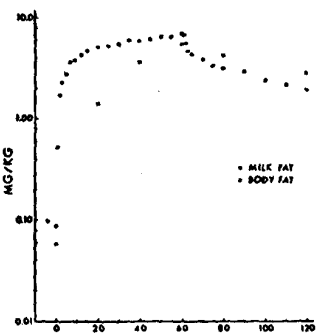


FIG. 3. Mean concentration of *p,p'*-DDE in the milk fat and body fat of cows fed *p,p'*-DDE.

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TABLE 1. Mean concentration and mean daily excretion of DDT analogs in milk fat from 40 t 60 days of continuous intake.

Cow	Milk fat	Milk fat concentration			Excretion in milk fat		
		DDE	DDD	DDT	DDE	DDD	DDT
	(kg/day)	(mg/kg)			(mg/day)		
				DDT Fed			
1	0.96	—	0.82	0.50	—	0.78	0.48
2	0.97	—	0.72	0.62	—	0.70	0.60
3	1.16	—	0.58	0.39	—	0.65	0.45
Mean	1.03	—	0.71	0.50	—	0.71	0.51
				DDD Fed			
4	1.01	—	1.59	—	—	1.61	—
5	1.09	—	1.85	—	—	2.02	—
6	1.07	—	1.95	—	—	2.08	—
Mean	1.06	—	1.80	—	—	1.90	—
				DDE Fed			
7	1.10	5.76	—	—	6.35	—	—
8	0.79	8.10	—	—	6.40	—	—
9	1.02	6.41	—	—	6.56	—	—
Mean	0.97	6.76	—	—	6.44	—	—

The most important feature of these results is the large difference among the compounds in the milk fat concentration and the total amount excreted into the milk. When *p,p'*-DDT was fed, about 5.1% of the amount consumed was recovered from the milk as *p,p'*-DDT (2.1%) and its metabolite *p,p'*DDD (3.0%). In contrast, 7.6% of the *p,p'*-DDD and 25.8% of the *p,p'*-DDE were recovered in the milk. The 5.1% value for *p,p'*-DDT is within the range of values reported by others (9, 12) for DDT-ROC in milk when either pure *p,p'*-DDT or technical grade DDT was fed.

Brown et al. (3) have noted that the apparent transfer of DDT-ROC to milk was greater in their work with environmentally contaminated feed than in the work of others with *p,p'*-DDT or technical grade DDT added to the diet. While no values are given for the individual compounds present in the feed, it is apparent from the milk composition that a significant proportion of the residue intake must have been as *p,p'*-DDE. Thus, the more efficient transfer of *p,p'*-DDE from the diet to the milk is one possible explanation for the differences they have noted. The possibility of differences in composition of the residue in either the feed or the milk must be considered when comparing different studies.

The large differences in the transfer of these compounds from diet to milk has an important practical implication. The Food and Drug Administration (FDA) tolerance for DDT and its metabolites in milk is 1.25 mg/kg of m fat. With cows similar in physiological a nutritional state to ours, an intake of appro mately 5 mg/day of DDE would result in m concentrations greater than the FDA toler On the other hand, if the sole contaminant w *p,p'*-DDT, an intake five times as great approximately 25 mg/day would not prod milk concentrations greater than the FDA t erance. In the environment the residue w not occur as a pure compound but as a mix with a composition which could vary depend upon the conditions and the length of the a process. Predicting the milk residue level be expected from a given feed would req knowledge not only of the total concentrat but also of the analog distribution of DDT-ROC in the feed.

A second parameter of importance is rate of decline in milk fat concentration the compounds following the end of intake of the compounds were similar in the re that they are adequately described by a s with two open compartments and a zero rate of introduction. This system is illustr in Figure 4, and its major features have b described by Reseigno and Segre (10). W precise boundaries cannot be placed on hypothetical compartments, Compartment would approximate the amount of the pound in the circulatory system and Com ment 2 the amount in the depot fat. The k_{10} is a zero-order rate because of the con

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TABLE 2. Constan
DDT analogs.

Compound

MONS 038627

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (p. p. m. in fat unless otherwise indicated)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
CATTLE, BEEF							
Lice* (con.)	Lindane	7	30	EC or WP, 0.03-0.05% S	Depending on size of animals and amount of hair	Immerse, spray, or dust thoroughly. Repeat all treatments after 2-3 weeks, if needed.	See page 173.
			60	EC or WP, 0.03% dip			
			30	1% D			
	Malathion	4 meat	--	EC or WP, 0.5% S			
				4-5% D			
	Methoxychlor	3	--	EC or WP, 0.5% S (1-1.5% for tail louse)			
				10% D			
	Carbaryl	--	7	WP, 0.5% S	1 qt.	Spray thoroughly. Repeat as needed.	
	Ronnel	0 meat	56	EC, 0.25% dip or S	Depending on size of animals and amount of hair	Immerse, spray, or dust thoroughly. Repeat all treatments after 2-3 weeks if needed.	
	Toxaphene	7	28	EC or WP, 0.5% dip or S			
				5% D			
	Ruelene**	--	28	EC, 0.375% S	Depending on size of animals and amount of hair	Spray thoroughly.	
				EC, 5.0% Soln., 9.4%	1 fl. oz./100 lb. body weight up to 800 lb., but no more than 8 fl. oz. per animal.	Pour on evenly along animal's backline.	

*Dips used to control lice will also control horn flies.
**Ruelene pour-on treatment (See Horn Flies) or spray will reduce numbers of lice.

MONS C38824

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (p. p. m. in fat unless otherwise indicated)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
CATTLE, BEEF							
Screw-worm (Cochliomyia hominivorax)	Coumaphos	1 meat and fat	--	5% D	--	Dust wounds and surrounding area thoroughly. Repeat as necessary.	See page 173.
				WP, 0.25% S, 0.125% dip EC, 0.25% S	Depending on size of animals and amount of hair	Spray wounds thoroughly and wet entire body; repeat after 2 weeks if needed.	
	Ronnel	0 meat	56	EC, 0.5% S			
			21	2.5% livestock bomb	--	Spray wounds thoroughly.	
Ticks	Carbaryl	--	7	WP, 0.5% S	1 qt.	Spray thoroughly. Repeat as needed.	
	Coumaphos	1 meat and fat	--	WP, 0.125% S or dip	Depending on size of animals and amount of hair	Immerse, dust, or spray thoroughly. Repeat all treatments after 2-3 weeks if needed.	
	Dioxathion	1	--	EC, 0.15% dip or S			
	Lindane	7	30 (S) 60 (dip)	EC or WP, 0.03% dip or S			
	Malathion	4 meat	--	EC or WP, 0.5% S 4 - 5% D			
	Ronnel	0 meat	56	EC, 0.75% S			
	Toxaphene	7	28	EC or WP, 0.5% dip or S			
Ear tick (Otobius megnini)	Coumaphos	1 meat and fat	--	5% D	--	Lightly inside ears. Also treat adjacent head area. Repeat as necessary.	
	Malathion	4 meat	--	EC or WP, 0.5% S (low pressure)	--		

Continued

MONS 038825

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (*p. p. m. in fat unless otherwise indicated*)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
CATTLE, BEEF							
Ear tick (con.)	Ronnel	0 meat	21	2.5% livestock bomb	--	Spray into ear to reach infested areas; repeat if necessary.	See below.

SAFETY RESTRICTIONS

Coumaphos, malathion, ronnel, and Ruelene may also be applied to dry dairy animals, with the limitations indicated below. Observe precautions on product labels as well as those given here.

Coumaphos, ronnel, Ruelene, and trichlorfon are systemic insecticides. If you feed ronnel, do not spray, dip or pour-on ronnel, coumaphos, Ruelene, or trichlorfon. Do not feed ronnel in more than one form. If you are not feeding ronnel and you spray, dip, or pour-on one of these four insecticides, do not treat the same animal with any of the other three.

Do not apply carbaryl more often than once every 4 days. Do not use on dairy animals.

Do not treat animals less than 3 months old with coumaphos. Spray animals 3 - 6 months old lightly. Do not use with synergized pyrethrins, allethrin, or synergist. Do not spray animals or apply pour-on for 10 days before or after shipping or weaning, or after exposure to disease. Do not apply in conjunction with oral drenches or other medications, such as phenothiazine, or with other organic phosphates. Do not apply to lactating dairy animals. Do not apply to dry dairy animals within 14 days of freshening. Do not dip overheated animals.

Do not reapply dioxathion sprays within 2 weeks or pour-on within 30 days. Do not dip calves less than 3 months old. Do not treat dairy animals.

Do not treat dairy animals with DDT or toxaphene. Do not use toxaphene on animals less than 3 months old.

Do not treat calves with dips or sprays containing more than 0.03% lindane. Do not dip, spray, or dust calves less than 3 months old with lindane. Do not use on emaciated or lactating animals.

Do not use malathion on calves less than one month old. Do not treat lactating dairy animals; do not treat dry dairy animals within 14 days of freshening. Do not use back rubbers on dairy animals.

Do not feed ronnel to sick or stressed animals. Do not feed 0.6% ronnel to lactating dairy animals, or to dry dairy animals within 60 days of freshening; or 0.26% in feed within 28 days or 5.5% in block or granules within 21 days of freshening. Do not use ronnel spray, back rubbers, or dust on lactating dairy animals; do not use on dry dairy animals within 21 days of freshening. Do not reapply sprays within 2 weeks. Do not apply to animals receiving organic phosphate treatment from any other source.

Do not apply Ruelene to lactating dairy animals. Do not apply to dry dairy animals within 28 days of freshening. Do not use Ruelene pour-on made from EC in extremely hot or humid weather; dermatitis may result. Do not apply more often than every 28 days.

Do not use trichlorfon on dairy animals. Do not treat animals less than 3 months old, sick, convalescent, or stressed animals. Do not treat 10 days before or after shipping, weaning, or after exposure to contagious diseases. Do not apply in conjunction with oral drenches, other internal medications, or other organic phosphates.

MUNS 038826

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (p. p. m. for fat unless otherwise indicated)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
HORSES							
Bots (Gasterophilus spp.)	Trichlorfon	--	--	Tech., 90%	1 packet (5 grams) per 250 lb. body weight	Single dose orally in feed, one month after killing frost.	See below

SAFETY RESTRICTIONS

Do not treat sick or debilitated horses, colts less than 4 months old, or mares in the last month of pregnancy. Do not administer trichlorfon in conjunction with (or 10 days after treatment with) other organic phosphates or cholinesterase inhibitors.

Do not repeat more often than once every 30 days. Do not administer intravenous anesthetics, especially muscle relaxants, for a period of 2 weeks after using trichlorfon. Do not treat horses to be used for food.

SHEEP AND GOATS							
Fleeceworms	Coumaphos	1 meat and fat 0 milk	15	0.5% D	1 - 2 oz.	Rub into wool over entire body.	See page 176.
				WP, 0.125% S or dip	Depending on size of animals and amount of hair	Immerse or spray thoroughly.	
	Dioxathion	1 0 milk	--	EC, 0.15% dip or S			
	Lindane	7	--	3% (EQ 335), 1 part to 9 parts water	--	Wet infested area and 3 in. around it.	
	Ronnel	--	21	2.5% livestock bomb	--	Spray infested area and 3 in. around it.	
			84	EC 0.5% dip or S	Depending on size of animals and amount of hair	Immerse or spray thoroughly.	
Lice	Ciodrin	--	--	EC, 0.5 - 1% S EC, 0.15 - 0.3% S	1 - 2 pt. 1 - 4 qt.	Spray thoroughly. Repeat once a week or as necessary.	

Continued

MONS 038827

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (p. p. m. in fat unless otherwise indicated)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
SHEEP AND GOATS							
Lice (con.)	Ciodrin (continued)	--	--	EC, 0.1-0.25% S	1-2 gal. (1 gal 0.25%)	Repeat application after 14 days.	See page 178.
	Coumaphos	1 meat and fat 0 milk	15	WP, 0.06% S or dip	Depending on size of animals and amount of hair	Immerse, spray, or dust thoroughly. Use DDT only once, but repeat other treatments after 2-3 weeks if needed.	
	DDT	7	30	EC or WP, 0.25% dip, 0.5% S			
	Dioxathion	1 0 milk	--	EC, 0.15% dip or S			
	Lindane	7	30	EC or WP, 0.05% S			
			60	0.025% dip			
			30	1% D			
	Malathion	4 meat 0 milk	--	EC or WP, 0.5% dip or S			
				4-5% D			
	Methoxychlor	3 0 milk	--	EC or WP, 0.5% dip or S			
	Carbaryl*	--	7	WP, 0.5% S	1 qt.	Spray thoroughly. Repeat as needed.	
	Ronnel	--	84	EC 0.25% dip or S	Depending on size of animals and amount of hair	Immerse, spray, or dust thoroughly. Repeat treatments after 2-3 weeks if needed.	
	Rotenone	--	--	5% WP (1-2 lb. per 100 gal. water)			
				0.5-1.0% D			
	Toxaphene	7	28	EC or WP, 0.25% dip, 0.5% S			

Continued

*Sheep only. Do not use on goats.

MONS 038828

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (p. p. m. for meat and fat unless otherwise indicated)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
SHEEP AND GOATS							
Lice (con.)	Diazinon*	0.75 meat and fat	14	EC or WP, 0.03% S	1 gal.	—	See page 178.
				0.06% S (low pressure)	1 qt.	—	
Screw-worm (Cochliomyia hominivorax)	Diphenylamine	0 meat 0 milk	—	35% (Smear 62)	Minimum necessary to treat wound	Brush or smear on and around wound, twice first week and weekly until healed.	
	Lindane	7	—	3% (EQ 335)			
	Ronnel	—	21	2.5% livestock bomb	—	Spray infested area and 3 inches around it.	
		—	84	EC, 0.5% S or dip	Depending on size of animals and amount of hair	Immerse or spray wounds thoroughly. Wet entire body.	
	Coumaphos	1 meat and fat 0 milk	15	WP, 0.25% S or dip			
			—	5% D	—	Dust wounds and surrounding area thoroughly. Repeat as necessary.	
Sheep ked (Sheep tick Melophagus ovinus)	Dieldrin*	—	90	1.5% D	1.5 - 3 oz.	Dust only once, after shearing.	
	Coumaphos	1 meat and fat 0 milk	15	0.5% D	1 - 2 oz.	Rub into wool over entire body.	
				WP, 0.125% S or dip	Depending on size of animals and amount of hair	Immerse or spray thoroughly. Use DDT only once, but repeat other treatments after 2 - 3 weeks if needed.	
	DDT	7	30	EC or WP, 0.25% dip, 0.5% S			
	Dioxathion	1 0 milk	—	EC, 0.15% dip or S			
	Lindane	7	30 (S) 60 (dip)	EC or WP, 0.025% dip, 0.05% S			

Continued

*Sheep only. Do not use on goats.

MDNS 038829

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (p. p. m. in fat unless otherwise indicated)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
SHEEP AND GOATS							
Sheep ked (Sheep tick Melophagus ovinus) (con.)	Malathion	4 meat 0 milk	--	EC or WP, 0.5% dip or S 4 - 5% D	Depending on size of animals and amount of hair	Immerse, spray, or dust thoroughly. Repeat treatments after 2 - 3 weeks if needed.	See page 178.
	Pyrethrins + Synergist*	--	--	0.1% + 1.0% S			
	Rosmel	--	84	EC, 0.25% dip or S			
	Rotenone	--	--	5% WP (8 oz. per 100 gal. water)			
	Toxaphene	7	28	EC or WP, 0.25% dip, 0.5% S			
	Diazinon**	0.75 meat and fat	14	EC or WP, 0.03%S 0.06% S (low pressure)	1 gal. 1 qt.	-- --	
				2% D	1.5 oz.	Immediately after shearing	
Ticks	Coumaphos	1 meat and fat 0 milk	15	WP, 0.125% S or dip	Depending on size of animals and amount of hair	Immerse or spray thoroughly. Repeat after 2 - 3 weeks, if needed.	
	Dioxathion	0 milk	--	EC, 0.15% dip or S			
	Lindane	7	30(S) 60 (dip)	EC or WP, 0.025 - 0.03% dip or S			
	Clodrin	Same as for lice.					
	Malathion	4 meat 0 milk	--	EC or WP, 0.5% dip or S 4 - 5% D	Depending on size of animals and amount of hair	Immerse, dust, or spray thoroughly. Repeat after 2 - 3 weeks, if needed.	
	Rosmel	--	84	EC, 0.25 - 0.5% dip or S			

Continued

*Piperonyl butoxide or sulfoxide.

**Sheep only. Do not use on goats.

MONS 038830

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ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (p. p. m. in fat unless otherwise indicated)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
SHEEP AND GOATS							
Ticks (con.)	Toxaphene	7	28	EC or WP, 0.5% dip or S	Depending on size of animals and amount of hair	Immerse or spray thoroughly. Repeat after 2-3 weeks, if needed.	See below.
	Carbaryl*	—	7	WP, 0.5% S	1 qt.	Spray thoroughly. Repeat as needed.	
Sheep nose bot (Oestrus ovis)	Ruelene	—	14	21% emulsion	2 cc./10 lbs. body weight	Use as drench.	

*Sheep only. Do not use on goats.

SAFETY RESTRICTIONS

Do not treat sick animals.

Do not apply carbaryl more often than once every 4 days. Do not use on goats.

Do not apply Clodrin more often than once a week.

Do not treat animals less than 3 months old with coumaphos. Spray animals 3-6 months old lightly. Do not use with synergized pyrethrins, allethrin, or synergist. Do not spray animals for 10 days before or after shipping or weaning or after exposure to disease. Do not apply in conjunction with oral drenches, or other medication, such as phenothiazine, or with other organic phosphates. Do not apply coumaphos on lactating dairy goats or to dry dairy goats within 14 days of freshening.

Do not dip animals less than 3 months old in dioxathion. Do not reapply spray or dip within 2 weeks. Do not use dioxathion on milk goats.

Do not use toxaphene on animals less than 3 months old.

Do not use lindane on emaciated or lactating animals, except in a smear for screw-worm control. Do not use lindane, DDT, or toxaphene on milk goats. Do not dip, spray, or dust animals less than 3 months old with lindane. Do not treat young animals with dips or sprays containing more than 0.03 percent of lindane.

Do not use malathion on animals less than 1 month old. Do not apply to dairy goats.

Do not use methoxychlor on lactating goats.

Do not reapply ronnel within 2 weeks. Do not apply on lactating dairy goats or dry goats within 21 days of freshening. Do not apply to animals receiving organic phosphate treatment from any other source.

Do not drench lambs under 30 pounds of body weight with Ruelene. Do not treat animals which are being fed in confinement. Do not treat lactating milk goats. Do not treat sick, weak, overbested, or pregnant animals within one month of lambing or kidding.

MONS 038831

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (p. p. m. in fat unless otherwise indicated)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
SWINE							
Lice	Carbaryl	--	7	WP, 0.5% S	1 qt.	Spray thoroughly. Repeat as needed.	Do not apply carbaryl more often than once every 4 days or Clodrin more often than once a week. Do not use coumaphos on animals less than 3 months old. Spray animals 3-6 months old only lightly. Do not use with synergized pyrethrins, allethrin, or synergist. Do not spray animals for 10 days before or after shipping or weaning or after exposure to disease. Do not apply in conjunction with oral drenches or other medications, such as phenothiazine or with other organic phosphates. Do not reapply dioxathion or ronnel within 2 weeks. Do not dip animals less than 3 months old in dioxathion. Withdraw bedding treated with ronnel 14 days before slaughter. Do not apply ronnel to animals receiving organic phosphate treatment from any other source. Do not use malathion on animals less than 1 month old. Do not treat young animals with dips or sprays containing more than 0.03% lindane. Do not dip, spray, or dust animals less than 3 months old with lindane. Do not treat sows within 2 weeks of farrowing or for at least 3 weeks thereafter. Do not use toxaphene on animals less than 3 months old.
	Clodria	--	--	EC, 0.5 - 1% S	1-2 pt.	Spray thoroughly. Repeat once a week or as necessary.	
				EC, 0.15 - 0.3% S	1-4 qt.		
				EC, 0.1 - 0.25% S	1-2 gal. (1 gal. 0.25%)	Repeat application after 14 days.	
	Coumaphos	1 meat and fat	--	WP, 0.06% S	Depending on size of animals and amount of hair	Immerse, spray, or dust thoroughly. Use lindane dusts and DDT dusts and sprays only once, but repeat other treatments after 2 - 3 weeks if needed.	
	DDT	7	30	EC or WP, 0.5% dip or S			
				10% D			
	Dioxathion	1	--	EC, 0.15% dip or S			
	Lindane	4	30(S) 60 (dip)	EC or WP, 0.05 - 0.06% dip or S			
			30 (D)	1% D			
	Malathion	4 meat	--	EC or WP, 0.5% dip or S			
				4 - 5% D			
	Methoxychlor	3	--	EC or WP, 0.5% dip or S			
	Ronnel	--	42	EC, 0.25% S			
			14	5% G	0.5 lb./100 sq. ft. bedding	--	
	Toxaphene	7	28	EC or WP, 0.5% S	Depending on size of animals and amount of hair	Spray thoroughly. Repeat after 2 - 3 weeks, if needed.	

MDNS 038832

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (*p. p. m. in fat unless otherwise indicated*)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
POULTRY							
Lice or mites	Coumaphos	1 meat and fat 0 eggs	--	WP, 0.25% S	1 gal./1,000 sq. ft. of surface	Thorough coverage.	Do not contaminate feed or water, or water utensils or feed troughs. Do not spray in a confined, non-ventilated area. Do not use coumaphos more often than once a week. Do not use coumaphos dust or spray on birds within 10 days of vaccination or other stress influence or in conjunction with other organic phosphates. Provide thorough ventilation while dusting.
				5% D	2 oz./100 sq. ft. of surface or 2 oz. per 30 sq. ft. of litter		
				0.5% D	1 lb./20 sq. ft. of litter		
				WP, 0.25% S	1 gal./100 birds	Direct on birds.	
				0.5% D	1 lb./100 birds		
	Malathion	4 meat 0 eggs	--	3% roost paint	1 pt./150 ft.	Paint roosts thoroughly.	
				EC or WP, 1% S	1-2 gal./1,000 sq.ft.	Thorough coverage. Force into cracks.	
				4-5% D	1 lb./50-60 sq. ft. of litter		
				4% D	1 lb./100 birds	Direct on birds. Dip only 3 or 4 inches of the tail.*	
				EC or WP, 0.5% S or 0.2% dip	1 gal./100 birds (1 gal./400 birds in dip)		
	Naled	--	--	EC, 0.3% S	1 gal./100 birds	Apply as a light mist to birds, except heads.	Do not apply naled direct on chickens under 6 weeks old or on turkeys under 3 months old.
				EC, 0.3% S	2 gal./1,000 sq. ft.	Thorough coverage.	
	Carbaryl	5 meat and fat 0 eggs	7	5% D	1 lb./100 birds	Dust birds thoroughly. Repeat in 4 weeks if needed, but not more often.	

Continued

*Northern fowl mite (Ornithonyssus sylviarum), chicken body louse (Menacanthus stramineus), and shaft louse (Menopon gallinae).

MONS 038833

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (p. p. m. in fat unless otherwise indicated)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
POULTRY							
Lice or mites (con.)	Carbaryl (con.)	5 meat and fat 0 eggs	7	5% D	1 lb./40 sq. ft. of litter and roosts	Thorough coverage. Force into cracks.	Do not contaminate feed or water, or water utensils or feed troughs.
				WP, 0.5% S	1-2 gal./1,000 sq. ft.		
				4% water mist spray	1.5 gal./1,000 birds with electric fog machine	Direct on birds, roosts, and walls.	Do not spray in a confined, non-ventilated area.
				0.5% water mist spray	1 gal./100 birds with cylinder sprayer		Do not apply carbaryl spray on birds except in a water mist spray. Do not treat nest litter. Ventilate while spraying.
	Nicotine sulfate*	--	--	40% nicotine soln.	1 pt./150-200 ft.	Paint on roosts only.	
Lice only	Rotenone	--	--	1% D	1 lb./100 birds	Direct on birds, roosts, and nests.	
Depluming mite only (Knemidokoptes gallinae)	Sulfur	--	--	100% D	--	Dust or immerse thoroughly.	
				1-2 oz. WP/gal. water dip	--		
Fowl tick (Argas persicus)	Malathion	4 meat 0 eggs	--	EC or WP, 3% S	1-2 gal./1,000 sq. ft.	Thorough coverage of walls, ceilings, and floors. Force into cracks.	
	Carbaryl	5 meat and fat 0 eggs	7	WP, 2% S	1-2 gal./1,000 sq. ft.		
	Naled	--	--	EC, 0.3% S	2 gal./1,000 sq. ft.		Do not apply naled direct on chickens under 6 weeks old or on turkeys under 3 months old.

*Not for control of Dermanyssus gallinae.

MUNS 0388834

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (p. p. m. in fat unless otherwise indicated)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
LIVESTOCK AREAS							
Chiggers (outdoors only)	Chlordane	—	—	EC or WP, 1% S or 5% D	2 lb./acre	Spray or dust every 4 - 8 weeks or as needed.	Do not permit dairy animals or livestock being finished for slaughter to graze on areas treated with chlordane, lindane or toxaphene. Do not use any insecticide on crops or grazing areas unless specified on the container label. In using any insecticide, do not contaminate animal feed, water, milk, or milking equipment. Exclude dairy animals while spraying barns with insecticides other than Clodrin. Do not apply dichlorvos in a fog in areas where animals have received direct applications of this insecticide within 8 hours. Do not treat milk processing rooms with Clodrin. Remove dairy animals, calves under 1 month of age, and poultry from buildings prior to spraying with dimethoate. Do not treat milk processing rooms with dimethoate. Do not apply fenthion in dairy barns, milk processing rooms, or poultry houses. Do not use lindane in poultry houses.
	Lindane	—	—	EC or WP, 0.1% S, 1% D	0.5 lb./acre 1 lb./acre		
	Toxaphene	—	—	EC or WP, 1% S or 5% D	2 lb./acre		
	Malathion	—	—	EC, 0.25% S	0.5 - 1 lb./acre	Apply 1 day before turkeys are put on range. Repeat after 2 - 3 weeks.	
House fly (Musca domestica), face fly (M. autumnalis), and stable fly (Stomoxys calcitrans)* Inside or outside of barns**	Clodrin	—	—	EC, 1% S	1 gal./1,000 sq. ft.	Thorough coverage of resting surfaces.	
	Compound 4072	—	—	EC, 0.5% S	1 - 2 gal./1,000 sq. ft.		
	Diazinon	—	—	EC or WP, 0.5 - 1% S	1 - 2 gal./1,000 sq. ft.		
	Dichlorvos	—	—	1 - 2% dry B 0.1% liquid B	--	Broadcast or sprinkle daily or as needed where flies congregate.	
				1% dry B 0.1% liquid B	--		
				EC, 0.5% S	1 qt./1,000 sq. ft.	Spray exterior and interior surfaces.	
				0.5% oil 1% oil	2 pt./8,000 cu. ft. 1 pt./8,000 cu. ft.	Fog.	
	Dimethoate	—	—	EC, 1% S	1 gal./1,000 sq. ft.	Thorough coverage of resting surfaces.	
	Fenthion	—	—	EC, 0.75 - 1.5% S	2 gal./1,000 sq. ft.		
	Lindane	—	—	EC or WP, 0.3 - 0.5% S	1 gal./1,000 sq. ft.		
	Malathion	—	—	EC or WP, 2.5% S	1 - 2 gal./1,000 sq. ft.		

Continued

*Baits ineffective against stable flies. For face flies, spray sunny surfaces of barns, shelters, and fences where flies congregate.

**Dairy barns assumed to include milking parlors.

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ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (p. p. m. in fat unless otherwise indicated)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
LIVESTOCK AREAS							
House fly, (Musca domestica), face fly (M. autumnalis), and stable fly (Stomoxys calcitrans)* (con.)	Malathion	—	—	3.5% dry B 1.25% liquid B	—	Broadcast or sprinkle daily or as needed where flies congregate.	Do not use any insecticide on crops or grazing areas unless specified on the container label. In using any insecticide, do not contaminate animal feed, water, milk, or milking equipment. Exclude dairy animals while spraying barns with insecticides other than naled and synergized pyrethrins. Do not apply oil solution of naled directly on animals or in poultry houses when birds are present. Do not permit dairy animals or livestock being finished for slaughter to graze on areas treated with chlordane, DDT, or toxaphene.
Inside or outside of barns** (con.)	Methoxychlor	—	—	EC or WP, 2.5-5% S	1-2 gal./1,000 sq. ft.	Thorough coverage of resting surfaces.	
	Naled	—	—	1% in oil	1 fl. oz./3,000 cu. ft.	Space spray or fog.	
				0.5% dry B 0.5% liquid B	—	Broadcast or sprinkle daily or as needed where flies congregate.	
	Pyrethrins + synergist***	—	—	0.1-0.25% + 1-2% S	—	Space spray.	
	Ronnel	—	—	EC, 0.5-1% S	1-2 gal./1,000 sq. ft.	Thorough coverage of resting surfaces.	
				EC, 2% S	—	Spray poultry droppings under cages.	
				1% dry B 2% liquid B	—	Broadcast or sprinkle daily or as needed where flies congregate.	
	Trichlorfon	—	—	1-2% dry B 0.1% liquid B	—		
Outside of barns only	Chlordane	—	—	EC or WP, 2-2.5% S	1-2 gal. S/1,000 sq. ft.	Thorough coverage of exterior surfaces, vegetation, manure, and refuse. Use DDT also as a space spray.	
	DDT	—	—	EC or WP, 2-5% S	0.5-1 gal. S/1,000 sq. ft. or cu. ft.		
	Toxaphene	—	—	EC or WP, 5% S	0.5-1 gal. S/1,000 sq. ft.		
	Dichlorvos	—	—	EC or oil soln. 0.5% S	0.2 lb./acre	Apply with mist blower to cattle feed lots, stockyards, holding pens, corrals.	

*Baits ineffective against stable flies. For face flies, spray sunny surfaces of barns, shelters, and fences where flies congregate.
**Dairy barns assumed to include milking parlors.
***Piperonyl butoxide or sulfoxide.

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ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (p. p. m. in fat unless otherwise indicated)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
LIVESTOCK AREAS							
Imported fire ant (*Solenopsis saevissima richteri*) (outdoors only)	Mirex*	—	—	0.075% B 0.15% B 0.3% B**	10 lb. B/acre 5 lb. B/acre 2.5 lb. B/acre	Broadcast in infested areas.	Do not use any insecticide on crops or grazing areas unless specified on the container label.
Ticks (outdoors only)	Chlordane	—	—	EC or WP, 1% S or 5 or 10% D	1 - 3 lb./acre	Once or twice a year as needed.	In using any insecticide, do not contaminate animal feed, water, milk, or milking equipment.
	DDT	—	—	EC or WP, 1% S or 10% D	1 - 3 lb./acre		Do not permit dairy animals or livestock being finished for slaughter to graze on areas treated with chlordane, DDT, lindane, or toxaphene.
	Lindane	—	—	EC or WP, 0.1% S 1% D	0.5 lb./acre 1 lb./acre		
	Toxaphene	—	—	EC or WP, 1% S or 5 or 10% D	1 - 3 lb./acre		Do not make more than 3 applications of mirex in any 12-month period or more than 1 application in any 45 - 60 day period. (See container label.)

*Aldrin, chlordane, dieldrin, and heptachlor may be used to treat individual nests. Follow label instructions.
**This application in Federal-State cooperative program only.

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COMMODITY, STORAGE, AND INSECT	INSECTICIDE OR TREATMENT	TOLERANCE (p. p. m.)	FORMULATION	DOSAGE (active ingredient per 1,000 cu. ft. unless otherwise stated)	HOW, WHERE, AND WHEN TO APPLY	SAFETY RESTRICTIONS
MILK, DRY						
In packages Dermestids	Inspection	—	—		Make certain that no insects are on multiwall paper bags or in drums or barrels before they are filled with dry milk.	Fumigants should be applied only by a trained operator. Aerate after fumigation with methyl bromide. Do not get insecticide in milk or on any utensil, equipment, container, or work surface that will come into direct contact with the milk. Aerosols may be used against exposed insects only.
	Methyl bromide	128 (inorganic bromide)	F	1 - 2 lb.	Fumigate 12 - 24 hr.	
In processing plant Beetles and moths	Malathion (premium grade)	—	1 pint 57% EC per 2.5 gal. water 1.5 lb. 25% WP per 2.5 gal. water	To point of runoff.	Apply as coarse spray to all places where insects might hide or crawl. Spray every month and immediately after vacuuming and cleaning, between April 1 and November 1 in cold areas, and throughout the year in warmer areas. Malathion breaks down rapidly on concrete surfaces.	
	Malathion (premium grade)	—	D (4 - 5%)	Light application.	With a blower, blow dust into cracks and behind or underneath equipment, or around electrical connections where liquids would cause short circuits.	
	Pyrethrum + piperonyl butoxide	—	Oil soln. (0.2 + 2.0%)	To point of runoff.	For direct contact with insects; there is little residual toxicity. Spray in areas where insects are observed. Aerosols are not recommended.	
	Pyrethrum + synergist	—	D (0.5-1%)	Light application	With a blower, blow dust into cracks and behind or underneath equipment, or around electrical connections where liquids would cause short circuits.	

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GRADE "A" PASTEURIZED MILK ORDINANCE



1965 Recommendations of the United States Public Health Service

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Public Health Service

MONS 038840

GRADE "A" PASTEURIZED MILK ORDINANCE

1965 Recommendations
of the United States
Public Health Service

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Bureau of Disease Prevention and Environmental Control
National Center for Urban and Industrial Health
Environmental Sanitation Program

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LIST OF PREVIOUS EDITIONS OF MILK ORDINANCES RECOMMENDED BY THE UNITED STATES PUBLIC HEALTH SERVICE

1924. *Ordinance* only. Reprint No. 971 from *Public Health Reports* of November 7, 1924.
1926. *Ordinance* only. Reprint No. 1099 from *Public Health Reports* of July 30, 1926.
1927. *Ordinance and Code.* Mimeographed tentative draft, November 1927.
1929. *Ordinance and Code.* Mimeographed, July 1929.
1929. *Ordinance and Code.* Mimeographed, September 1929.
1931. *Ordinance and Code.* Mimeographed, September 1931.
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1933. *Ordinance and Code.* Rotoprinted, December 1933.
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1939. *Ordinance* only. Mimeographed, November 1939.
1939. *Ordinance and Code.* Printed as *Public Health Bulletin No. 220*, 1939 edition, February 1940.
1947. *Ordinance* only. Mimeographed tentative draft, August 1947.
1949. *Ordinance* only. Multilithed, April 1949.
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FOREWORD

The milk sanitation program of the United States Public Health Service is one of its oldest and most respected activities. The interest of the Public Health Service in milk sanitation stems from two important public health considerations. First, of all foods, none surpasses milk as a single source of those dietary elements needed for the maintenance of proper health—especially in children and older citizens. For this reason, the Service has for many years promoted increased milk consumption. Second, milk has a potential to serve as a carrier of disease and has, in the past, been associated with disease outbreaks of major proportions.

The incidence of milkborne illness in the United States has been sharply reduced in recent years. In 1938, milkborne outbreaks constituted 25 percent of all disease outbreaks due to infected foods and contaminated water. Our most recent information reveals that milk and fluid milk products are associated with only 2½ percent of such reported outbreaks. Many groups have contributed to this commendable achievement, including public health and agricultural agencies, the dairy and related industries, the several interested professional groups, educational institutions, and the consuming public. The Public Health Service is proud to have contributed to the protection and improvement of the milk supply of the Nation through technical assistance, training, research, standards development, evaluation, and certification activities.

Despite the progress that has been made, occasional milkborne outbreaks of illness still occur, emphasizing the need for continued vigilance at every stage of production, processing, pasteurization, and distribution of milk and milk products. During the past decade, problems associated with the sanitary control of milk and milk products have become extremely complex because of new products, new processes, new chemicals, new materials, and new marketing patterns, which must be evaluated in terms of their public health significance. The *Grade A Pasteurized Milk Ordinance—1965 Recommendations of the United States Public Health Service* translates this new knowledge and technology into effective and practicable public health practices.

The responsibility for insuring the ready availability and safety of milk and milk products is not confined to an individual community

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or a State, or to the Federal Government—it is the concern of the entire Nation. With the continued cooperation of all interested groups, both Government and industry, engaged in the sanitary control of milk and milk products, such responsibility can be accepted with confidence.

RICHARD D. VAUGHAN,
Chief, Environmental Sanitation Program.

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ICHARD D. VAUGHAN,
ntal Sanitation Program.

PREFACE

The activities of the Public Health Service in milk sanitation began at the turn of the century with studies on the role of milk in the spread of disease. This work led to the conclusion that effective public health control of milkborne disease requires the application of sanitation measures throughout the production, handling, pasteurization, and distribution of milk. These early studies were followed by research to identify and evaluate sanitary measures which might be used to control disease, including studies which led to improvement of the pasteurization process.

To assist States and municipalities in initiating and maintaining effective programs for prevention of milkborne disease, the Public Health Service in 1924 developed a model regulation, known as the "*Standard Milk Ordinance*," for voluntary adoption by State and local milk control agencies. To provide for uniform interpretation of this *Ordinance*, an accompanying *Code* was published in 1927 which provided administrative and technical details as to satisfactory compliance. This model milk regulation, now titled the *Grade A Pasteurized Milk Ordinance—1965 Recommendations of the United States Public Health Service*, represents the 13th revision since 1924 and incorporates new knowledge into public health practice.

The *Grade A Pasteurized Milk Ordinance* was not produced by the Public Health Service alone. As with every preceding edition, it was developed with the assistance of milk sanitation and regulatory agencies in every level of Federal, State, and local government including both health and agriculture departments; all segments of the dairy industry including producers, plant operators, equipment manufacturers, and associations; many educational and research institutions; and with helpful comments from many individual sanitarians, citizens, doctors, lawyers, and legislators. More than 5,000 separate and constructive recommendations were received after the Public Health Service requested critical review of nearly 3,000 widely distributed prepublication draft copies. Most careful consideration was given to every comment submitted.

A panel of 12 experienced milk sanitation specialists, representing particular competencies in the fields of milk production, processing, administration, education, and technology, assisted the Public Health

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Service in evaluating the literally thousands of recommendations relating to the revision of the *Milk Ordinance and Code—1953 Recommendations of the Public Health Service*. The counsel and guidance rendered by these authorities in the preparation of this edition of the *Pasteurized Milk Ordinance* are deeply appreciated. The panel consisted of the following members:

HAROLD J. BARNUM, Denver City-County Department of Health and Hospitals, Denver, Colo.

GEORGE BAUER, Department of Public Health and Welfare, Springfield, Mo.

PAUL CORASH, Metropolitan Dairy Institute, Inc., New York, N.Y.

WILLIAM A. DEAN, Jr., Bowman Dairy Co., Chicago, Ill.

G. A. HOURAN, The DeLaval Separator Co., Poughkeepsie, N.Y.

SHELBY JOHNSON, Kentucky State Department of Health, Frankfort, Ky.

ROBERT W. METZGER, D.V.M., Dairymen's League Co-operative Association, Inc., Syracuse, N.Y.

ALFRED E. REYNOLDS, California State Department of Agriculture, Sacramento, Calif.

ELBRIDGE D. SULLIVAN, Central Oklahoma Milk Producer's Association, Lawton, Okla.

CLINTON VAN DEVENDER, Mississippi State Board of Health, Jackson, Miss.

H. H. VAUX, Indiana State Board of Health, Indianapolis, Ind.

K. G. WECKEL, Ph. D., The University of Wisconsin, Madison, Wis.

As of December 1964, the *Milk Ordinance* recommended by the Public Health Service (1953 edition) was the basis of the milk sanitation law or regulations of 37 States. Its provisions have been voluntarily adopted by 1,435 municipalities and 512 counties located in 40 States. Included are 71 cities of over 100,000 population and 72 cities with population between 50,000 and 100,000. Almost 110 million people in this country live in jurisdictions utilizing the provisions of the Public Health Service recommended *Milk Ordinance*.

The Public Health Service recommended *Milk Ordinance* is the basic standard used in the voluntary Cooperative State-PHS Program for Certification of Interstate Milk Shippers. It is incorporated by reference in Federal specifications for procurement of milk and milk products; is used as the sanitary regulation for milk and milk products served on interstate carriers; and is recognized by the public health

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agencies, the milk industry, and many others as a national standard for milk sanitation.

The *Grade A Pasteurized Milk Ordinance—1965 Recommendations of the United States Public Health Service*, adopted and uniformly applied, will continue to provide effective public health protection without being unduly burdensome to either regulatory agencies or the dairy industry. It represents a "grass-roots" concensus of current knowledge and experiences and as such represents a practical and equitable milk sanitation standard for the Nation.

WILLIAM C. MILLER, JR.,
Acting Chief, Milk and Food Branch,
Environmental Sanitation Program.

MDNS 038847

INTRODUCTION

The following *Pasteurized Milk Ordinance*, with Appendixes, is recommended for legal adoption by States, counties, and municipalities, in order to encourage a greater uniformity and a higher level of excellence of milk sanitation practice in the United States. An important purpose of this recommended standard is to facilitate the shipment and acceptance of milk and milk products of high sanitary quality in interstate and intrastate commerce.

This edition of the *Ordinance* contains sanitary standards for Grade A pasteurized milk and milk products only.

Outline of Contents.—As shown by the table of contents, the publication consists of two parts and the appendixes.

Part I is the unabridged form of the *Ordinance*, arranged and presented in a form which can be adopted as an ordinance or as any other legal instrument. Section I defines milk and those milk products which are to be controlled under it. Communities desiring to regulate cottage cheese and creamed cottage cheese under the terms of this *Ordinance* can optionally insert these products in this section as defined in footnote 4. Section I also specifies those milks and milk products which are not intended to be regulated under this *Ordinance*, such as ice cream, evaporated milk, sterile milk and milk products, butter, etc. Section 7 establishes the sanitation standards for Grade A milk and milk products and specifies, as well, the chemical, bacteriological, and temperature requirements thereof. Section 11 regulates milk and milk products received from points beyond the limits of routine inspection and supervision. Sections 8 and 13 include requirements relating to animal health and personal health, respectively. The other sections are largely concerned with various phases of administration and enforcement of the *Ordinance;* e.g., permits, labeling, inspection, laboratory examinations, future construction, etc.

Part II contains the *Ordinance*, together with administrative procedures which are designed to unify the interpretation of the *Ordinance* and, particularly in the case of the sanitation requirements contained therein, provide details as to methods of satisfactory compliance. It will be noted that Section 15 of the *Pasteurized Milk Ordinance* provides that enforcement of the *Ordinance* shall be in ac-

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cordance with the administrative procedures contained in Part II thereof.

The *Appendixes* are 12 in number, containing detailed, explanatory material on various aspects of milk sanitation technology and administration—e.g., individual water supply and sewage disposal system standards; pasteurization equipment specifications and tests; industry dairy farm inspector certification procedures; milk production methods; examples of inspection and ledger forms, etc. Where mandatory compliance with specific provisions of the appendixes is referenced in the *Pasteurized Milk Ordinance*, such provisions shall be deemed a legal requirement of the *Ordinance*.

Appendix K contains the adoption-by-reference form of the recommended *Pasteurized Milk Ordinance*. The short form reduces the cost of publishing and printing and helps to keep the *Ordinance* up to date, since it is readily amendable. It is suggested for adoption in those jurisdictions where adoption of ordinances by reference to published standards is considered legal.

Legal Aspects.—Recommendations concerning legal aspects have been suggested from time to time by the Office of the General Counsel of the U.S. Department of Health, Education, and Welfare, and have been incorporated into the *Ordinance*. Other changes have also been incorporated on the advice of various State and local legal counsel.

The *Ordinance* has been widely adopted and used for many years, and has been upheld by court actions. One of the most comprehensive decisions upholding the various provisions of the *Ordinance* was that of the district court, Reno County, Kans., in the case of *Billings et al.* v. *City of Hutchinson et al.*, decided May 1, 1934. In this action, the plaintiffs unsuccessfully sought to enjoin the enforcement of the Hutchinson ordinance on the grounds that (*a*) it was unreasonable, (*b*) it conflicted with State statutes, (*c*) the license fees provided in the local ordinance (but not in the *Ordinance* recommended by the Public Health Service) were in excess of expenses, and (*d*) the milk inspector was clothed with arbitrary powers (Reprint No. 1629 from *Public Health Reports* of June 8, 1934).

The model ordinance discourages the use of public health regulations to establish unwarranted trade barriers against the acceptance of high quality milk from other milksheds (Sec. 11). On repeated requests of the Association of State and Territorial Health Officers and of the National Conference on Interstate Milk Shipments, the Public Health Service is cooperating actively in a voluntary program for certification of interstate milk shippers. Such a program would

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be impossible without widespread agreement on uniform standards, such as those of the recommended *Ordinance*.

This program of interstate milk certification was supported also by the Committee on Agriculture and Forestry of the U.S. Senate, which "strongly recommended" (in its Report on Utilization of Farm Crops, Aug. 1, 1961), "that the *Milk Ordinance* of the Public Health Service should be used as the minimum standard for the sanitary rating and acceptance of interstate milk shipments."

The value of these standards as a means of overcoming interstate trade barriers was recognized by the U.S. Supreme Court in the case of the *Dean Milk Company* v. *City of Madison*. The Court reversed the decision of the Wisconsin Supreme Court which had sustained an ordinance requirement imposing a 5-mile limit on the location of pasteurization plants selling milk in Madison, and pointed out that Madison consumers would be adequately safeguarded if the city relied upon the provisions of Section 11 of the Public Health Service recommended *Milk Ordinance* (No. 258—October term, 1950).

The Public Health Service has no legal jurisdiction in the enforcement of milk sanitation standards except on interstate carriers. Elsewhere, it serves solely in an advisory and stimulative capacity. Its program is designed primarily to assist State and local regulatory agencies. Its aim is to promote the establishment of effective and well-balanced milk sanitation programs in each State, to stimulate the adoption of adequate and uniform State and local control legislation, and to encourage the application of uniform enforcement procedures through appropriate legal and educational measures.

When this *Ordinance* is adopted locally, its enforcement becomes a function of the local or State authorities. Consequently, the *Ordinance* should be adopted only if adequate provision can be made for qualified personnel and for suitable laboratory facilities. Small municipalities which cannot afford to provide these services should arrange for supervision by the county or State health department, or seek cooperation with neighboring municipalities in organizing a milk-control district or area.

The charter and the legal counsel of the government unit involved should be consulted for information or advice on proper legal procedures, such as the recording and advertising of the *Ordinance* after passage.

Adoption.—In the interest of national uniformity, it is recommended that no changes be made in this *Ordinance* when adopted by a State or local community, unless changes are necessary to avoid conflict with State law. Modifications should be contemplated with extreme caution so as not to render the *Ordinance* unenforceable.

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Amendment of Existing Regulations.—States and communities that have adopted the 1953, or an earlier, edition of the PHS recommended *Milk Ordinance* are urged to bring such *Ordinance* up to date in order to take advantage of the most current developments in milk sanitation and administration. States and communities whose milk sanitation law or regulations are not based on past PHS recommended milk sanitation ordinances are urged to consider the attendant public health benefits, as well as those economic in nature, which can accrue upon adoption and implementation of the *Pasteurized Milk Ordinance.*

Acknowledgments.—The basic responsibility for the preparation and publication of this *Pasteurized Milk Ordinance* was assumed by the Milk Sanitation Section of the Milk and Food Branch, Environmental Sanitation Program, under the direction of Darold W. Taylor, Sanitarian Director, with invaluable assistance from the operational and research milk and food consultants of the Public Health Service. Particular credit is due to Luther A. Black, Ph. D., Robert B. Carson, Frederick O. DeSieghardt, Joe L. Perrin, Richard W. Peterson, Kenneth L. Pool, and Irving H. Schlafman for their very substantial contributions.

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PART I

GRADE A PASTEURIZED MILK ORDINANCE—1965 RECOMMENDATIONS OF THE UNITED STATES PUBLIC HEALTH SERVICE

An ordinance defining "milk" and certain "milk products," "milk producer," "pasteurization," etc.; prohibiting the sale of adulterated and misbranded milk and milk products; requiring permits for the sale of milk and milk products; regulating the inspection of dairy farms and milk plants, and the examination, labeling, pasteurization, distribution and sale of milk and milk products; providing for the construction of future dairy farms and milk plants, the enforcement of this Ordinance, and the fixing of penalties.

Be it ordained by the ---------- of ---------- [a-1] as follows:

SECTION 1. DEFINITIONS

The following definitions shall apply in the interpretation and the enforcement of this *Ordinance:*

A. Milk.—Milk is hereby defined to be the lacteal secretion, practically free from colostrum, obtained by the complete milking of one or more healthy cows, which contains not less than 8¼ percent milk solids-not-fat and not less than 3¼ percent milkfat. (Milkfat or butterfat is the fat of milk.)

A-1. Goat Milk.—Goat milk is the lacteal secretion, practically free from colostrum, obtained by the complete milking of healthy goats. The word "milk" shall be interpreted to include goat milk.

B. Cream.—Cream is the sweet, fatty liquid separated from milk, with or without the addition of milk or skim milk, which contains not less than 18 percent milkfat.

B-1. Light Cream, Coffee Cream, or Table Cream.—Light cream, coffee cream, or table cream is cream which contains not less than 18 percent but less than 30 percent milkfat.

B-2. Whipping Cream.—Whipping cream is cream which contains not less than 30 percent milkfat.

B-3. Light Whipping Cream.—Light whipping cream is cream that contains not less than 30 percent but less than 36 percent milkfat.

[a] Numbered footnotes are assembled on p. 91.

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B-4. Heavy Cream or Heavy Whipping Cream.—Heavy cream or heavy whipping cream is cream which contains not less than 36 percent milkfat.

B-5. Whipped Cream.—Whipped cream is whipping cream into which air or gas has been incorporated.[2]

B-6. Whipped Light Cream, Coffee Cream, or Table Cream.—Whipped light cream, coffee cream, or table cream is light cream, coffee cream, or table cream into which air or gas has been incorporated.[2]

B-7. Sour Cream or Cultured Sour Cream.—Sour cream or cultured sour cream is a fluid or semifluid cream resulting from the souring, by lactic acid producing bacteria or similar culture, of pasteurized cream, which contains not less than 0.20 percent acidity expressed as lactic acid.[2]

C. Half-and-Half.—Half-and-half is a product consisting of a mixture of milk and cream which contains not less than 10.5 percent milkfat.[2]

C-1. Sour Half-and-Half or Cultured Half-and-Half.—Sour half-and-half or cultured half-and-half is fluid or semifluid half-and-half derived from the souring, by lactic acid producing bacteria or similar culture, of pastourized half-and-half, which contains not less than 0.20 percent acidity expressed as lactic acid.[2]

D. Reconstituted or Recombined Milk and Milk Products.—Reconstituted or recombined milk and/or milk products shall mean milk or milk products defined in this section which result from the recombining of milk constituents with potable water.[2] [3]

E. Concentrated Milk.—Concentrated milk is a fluid product, unsterilized and unsweetened, resulting from the removal of a considerable portion of the water from milk, which, when combined with potable water, results in a product conforming with the standards for milkfat and solids-not-fat of milk as defined above.[2]

E-1. Concentrated Milk Products.—Concentrated milk products shall be taken to mean and to include homogenized concentrated milk, vitamin D concentrated milk, concentrated skim milk, fortified concentrated skim milk, concentrated lowfat milk, fortified concentrated lowfat milk, concentrated flavored milk, concentrated flavored milk products, and similar concentrated products made from concentrated milk or concentrated skim milk, and which, when combined with potable water in accordance with instructions printed on the container, conform with the definitions of the corresponding milk products in this section.[2]

E-2. Frozen Milk Concentrate.—Frozen milk concentrate is a frozen milk product with a composition of milkfat and milk solids not

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fat in such proportions that when a given volume of concentrate is mixed with a given volume of water the reconstituted product conforms to the milkfat and milk solids not fat requirements of whole milk. In the manufacturing process, water may be used to adjust the primary concentrate to the final desired concentration. The adjusted primary concentrate is pasteurized, packaged, and immediately frozen. This product is stored, transported, and sold in the frozen state.[7]

F. Skim Milk or Skimmed Milk.—Skim milk or skimmed milk is milk from which sufficient milkfat has been removed to reduce its milkfat content to less than 0.50 percent.[8]

G. Lowfat Milk.—Lowfat milk is milk from which a sufficient portion of milkfat has been removed to reduce its milkfat content to not less than 0.50 percent and not more than 2.0 percent.[9]

H. Vitamin D Milk and Milk Products.—Vitamin D milk and milk products are milk and milk products, the vitamin D content of which has been increased by an approved method to at least 400 U.S.P. units per quart.[2]

I. Fortified Milk and Milk Products.—Fortified milk and milk products are milk and milk products other than vitamin D milk and milk products, the vitamin and/or mineral content of which have been increased by a method and in an amount approved by the health authority.[3]

J. Homogenized Milk.—Homogenized milk is milk which has been treated to insure breakup of the fat globules to such an extent that, after 48 hours of quiescent storage at 45° F., no visible cream separation occurs on the milk, and the fat percentage of the top 100 milliliters of milk in a quart, or of proportionate volumes in containers of other sizes, does not differ by more than 10 percent from the fat percentage of the remaining milk as determined after thorough mixing. The word "milk" shall be interpreted to include homogenized milk.[3]

K. Flavored Milk or Milk Products.—Flavored milk or milk products shall mean milk and milk products as defined in this *Ordinance* to which has been added a flavor and/or sweetener.[3]

K-1. Eggnog Flavored Milk.—Eggnog flavored milk is a milk product consisting of a mixture of at least 3.25 percent butterfat, at least 0.5 percent egg yolk solids, sweetener, and flavoring. Emulsifier and a maximum of 0.5 percent stabilizer may be added.

K-2. Eggnog.—Eggnog is a milk product consisting of a mixture of milk or milk product of at least 6.0 percent butterfat, at least 1.0 percent egg yolk solids, sweetener, and flavoring. Emulsifier and not over 0.5 percent stabilizer may be added.

L. Buttermilk.—Buttermilk is a fluid product resulting from the manufacture of butter from milk or cream. It contains not less than 8¼ percent of milk solids-not-fat.[2]

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L-1. Cultured Buttermilk.—Cultured buttermilk is a fluid product resulting from the souring, by lactic acid producing bacteria or similar culture, of pasteurized skim milk or pasteurized lowfat milk.[8]

M. Cultured Milk or Cultured Whole Milk Buttermilk.—Cultured milk or cultured whole milk buttermilk is a fluid product resulting from the souring, by lactic acid producing bacteria or similar culture, of pasteurized milk.[8]

N. Acidified Milk and Milk Products.—Acidified milk and milk products are milk and milk products obtained by the addition of food grade acids to pasteurized cream, half-and-half, milk, lowfat milk, or skim milk, resulting in a product acidity of not less than 0.20 percent expressed as lactic acid.[8]

O. Milk Products.—Milk products include cream, light cream, coffee cream, table cream, whipping cream, light whipping cream, heavy cream, heavy whipping cream, whipped cream, whipped light cream, whipped coffee cream, whipped table cream, sour cream, cultured sour cream, half-and-half, sour half-and-half, cultured half-and-half, reconstituted or recombined milk and milk products, concentrated milk, concentrated milk products, skim milk, skimmed milk, lowfat milk, fortified milk and milk products, vitamin D milk and milk products, homogenized milk, flavored milk or milk products, eggnog, eggnog flavored milk, buttermilk, cultured buttermilk, cultured milk, cultured whole milk buttermilk, and acidified milk and milk products.[2,3,4]

This definition is not intended to include such products as sterilized milk and milk products hermetically sealed in a container and so processed, either before or after sealing, as to prevent microbial spoilage, or evaporated milk, condensed milk, ice cream and other frozen desserts, butter, dry milk products (except as defined herein), or cheese except when they are combined with other substances to produce any pasteurized milk or milk product defined herein.

P. Grade A Dry Milk Products.—Grade A dry milk products are milk products which have been produced for use in Grade A pasteurized milk products and which have been manufactured under the provisions of *Grade A Dry Milk Products—Recommended Sanitation Ordinance and Code for Dry Milk Products Used in Grade A Pasteurized Milk Products.*

Q. Optional Ingredients.—Optional ingredients shall mean and include Grade A dry milk products, concentrated milk, concentrated milk products, flavors, sweeteners, stabilizers, emulsifiers, acidifiers, vitamins, minerals, and similar ingredients.

R. Adulterated Milk and Milk Products.—Any milk or milk product shall be deemed to be adulterated (1) if it bears or contains any poisonous or deleterious substance in a quantity which may render it

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injurious to health; (2) if it bears or contains any added poisonous or deleterious substance for which no safe tolerance has been established by State or Federal regulation, or in excess of such tolerance if one has been established; (3) if it consists, in whole or in part, of any substance unfit for human consumption; (4) if it has been produced, processed, prepared, packed, or held under insanitary conditions; (5) if its container is composed, in whole or in part, of any poisonous or deleterious substance which may render the contents injurious to health; or (6) if any substance has been added thereto or mixed or packed therewith so as to increase its bulk or weight, or reduce its quality or strength, or make it appear better or of greater value than it is.

R–1. Misbranded Milk and Milk Products.—Milk and milk products are misbranded (1) when their container(s) bear or accompany any false or misleading written, printed or graphic matter; (2) when such milk and milk products do not conform to their definitions as contained in this *Ordinance;* and (3) when such products are not labeled in accordance with Section 4 of this *Ordinance.*

S. Pasteurization.—The terms "pasteurization," "pasteurized," and similar terms shall mean the process of heating every particle of milk or milk product to at least 145° F., and holding it continuously at or above this temperature for at least 30 minutes, or to at least 161° F., and holding it continuously at or above this temperature for at least 15 seconds, in equipment which is properly operated and approved by the health authority: *Provided,* That milk products which have a higher milkfat content than milk and/or contain added sweeteners shall be heated to at least 150° F., and held continuously at or above this temperature for at least 30 minutes, or to at least 166° F., and held continuously at or above this temperature for at least 15 seconds: *Provided further,* That nothing in this definition shall be construed as barring any other pasteurization process which has been recognized by the United States Public Health Service to be equally efficient and which is approved by the State health authority.

T. Sanitization.—Sanitization is the application of any effective method or substance to a clean surface for the destruction of pathogens, and of other organisms as far as is practicable. Such treatment shall not adversely affect the equipment, the milk or milk product or the health of consumers, and shall be acceptable to the health authority.

U. Milk Producer.—A milk producer is any person who operates a dairy farm and provides, sells, or offers milk for sale to a milk plant, receiving station, or transfer station.

V. Milk Hauler.—A milk hauler is any person who transports raw milk and/or raw milk products to or from a milk plant, a receiving or transfer station.

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W. Milk Distributor.—A milk distributor is any person who offers for sale or sells to another any milk or milk products.

X. Health Authority.—The health authority shall mean the ---------- of the ----------[1] or his authorized representative. The term, "Health Authority," wherever it appears in this *Ordinance*, shall mean the appropriate agency having jurisdiction and control over the matters embraced within this *Ordinance*.

Y. Dairy Farm.—A dairy farm is any place or premises where one or more cows or goats are kept, and from which a part or all of the milk or milk product (s) is provided, sold, or offered for sale to a milk plant, transfer station, or receiving station.

Z. Milk Plant and/or Receiving Station.—A milk plant and/or receiving station is any place, premises, or establishment where milk or milk products are collected, handled, processed, stored, pasteurized, bottled, or prepared for distribution.

Z-1. Transfer Station.—A transfer station is any place, premises, or establishment where milk or milk products are transferred directly from one transport tank to another.

AA. Official Laboratory.—An official laboratory is a biological, chemical, or physical laboratory which is under the direct supervision of the State or a local health authority.

BB. Officially Designated Laboratory.—An officially designated laboratory is a commercial laboratory authorized to do official work by the supervising agency, or a milk industry laboratory officially designated by the supervising agency for the examination of producer samples of Grade A raw milk for pasteurization.

CC. Person.—The word "person" shall mean any individual, plant operator, partnership, corporation, company, firm, trustee, or association.

DD. And/or.—Where the term "and/or" is used, "and" shall apply where appropriate, otherwise "or" shall apply.

SECTION 2. ADULTERATED OR MISBRANDED MILK OR MILK PRODUCTS

No person shall, within the municipality of ---------- of ----------,[1] or its police jurisdiction, produce, provide, sell, offer, or expose for sale, or have in possession with intent to sell any milk or milk product which is adulterated or misbranded: *Provided*, That in an emergency, the sale of pasteurized milk and milk products which have not been graded, or the grade of which is unknown, may be authorized by the health authority, in which case such products shall be labeled "ungraded."

Any adulterated or misbranded milk or milk product may be impounded by the health authority and disposed of in accordance with applicable laws or regulations.

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SECTION 3. PERMITS

It shall be unlawful for any person who does not possess a permit from the health authority of the ---------- of ---------- [1] to bring into, send into, or receive into the ---------- of ---------- [1] or its police jurisdiction, for sale, or to sell, or offer for sale therein, or to have in storage any milk or milk products defined in this *Ordinance: Provided*, That, grocery stores, restaurants, soda fountains, and similar establishments where milk or milk products are served or sold at retail, but not processed, may be exempt from the requirements of this section.

Only a person who complies with the requirements of this *Ordinance* shall be entitled to receive and retain such a permit. Permits shall not be transferable with respect to persons and/or locations.

The health authority shall suspend such permit, whenever he has reason to believe that a public health hazard exists; or whenever the permit holder has violated any of the requirements of this *Ordinance;* or whenever the permit holder has interfered with the health authority in the performance of his duties: *Provided*, That the health authority shall, in all cases except where the milk or milk product involved creates, or appears to create, an imminent hazard to the public health; or in any case of a willful refusal to permit authorized inspection, serve upon the holder a written notice of intent to suspend permit, which notice shall specify with particularity the violation(s) in question and afford the holder such reasonable opportunity to correct such violation(s) as may be agreed to by the parties, or in the absence of agreement, fixed by the health authority, before making any order of suspension effective. A suspension of permit shall remain in effect until the violation has been corrected to the satisfaction of the health authority.

Upon written application of any person whose permit has been suspended, or upon application within 48 hours of any person who has been served with a notice of intention to suspend, and in the latter case before suspension, the health authority shall within 72 hours proceed to a hearing to ascertain the facts of such violation or interference and upon evidence presented at such hearing shall affirm, modify, or rescind the suspension or intention to suspend.

Upon repeated violation(s), the health authority may revoke such permit following reasonable notice to the permit holder and an opportunity for a hearing. This section is not intended to preclude the institution of court action as provided in Sections 5 and 6.

SECTION 4. LABELING

All bottles, containers, and packages enclosing milk or milk products defined in Section 1 shall be conspicuously labeled or marked with (1) the name of the contents as given in the definitions of this *Ordinance;*

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(2) the word "reconstituted" or "recombined" if the product is made by reconstitution or recombination;[a] (3) the grade of the contents; (4) the word "pasteurized" if the contents are pasteurized and the identity of the plant where pasteurized; (5) the word "raw" if the contents are raw and the name or other identity of the producer; (6) the designation "Vitamin D" and the number of U.S.P. units per quart in the case of vitamin D milk or milk products; (7) the volume or proportion of water to be added for recombining in the case of concentrated milk or milk products; (8) the words "nonfat milk solids added" and the percentage added if such solids have been added, except that this requirement shall not apply to reconstituted or recombined milk or milk products; (9) the words "artificially sweetened" in the name if non-nutritive and/or artificial sweeteners are used; and (10) the common name of stabilizers, distillates, and ingredients: *Provided*, That (a) only the identity of the milk producer shall be required on cans delivered to a milk plant which receives only Grade A raw milk for pasteurization, and which immediately dumps, washes, and returns the cans to the milk producer; (b) the identity of both milk producer and the grade shall be required on cans delivered to a milk plant which receives both Grade A raw milk for pasteurization and ungraded raw milk, and which immediately dumps, washes, and returns the cans to the milk producer; (c) in the case of concentrated milk products, the specific name of the product shall be substituted for the generic term "concentrated milk products," e.g., "homogenized concentrated milk," "concentrated skim milk," "concentrated chocolate milk," "concentrated chocolate flavored lowfat milk"; (d) in the case of flavored milk or flavored reconstituted milk, the name of the principal flavor shall be substituted for the word "flavored";[b] and (e) in the case of cultured milk and milk products, the special type culture used may be substituted for the word "cultured," e.g., "acidophilus buttermilk," "bulgarian buttermilk," and "yogurt."

All vehicles and transport tanks containing milk or milk products shall be legibly marked with the name and address of the milk plant or hauler in possession of the contents.

Tanks transporting raw milk and milk products to a milk plant from sources of supply not under the routine supervision of the health authority are required to be marked with the name and address of

[b] The Federal Food and Drug Administration considers the term "chocolate milk" misleading unless the flavoring ingredient used is "chocolate," "sweet chocolate," or "milk chocolate" complying with the appropriate standards of identity for these products. Milk and milk products flavored with "cocoa" may be labeled "chocolate flavored."

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the milk plant or hauler and shall be sealed; in addition, for each such shipment, a shipping statement shall be prepared containing at least the following information:

(1) Shipper's name, address, and permit number.
(2) Permit number of hauler, if not employee of shipper.
(3) Point of origin of shipment.
(4) Tanker identity number.
(5) Name of product.
(6) Weight of product.
(7) Grade of product.
(8) Temperature of product.
(9) Date of shipment.
(10) Name of supervising health authority at the point of origin.
(11) Whether the contents are raw, pasteurized, or otherwise heat treated.

Such statement shall be prepared in triplicate and shall be kept on file by the shipper, the consignee, and the carrier for a period of 6 months for the information of the health authority.

The labeling information which is required on all bottles, containers or packages of milk or milk products shall be in letters of an acceptable size, kind, and color satisfactory to the health authority and shall contain no marks or words which are misleading.

SECTION 5. INSPECTION OF DAIRY FARMS AND MILK PLANTS

Each dairy farm, milk plant, receiving station, and transfer station whose milk or milk products are intended for consumption within ----------[1] or its police jurisdiction shall be inspected by the health authority prior to the issuance of a permit. Following the issuance of a permit, each dairy farm and transfer station shall be inspected at least once every 6 months and each milk plant and receiving station shall be inspected at least once every 3 months. Should the violation of any requirement set forth in Section 7 be found to exist on an inspection, a second inspection shall be required after the time deemed necessary to remedy the violation, but not before 3 days; this second inspection shall be used to determine compliance with the requirements of Section 7. Any violation of the same requirement of Section 7 on such second inspection shall call for permit suspension in accordance with Section 3 and/or court action.

One copy of the inspection report shall be handed to the operator, or other responsible person, or be posted in a conspicuous place on an inside wall of the establishment. Said inspection report shall not be defaced and shall be made available to the health authority upon

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request. An identical copy of the inspection report shall be filed with the records of the health authority.

Every milk producer, hauler, distributor, or plant operator shall, upon request of the health authority, permit access of officially designated persons to all parts of his establishment or facilities to determine compliance with the provisions of this *Ordinance*. A distributor or plant operator shall furnish the health authority, upon request, for official use only, a true statement of the actual quantities of milk and milk products of each grade purchased and sold, and a list of all sources of such milk and milk products, records of inspections, tests, and pasteurization time and temperature records.

It shall be unlawful for any person who in an official capacity obtains any information under the provisions of this *Ordinance* which is entitled to protection as a trade secret (including information as to quantity, quality, source or disposition of milk or milk products, or results of inspections or tests thereof) to use such information to his own advantage or to reveal it to any unauthorized person.

SECTION 6. THE EXAMINATION OF MILK AND MILK PRODUCTS

During any consecutive 6 months, at least four samples of raw milk for pasteurization shall be taken from each producer and four samples of raw milk for pasteurization shall be taken from each milk plant after receipt of the milk by the milk plant and prior to pasteurization. In addition, during any consecutive 6 months, at least four samples of pasteurized milk and at least four samples of each milk product defined in this *Ordinance* shall be taken from every milk plant. Samples of milk and milk products shall be taken while in possession of the producer or distributor at any time prior to final delivery. Samples of milk and milk products from dairy retail stores, food service establishments, grocery stores, and other places where milk and milk products are sold shall be examined periodically as determined by the health authority; and the results of such examination shall be used to determine compliance with Sections 2, 4, and 10. Proprietors of such establishments shall furnish the health authority, upon his request, with the names of all distributors from whom milk or milk products are obtained.

Required bacterial counts and cooling temperature checks shall be performed on raw milk for pasteurization. In addition, antibiotic tests on each producer's milk or on commingled raw milk shall be conducted at least four times during any consecutive 6 months. When commingled milk is tested, all producers shall be represented in the sample. All individual sources of milk shall be tested when test results on the commingled milk are positive. Required bacterial counts,

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coliform determinations, phosphatase and cooling temperature checks shall be performed on pasteurized milk and milk products.

Whenever two of the last four consecutive bacteria counts, coliform determinations, or cooling temperatures, taken on separate days, exceed the limit of the standard for the milk and/or milk product, the health authority shall send a written notice thereof to the person concerned. This notice shall be in effect so long as two of the last four consecutive samples exceed the limit of the standard. An additional sample shall be taken within 14 days of the sending of such notice, but not before the lapse of 3 days. Immediate suspension of permit in accordance with Section 3 and/or court action shall be instituted whenever the standard is violated by three of the last five bacteria counts, coliform determinations, or cooling temperatures.

Whenever a phosphatase test is positive, the cause shall be determined. Where the cause is improper pasteurization, it shall be corrected; and any milk or milk product involved shall not be offered for sale.

Samples shall be analyzed at an official or appropriate officially designated laboratory. All sampling procedures and required laboratory examinations shall be in substantial compliance with the ------ Edition of *Standard Methods for the Examination of Dairy Products* of the American Public Health Association, and the ------ Edition of *Official Methods of Analyses* of the Association of Official Analytical Chemists. (Insert edition number current at time of adoption.) Such procedures and examinations shall be evaluated in accordance with the methods of evaluating milk laboratories recommended by the (U.S.) Public Health Service. Examinations and tests shall be conducted to detect adulterants, including pesticides, as the health authority shall require. Assays of vitamin D milk or milk products and/or fortified milk and milk products shall be made at least annually in a laboratory acceptable to the health authority.

SECTION 7. STANDARDS FOR MILK AND MILK PRODUCTS

All Grade A raw milk for pasteurization and all Grade A pasteurized milk and milk products shall be produced, processed, and pasteurized to conform with the following chemical, bacteriological, and temperature standards, and the sanitation requirements of this section.

No process or manipulation other than pasteurization, processing methods integral therewith, and appropriate refrigeration shall be applied to milk and milk products for the purpose of removing or deactivating microorganisms.

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Chemical, Bacteriological and Temperature Standards for Grade A Milk and Milk Products

Grade A raw milk for pasteurization.	Temperature	Cooled to 50° F. or less and maintained thereat until processed.
	Bacterial limits	Individual producer milk not to exceed 100,000 per ml. prior to commingling with other producer milk. Not exceeding 300,000 per ml. as commingled milk prior to pasteurization.
	Antibiotics	Less than 0.05 unit/ml. by the *Bacillus subtilis* method or equivalent.
Grade A pasteurized milk and milk products (except cultured products).	Temperature	Cooled to 45° F. or less and maintained thereat.
	Bacterial limits	Milk and milk products—20,000 per ml.
	Coliform limit	Not exceeding 10 per ml.
	Phosphatase	Less than 1μg per ml., by Scharer Rapid Method (or equivalent by other means).
Grade A pasteurized cultured products.	Temperature	Same as above.
	Coliform limit	Do.
	Phosphatase	Do.
	Bacterial limits	Exempt.

SANITATION REQUIREMENTS FOR GRADE A RAW MILK FOR PASTEURIZATION

ITEM 1r. ABNORMAL MILK

Cows which show evidence of the secretion of abnormal milk in one or more quarters based upon bacteriological, chemical, or physical examination, shall be milked last or with separate equipment, and the milk shall be discarded. Cows treated with, or cows which have consumed chemical, medicinal or radioactive agents which are capable of being secreted in the milk and which, in the judgment of the health authority, may be deleterious to human health, shall be milked last or with separate equipment, and the milk disposed of as the health authority may direct.

ITEM 2r. MILKING BARN, STABLE, OR PARLOR—CONSTRUCTION

A milking barn, stable, or parlor shall be provided on all dairy farms in which the milking herd shall be housed during milking time operations. The areas used for milking purposes shall (1) have floors constructed of concrete or equally impervious material; (2) have walls and ceilings which are smooth, painted or finished in an approved manner, in good repair, ceiling dusttight; (3) have separate stalls or pens for horses, calves, and bulls; (4) be provided with natural and/or artificial light, well distributed for day and/or night milking; (5) provide sufficient airspace and air circulation to prevent condensation and excessive odors; (6) not be overcrowded; and (7) have dusttight covered boxes or bins, or separate storage facilities for ground, chopped, or concentrated feed.

ITEM 3r. MILKING BARN, STABLE, OR PARLOR—CLEANLINESS

The interior shall be kept clean. Floors, walls, windows, pipelines,

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and equipment shall be free of filth and/or litter and shall be clean. Swine and fowl shall be kept out of the milking barn.

ITEM 4r. COWYARD

The cowyard shall be graded and drained and shall have no standing pools of water or accumulations of organic wastes: *Provided*, That in loafing or cattle-housing areas, cow droppings and soiled bedding shall be removed, or clean bedding added, at sufficiently frequent intervals to prevent the soiling of the cow's udder and flanks. Waste feed shall not be allowed to accumulate. Manure packs shall be properly drained and shall provide a reasonably firm footing. Swine shall be kept out of the cowyard.

ITEM 5r. MILKHOUSE OR ROOM—CONSTRUCTION AND FACILITIES

A milkhouse or room of sufficient size shall be provided, in which the cooling, handling, and storing of milk and the washing, sanitizing, and storing of milk containers and utensils shall be conducted.

The milkhouse shall be provided with a smooth floor constructed of concrete or equally impervious material graded to drain and maintained in good repair. Liquid waste shall be disposed of in a sanitary manner; all floor drains shall be accessible and shall be trapped if connected to a sanitary sewer system.

The walls and ceilings shall be constructed of smooth material, in good repair, well painted, or finished in an equally suitable manner.

The milkhouse shall have adequate natural and/or artificial light and be well ventilated.

The milkhouse shall be used for no other purpose than milkhouse operations; there shall be no direct opening into any barn, stable, or into a room used for domestic purposes: *Provided*, That a direct opening between the milkhouse and milking barn, stable, or parlor is permitted when a tight-fitting self-closing solid door(s) hinged to be single or double acting is provided.

Water under pressure shall be piped into the milkhouse.

The milkhouse shall be equipped with a two-compartment wash vat and adequate hot water heating facilities.

When a transportation tank is used for the cooling and storage of milk on the dairy farm, such tank shall be provided with a suitable shelter for the receipt of milk. Such shelter shall be adjacent to, but not a part of, the milkroom and shall comply with the requirements of the milkroom with respect to construction, light, drainage, insect and rodent control, and general maintenance.

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ITEM 6r. MILKHOUSE OR ROOM—CLEANLINESS

The floors, walls, ceilings, windows, tables, shelves, cabinets, wash vats, non-product contact surfaces of milk containers, utensils, and equipment, and other milkroom equipment shall be clean. Only articles directly related to milkroom activities shall be permitted in the milkroom. The milkroom shall be free of trash, animals, and fowl.

ITEM 7r. TOILET

Every dairy farm shall be provided with one or more toilets, conveniently located and properly constructed, operated, and maintained in a sanitary manner. The waste shall be inaccessible to flies and shall not pollute the soil surface or contaminate any water supply.

ITEM 8r. WATER SUPPLY

Water for milkhouse and milking operations shall be from a supply properly located, protected, and operated, and shall be easily accessible, adequate, and of a safe, sanitary quality.

ITEM 9r. UTENSILS AND EQUIPMENT—CONSTRUCTION

All multiuse containers, equipment, and utensils used in the handling, storage, or transportation of milk shall be made of smooth, nonabsorbent, corrosion-resistant, nontoxic materials, and shall be so constructed as to be easily cleaned. All containers, utensils, and equipment shall be in good repair. All milk pails used for hand milking and stripping shall be seamless and of the hooded type. Multiple-use woven material shall not be used for straining milk. All single-service articles shall have been manufactured, packaged, transported, stored, and handled in a sanitary manner and shall comply with the applicable requirements of item 11p. of this section. Articles intended for single-service use shall not be reused.

Farm holding/cooling tanks, welded sanitary piping, and transportation tanks shall comply with the applicable requirements of items 10p. and 11p. of this section.

ITEM 10r. UTENSILS AND EQUIPMENT—CLEANING

The product-contact surfaces of all multiuse containers, equipment, and utensils used in the handling, storage, or transportation of milk shall be cleaned after each usage.

ITEM 11r. UTENSILS AND EQUIPMENT—SANITIZATION

The product-contact surfaces of all multiuse containers, equipment, and utensils used in the handling, storage, or transportation of milk shall be sanitized before each usage.

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ITEM 12r. UTENSILS AND EQUIPMENT—STORAGE

All containers, utensils, and equipment used in the handling, storage, or transportation of milk, unless stored in sanitizing solutions, shall be stored to assure complete drainage, and shall be protected from contamination prior to use.

ITEM 13r. UTENSILS AND EQUIPMENT—HANDLING

After sanitization, all containers, utensils, and equipment shall be handled in such manner as to prevent contamination of any product-contact surface.

ITEM 14r. MILKING—FLANKS, UDDERS, AND TEATS

Milking shall be done in the milking barn, stable, or parlor. The flanks, udders, bellies, and tails of all milking cows shall be free from visible dirt. All brushing shall be completed prior to milking. The udders and teats of all milking cows shall be cleaned and treated with a sanitizing solution just prior to the time of milking, and shall be relatively dry before milking. Wet hand milking is prohibited.

ITEM 15r. MILKING—SURCINGLES, MILK STOOLS, AND ANTIKICKERS

Surcingles, milk stools, and antikickers shall be kept clean and stored above the floor.

ITEM 16r. MILKING—TRANSFER AND PROTECTION OF MILK

Each pail or container of milk shall be transferred immediately from the milking barn, stable, or parlor to the milkhouse. No milk shall be strained, poured, transferred, or stored unless it is properly protected from contamination.

ITEM 17r. PERSONNEL—HAND-WASHING FACILITIES

There shall be provided adequate hand-washing facilities, including running water, soap or detergent, and individual sanitary towels, in the milkhouse and in or convenient to the milking barn, stable, or parlor.

ITEM 18r. PERSONNEL—CLEANLINESS

Hands shall be washed clean and dried with an individual sanitary towel immediately before milking, before performing any milkhouse function, and immediately after the interruption of any of these activities. Milkers and milk haulers shall wear clean outer garments while milking or handling milk, milk containers, utensils, or equipment.

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ITEM 19r. COOLING

Raw milk for pasteurization shall be cooled to 50° F. or less within 2 hours after milking and shall be maintained at that temperature until delivered.

ITEM 20r. VEHICLES

Vehicles used to transport milk in cans from the dairy farm to the milk plant or receiving station shall be constructed and operated to protect their contents from sun, freezing, and contamination. Such vehicles shall be kept clean, inside and out; and no substance capable of contaminating milk shall be transported with milk.

ITEM 21r. INSECT AND RODENT CONTROL

Effective measures shall be taken to prevent the contamination of milk, containers, equipment, and utensils by insects and rodents, and by chemicals used to control such vermin. Milkrooms shall be free of insects and rodents. Surroundings shall be kept neat, clean, and free of conditions which might harbor or be conducive to the breeding of insects and rodents.

SANITATION REQUIREMENTS FOR GRADE A PASTEURIZED MILK AND MILK PRODUCTS

A receiving station shall comply with items 1p to 15p, inclusive, and 17p, 20p, and 22p, except that the partitioning requirement of item 5p shall not apply.

A transfer station shall comply with items 1p, 4p, 6p, 7p, 8p, 9p, 10p, 11p, 12p, 14p, 15p, 20p, and 22p; and as climatic and operating conditions require, the applicable provisions of items 2p and 3p: *Provided*, That in every case, overhead protection shall be provided. Facilities for the cleaning and sanitizing of bulk transport tanks shall comply with items 1p, 4p, 6p, 7p, 8p, 9p, 10p, 11p, 12p, 14p, 15p, 20p, and 22p; and as climatic and operating conditions require, the applicable provisions of items 2p and 3p: *Provided*, That in every case, overhead protection shall be provided.

ITEM 1p. FLOORS—CONSTRUCTION

The floors of all rooms in which milk or milk products are processed, handled, or stored, or in which milk containers, equipment, and utensils are washed, shall be constructed of concrete or other equally impervious and easily cleaned material; and shall be smooth, properly sloped, provided with trapped drains, kept in good repair: *Provided*, That cold-storage rooms used for storing milk and milk products need not be provided with floor drains when the floors are sloped to drain

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to one or more exits: *Provided further*, That storage rooms for storing dry ingredients and/or packaging materials need not be provided with drains; and the floors may be constructed of tightly joined wood.

ITEM 2p. WALLS AND CEILINGS—CONSTRUCTION

Walls and ceilings of rooms in which milk or milk products are handled, processed, or stored, or in which milk containers, utensils, and equipment are washed, shall have a smooth, washable, light-colored surface, in good repair.

ITEM 3p. DOORS AND WINDOWS

Effective means shall be provided to prevent the access of flies and rodents. All openings to the outside shall have solid doors or glazed windows which shall be closed during dusty weather.

ITEM 4p. LIGHTING AND VENTILATION

All rooms in which milk or milk products are handled, processed, or stored and/or in which milk containers, equipment, and utensils are washed shall be well lighted and well ventilated.

ITEM 5p. SEPARATE ROOMS

There shall be separate rooms for (1) pasteurizing, processing, cooling, and packaging; (2) cleaning of milk cans and bottles. In addition, plants receiving milk in bulk transport tanks shall provide for cleaning and sanitizing facilities.

Unless all milk and milk products are received in bulk transport tanks, a receiving room, separate from rooms (1) and (2) above, shall be required. Rooms in which milk or milk products are handled, processed, or stored, or in which milk containers, utensils, and equipment are washed or stored, shall not open directly into any stable or any room used for domestic purposes.

ITEM 6p. TOILET-SEWAGE DISPOSAL FACILITIES

Every milk plant shall be provided with toilet facilities conforming with the ordinances of the _____ of _____.[1] Toilet rooms shall not open directly into any room in which milk and/or milk products are processed. Toilet rooms shall be completely enclosed and shall have tight-fitting, self-closing doors. Dressing rooms, toilet rooms, and fixtures shall be kept in a clean condition, in good repair, and shall be well ventilated and well lighted. Sewage and other liquid wastes shall be disposed of in a sanitary manner.

ITEM 7p. WATER SUPPLY

Water for milk plant purposes shall be from a supply properly

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located, protected, and operated, and shall be easily accessible, adequate, and of a safe, sanitary quality.

ITEM 8p. HAND-WASHING FACILITIES

Convenient hand-washing facilities shall be provided, including hot and cold and/or warm running water, soap, and individual sanitary towels or other approved hand-drying devices. Hand-washing facilities shall be kept in a clean condition and in good repair.

ITEM 9p. MILK PLANT CLEANLINESS

All rooms in which milk and milk products are handled, processed, or stored, and/or in which containers, utensils, or equipment are washed or stored, shall be kept clean, neat, and free of evidence of insects and rodents. Pesticides shall be safely used. Only equipment directly related to processing operations or to the handling of containers, utensils, and equipment, shall be permitted in the pasteurizing, processing, cooling, packaging, and bulk milk storage rooms.

ITEM 10p. SANITARY PIPING

All sanitary piping, fittings, and connections which are exposed to milk or milk products, or from which liquids may drip, drain, or be drawn into milk or milk products, shall consist of smooth, impervious, corrosion-resistant, nontoxic, easily cleanable material. All piping shall be in good repair. Pasteurized milk and milk products shall be conducted from one piece of equipment to another only through sanitary piping.*

ITEM 11p. CONSTRUCTION AND REPAIR OF CONTAINERS AND EQUIPMENT

All multiuse containers and equipment with which milk or milk products come into contact shall be of smooth, impervious, corrosion-resistant, nontoxic material; shall be constructed for ease of cleaning; and shall be kept in good repair. All single-service containers, closures, gaskets, and other articles with which milk or milk products come in contact shall be nontoxic, and shall have been manufactured, packaged, transported, and handled in a sanitary manner. Articles intended for single-service use shall not be reused.

ITEM 12p. CLEANING AND SANITIZING OF CONTAINERS AND EQUIPMENT

The product-contact surfaces of all multiuse containers, utensils,

* Communities desiring to regulate cottage cheese and creamed cottage cheese under the terms of this Ordinance should add the following: "*Provided*, That cottage cheese, cheese dressings, or cheese ingredients may be transported by other methods which protect the product from contamination."

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and equipment used in the transportation, processing, handling, and storage of milk or milk products shall be effectively cleaned and shall be sanitized before each use.

ITEM 13p. STORAGE OF CLEANED CONTAINERS AND EQUIPMENT

After cleaning, all multiuse milk or milk product containers, utensils, and equipment shall be transported and stored to assure complete drainage, and shall be protected from contamination before use.

ITEM 14p. STORAGE OF SINGLE-SERVICE CONTAINERS, UTENSILS AND MATERIALS

Single-service caps, cap stock, parchment paper, containers, gaskets, and other single-service articles for use in contact with milk and milk products shall be purchased and stored in sanitary tubes, wrappings, or cartons; shall be kept therein in a clean, dry place until used; and shall be handled in a sanitary manner.

ITEM 15p. PROTECTION FROM CONTAMINATION

Milk plant operations, equipment, and facilities shall be located and conducted to prevent any contamination of milk or milk products, ingredients, equipment, containers, and utensils. All milk or milk products or ingredients which have been spilled, overflowed, or leaked shall be discarded. The processing or handling of products other than milk and milk products in the pasteurization plant shall be performed to preclude the contamination of such milk and milk products.

ITEM 16p. PASTEURIZATION

Pasteurization shall be performed as defined in Section 1, Definition (S), of this *Ordinance*.

ITEM 17p. COOLING OF MILK

All raw milk and milk products shall be maintained at 50° F. or less until processed. All pasteurized milk and milk products, except those to be cultured, shall be cooled immediately prior to filling or packaging in approved equipment to a temperature of 45° F. or less. All pasteurized milk and milk products shall be stored at a temperature of 45° F. or less. On delivery vehicles the temperature of milk and milk products shall not exceed 50° F. Every room or tank in which milk or milk products are stored shall be equipped with an accurate thermometer.

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ITEM 18p. BOTTLING AND PACKAGING

Bottling and packaging of milk and milk products shall be done at the place of pasteurization in approved mechanical equipment.[4]

ITEM 19p. CAPPING

Who else should be designated in specifically designated

Capping or closing of milk and milk product containers shall be done in a sanitary manner by approved mechanical capping and/or closing equipment. The cap or closure shall protect the pouring lip to at least its largest diameter.

ITEM 20p. PERSONNEL—CLEANLINESS

Hands shall be thoroughly washed before commencing plant functions and as often as may be required to remove soil and contamination. No employee shall resume work after visiting the toilet room without thoroughly washing his hands. All persons engaged in the processing, pasteurization, handling, storage, or transportation of milk, milk products, containers, equipment, and utensils shall wear clean outer garments. The use of tobacco by any person engaged in the processing of milk or milk products is prohibited.

ITEM 21p. VEHICLES

All vehicles used for transportation of pasteurized milk and milk products shall be constructed and operated so that the milk and milk products are maintained at 45° F. or less, and are protected from sun, from freezing, and from contamination.

ITEM 22p. SURROUNDINGS

Milk plant surroundings shall be kept neat, clean, and free from conditions which might attract or harbor flies, other insects, and rodents, or which otherwise constitute a nuisance.

SECTION 8. ANIMAL HEALTH

All milk for pasteurization shall be from herds which are located in a Modified Accredited Tuberculosis Area as determined by the U.S. Department of Agriculture: *Provided*, That herds located in an area that fails to maintain such accredited status shall have been accredited by said Department as tuberculosis free, or shall have passed an annual tuberculosis test.

[4] Communities desiring to regulate the sale of cottage cheese and creamed cottage cheese under the terms of this *Ordinance* should add the following: "*Provided*, That cottage cheese and creamed cottage cheese may be transported in sealed containers in a protected, sanitary manner from one plant to another for creaming and/or packaging."

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All milk for pasteurization shall be from herds under a brucellosis eradication program which meets one of the following conditions:

1. Located in a Certified Brucellosis-Free Area as defined by the U.S. Department of Agriculture and enrolled in the testing program for such areas; or

2. Located in a Modified Certified Brucellosis Area as defined by the U.S. Department of Agriculture and enrolled in the testing program for such areas; or

3. Meet U.S. Department of Agriculture requirements for an individually certified herd; or

4. Participating in a milk ring testing program which is conducted on a continuing basis at intervals of not less than every 3 months or more than every 6 months with individual blood tests on all animals in herds showing suspicious reactions to the milk ring test; or

5. Have an individual blood agglutination test annually with an allowable maximum grace period not exceeding 2 months.

For diseases other than brucellosis and tuberculosis, the health authority shall require such physical, chemical, or bacteriological tests as he deems necessary. The diagnosis of other diseases in dairy cattle shall be based upon the findings of a licensed veterinarian or a veterinarian in the employ of an official agency. Any diseased animal disclosed by such test(s) shall be disposed of as the health authority directs.

SECTION 9. MILK AND MILK PRODUCTS WHICH MAY BE SOLD

From and after 12 months from the date on which this *Ordinance* is adopted, only Grade A pasteurized milk and milk products* shall be sold to the final consumer, or to restaurants, soda fountains, grocery stores, or similar establishments: *Provided*, That in an emergency, the sale of pasteurized milk and milk products which have not been graded, or the grade of which is unknown, may be authorized by the health authority; in which case, such milk and milk products shall be labeled "ungraded."

Note.—Certified pasteurized milk is derived from certified raw milk which meets the latest requirements of the American Association of Medical Milk Commissions, Inc., 405 Lexington Ave., New York, N.Y., 10017.

SECTION 10. TRANSFERRING; DELIVERY CONTAINERS; COOLING

Except as permitted in this section, no milk producer or distributor shall transfer milk or milk products from one container or tank truck to another on the street, in any vehicle, store, or in any place except a

* Communities wishing to provide for the sale of certified pasteurized milk should include such product in this section.

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milk plant, receiving station, transfer station, or milkhouse especially used for that purpose. The dipping or ladling of milk or fluid milk products is prohibited.

It shall be unlawful to sell or serve any milk or fluid milk product except in the individual, original container received from the distributor, or from an approved bulk dispenser: *Provided*, That this requirement shall not apply to milk for mixed drinks requiring less than one-half pint of milk, or to cream, whipped cream, or half-and-half which is consumed on the premises and which may be served from the original container of not more than one-half gallon capacity, or from a bulk dispenser approved for such service by the health authority.

It shall be unlawful to sell or serve any pasteurized milk or milk product which has not been maintained at a temperature of 45° F. or less. If containers of pasteurized milk or milk products are stored in ice, the storage container shall be properly drained.

SECTION 11. MILK AND MILK PRODUCTS FROM POINTS BEYOND THE LIMITS OF ROUTINE INSPECTION

Milk and milk products from points beyond the limits of routine inspection of the _____ of _____,[1] or its police jurisdiction may be sold in _____,[1] or its police jurisdiction, provided they are produced and pasteurized under regulations which are substantially equivalent to this *Ordinance* and have been awarded an acceptable milk sanitation compliance and enforcement rating made by a State milk sanitation rating officer certified by the U.S. Public Health Service.

SECTION 12. FUTURE DAIRY FARMS AND MILK PLANTS

Properly prepared plans for all milkhouses, milking barns, stables, parlors, transfer stations, receiving stations, and milk plants regulated under this *Ordinance* which are hereafter constructed, reconstructed, or extensively altered, shall be submitted to the health authority for written approval before work is begun.

SECTION 13. PERSONNEL HEALTH

No person affected with any disease in a communicable form, or while a carrier of such disease, shall work at any dairy farm or milk plant in any capacity which brings him into contact with the production, handling, storage, or transportation of milk, milk products, containers, equipment, and utensils; and no dairy farm or milk plant operator shall employ in any such capacity any such person, or any person suspected of having any disease in a communicable form, or

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of being a carrier of such disease. Any producer or distributor of milk or milk products, upon whose dairy farm, or in whose milk plant any communicable disease occurs, or who suspects that any employee has contracted any disease in a communicable form, or has become a carrier of such disease, shall notify the health authority immediately.

SECTION 14. PROCEDURE WHEN INFECTION IS SUSPECTED

When reasonable cause exists to suspect the possibility of transmission of infection from any person concerned with the handling of milk and/or milk products, the health authority is authorized to require any or all of the following measures: (1) the immediate exclusion of that person from milk handling; (2) the immediate exclusion of the milk supply concerned from distribution and use; and (3) adequate medical and bacteriological examination of the person, of his associates, and of his and their body discharges.

SECTION 15. ENFORCEMENT

This *Ordinance* shall be enforced by the health authority in accordance with the *Grade A Pasteurized Milk Ordinance with Administrative Procedures—1965 Recommendations of the United States Public Health Service*, a certified copy [2] of which shall be on file at the municipal clerk's office.[3] Where the mandatory compliance with provisions of the appendixes is specified, such provisions shall be deemed a requirement of the *Ordinance*.

SECTION 16. PENALTY

Any person who shall violate any of the provisions of this *Ordinance* shall be guilty of a misdemeanor and, upon conviction thereof, shall be punished by a fine of not more than $____, and/or such persons may be enjoined from continuing such violations. Each day upon which such a violation occurs shall constitute a separate violation.

SECTION 17. REPEAL AND DATE OF EFFECT

All ordinances and parts of ordinances in conflict with this *Ordinance* shall be repealed 12 months after the adoption of this *Ordinance*, at which time this *Ordinance* shall be in full force and effect, as provided by law.

SECTION 18. UNCONSTITUTIONALITY CLAUSE

Should any section, paragraph, sentence, clause, or phrase of this *Ordinance* be declared unconstitutional or invalid for any reason, the remainder of this *Ordinance* shall not be affected thereby.

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PART II

GRADE A PASTEURIZED MILK ORDINANCE WITH ADMINISTRATIVE PROCEDURES—1965 RECOMMENDATIONS OF THE UNITED STATES PUBLIC HEALTH SERVICE

An ordinance defining "milk" and certain "milk products," "milk producer," "pasteurization," etc.; prohibiting the sale of adulterated and misbranded milk and milk products; requiring permits for the sale of milk and milk products; regulating the inspection of dairy farms and milk plants, and the examination, labeling, pasteurization, distribution and sale of milk and milk products; providing for the construction of future dairy farms and milk plants, the enforcement of this Ordinance, and the fixing of penalties.

Be it ordained by the ---------- of ---------- [a] as follows:

SECTION I. DEFINITIONS

The following definitions shall apply in the interpretation and the enforcement of this *Ordinance:*

A. Milk.—Milk is hereby defined to be the lacteal secretion, practically free from colostrum, obtained by the complete milking of one or more healthy cows, which contains not less than 8¼ percent milk solids-not-fat and not less than 3¼ percent milkfat. (Milkfat or butterfat is the fat of milk.)

A–1. Goat Milk.—Goat milk is the lacteal secretion, practically free from colostrum, obtained by the complete milking of healthy goats. The word "milk" shall be interpreted to include goat milk.

B. Cream.—Cream is the sweet, fatty liquid separated from milk, with or without the addition of milk or skim milk, which contains not less than 18 percent milkfat.

***B–1. Light Cream, Coffee Cream, or Table Cream.**—Light cream, coffee cream, or table cream is cream which contains not less than 18 percent but less than 30 percent milkfat.*

B–2. Whipping Cream.—Whipping cream is cream which contains not less than 30 percent milkfat.

[a] Numbered footnotes are assembled on p. 91.

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B–3. Light Whipping Cream.—Light whipping cream is cream that contains not less than 30 percent but less than 36 percent milkfat.

B–4. Heavy Cream or Heavy Whipping Cream.—Heavy cream or heavy whipping cream is cream which contains not less than 36 percent milkfat.

B–5. Whipped Cream.—Whipped cream is whipping cream into which air or gas has been incorporated.[2]

B–6. Whipped Light Cream, Coffee Cream, or Table Cream.—Whipped light cream, coffee cream, or table cream is light cream, coffee cream, or table cream into which air or gas has been incorporated.[2]

B–7. Sour Cream or Cultured Sour Cream.—Sour cream or cultured sour cream is a fluid or semifluid cream resulting from the souring, by lactic acid producing bacteria or similar culture, of pasteurized cream, which contains not less than 0.20 percent acidity expressed as lactic acid.[2]

C. Half-and-Half.—Half-and-half is a product consisting of a mixture of milk and cream which contains not less than 10.5 percent milkfat.[2]

C–1. Sour Half-and-Half or Cultured Half-and-Half.—Sour half-and-half or cultured half-and-half is fluid or semifluid half-and-half derived from the souring, by lactic acid producing bacteria or similar culture, of pasteurized half-and-half, which contains not less than 0.20 percent acidity expressed as lactic acid.[2]

D. Reconstituted or Recombined Milk and Milk Products.—Reconstituted or recombined milk and/or milk products shall mean milk or milk products defined in this section which result from the recombining of milk constituents with potable water.[2,3]

E. Concentrated Milk.—Concentrated milk is a fluid product, unsterilized and unsweetened, resulting from the removal of a considerable portion of the water from milk, which, when combined with potable water, results in a product conforming with the standards for milkfat and solids-not-fat of milk as defined above.[2]

E–1. Concentrated Milk Products.—Concentrated milk products shall be taken to mean and to include homogenized concentrated milk, vitamin D concentrated milk, concentrated skim milk, fortified concentrated skim milk, concentrated lowfat milk, fortified concentrated lowfat milk, concentrated flavored milk, concentrated flavored milk products, and similar concentrated products made from concentrated milk or concentrated skim milk, and which, when combined with potable water in accordance with instructions printed on the container, conform with the definitions of the corresponding milk products in this section.[2]

E-2. Frozen Milk Concentrate.—Frozen milk concentrate is a frozen milk product with a composition of milkfat and milk solids not fat in such proportions that when a given volume of concentrate is mixed with a given volume of water the reconstituted product conforms to the milkfat and milk solids not fat requirements of whole milk. In the manufacturing process, water may be used to adjust the primary concentrate to the final desired concentration. The adjusted primary concentrate is pasteurized, packaged, and immediately frozen. This product is stored, transported, and sold in the frozen state.[2]

F. Skim Milk or Skimmed Milk.—Skim milk or skimmed milk is milk from which sufficient milkfat has been removed to reduce its milkfat content to less than 0.50 percent.[2]

G. Lowfat Milk.—Lowfat milk is milk from which a sufficient portion of milkfat has been removed to reduce its milkfat content to not less than 0.50 percent and not more than 2.0 percent.[2]

H. Vitamin D Milk and Milk Products.—Vitamin D milk and milk products are milk and milk products, the vitamin D content of which has been increased by an approved method to at least 400 U.S.P. units per quart.[2]

I. Fortified Milk and Milk Products.—Fortified milk and milk products are milk and milk products other than vitamin D milk and milk products, the vitamin and/or mineral content of which have been increased by a method and in an amount approved by the health authority.[2]

J. Homogenized Milk.—Homogenized milk is milk which has been treated to insure breakup of the fat globules to such an extent that, after 48 hours of quiescent storage at 45° F., no visible cream separation occurs on the milk, and the fat percentage of the top 100 milliliters of milk in a quart, or of proportionate volumes in containers of other sizes, does not differ by more than 10 percent from the fat percentage of the remaining milk as determined after thorough mixing. The word "milk" shall be interpreted to include homogenized milk.[2]

K. Flavored Milk or Milk Products.—Flavored milk or milk products shall mean milk and milk products as defined in this Ordinance *to which have been added a flavor and/or sweetener.*[2]

K-1. Eggnog Flavored Milk.—Eggnog flavored milk is a milk product consisting of a mixture of at least 3.25 percent butterfat, at least 0.5 percent egg yolk solids, sweetener, and flavoring. Emulsifier and a maximum of 0.5 percent stabilizer may be added.

K-2. Eggnog.—Eggnog is a milk product consisting of a mixture of milk or milk product of at least 6.0 percent butterfat, at least 1.0 percent egg yolk solids, sweetener, and flavoring. Emulsifier and not over 0.5 percent stabilizer may be added.

L. Buttermilk.—Buttermilk is a fluid product resulting from the

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manufacture of butter from milk or cream. It contains not less than 8¼ percent of milk solids-not-fat.[3]

L-I. Cultured Buttermilk.—Cultured buttermilk is a fluid product resulting from the souring, by lactic acid producing bacteria or similar culture, of pasteurized skim milk or pasteurized lowfat milk.[3]

M. Cultured Milk or Cultured Whole Milk Buttermilk.—Cultured milk or cultured whole milk buttermilk is a fluid product resulting from the souring, by lactic acid producing bacteria or similar culture, of pasteurized milk.[3]

N. Acidified Milk and Milk Products.—Acidified milk and milk products are milk and milk products obtained by the addition of food grade acids to pasteurized cream, half-and-half, milk, lowfat milk, or skim milk, resulting in a product acidity of not less than 0.20 percent expressed as lactic acid.[3]

O. Milk Products.—Milk products include cream, light cream, coffee cream, table cream, whipping cream, light whipping cream, heavy cream, heavy whipping cream, whipped cream, whipped light cream, whipped coffee cream, whipped table cream, sour cream, cultured sour cream, half-and-half, sour half-and-half, cultured half-and-half, reconstituted or recombined milk and milk products, concentrated milk, concentrated milk products, skim milk, skimmed milk, lowfat milk, fortified milk and milk products, vitamin D milk and milk products, homogenized milk, flavored milk or milk products, eggnog, eggnog flavored milk, buttermilk, cultured buttermilk, cultured milk, cultured whole milk buttermilk, and acidified milk and milk products.[3 5 4]

This definition is not intended to included such products as sterilized milk and milk products hermetically sealed in a container and so processed, either before or after sealing, as to prevent microbial spoilage, or evaported milk, condensed milk, butter, ice cream and other frozen desserts, dry milk products (except as defined herein), or cheese except when they are combined with other substances to produce any pasteurized milk or milk product defined herein.

P. Grade A Dry Milk Products.—Grade A dry milk products are milk products which have been produced for use in Grade A pasteurized milk products and which have been manufactured under the provisions of Grade A Dry Milk Products Recommended Sanitation Ordinance and Code for Dry Milk Products Used in Grade A Pasteurized Milk Products.

Q. Optional Ingredients.—Optional ingredients shall mean and include Grade A dry milk products, concentrated milk, concentrated milk products, flavors, sweeteners, stabilizers, emulsifiers, acidifiers, vitamins, minerals, and similar ingredients.

R. Adulterated Milk and Milk Products.—Any milk or milk product shall be deemed to be adulterated (1) if it bears or contains

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any poisonous or deleterious substance in a quantity which may render it injurious to health; (2) if it bears or contains any added poisonous or deleterious substance for which no safe tolerance has been established by State or Federal regulation, or in excess of such tolerance if one has been established; (3) if it consists, in whole or in part, of any substance unfit for human consumption; (4) if it has been produced, processed, prepared, packed, or held under insanitary conditions; (5) if its container is composed, in whole or in part, of any poisonous or deleterious substance which may render the contents injurious to health; or (6) if any substance has been added thereto or mixed or packed therewith so as to increase its bulk or weight, or reduce its quality or strength, or make it appear better or of greater value than it is.

R-1. Misbranded Milk and Milk Products.—Milk and milk products are misbranded (1) when their container(s) bear or accompany any false or misleading written, printed or graphic matter; (2) when such milk and milk products do not conform to their definitions as contained in this Ordinance; *and (3) when such products are not labeled in accordance with Section 4 of this* Ordinance.

S. Pasteurization.—The terms "pasteurization," "pasteurised," and similar terms shall mean the process of heating every particle of milk or milk product to at least 145° F., and holding it continuously at or above this temperature for at least 30 minutes, or to at least 161° F., and holding it continuously at or above this temperature for at least 15 seconds, in equipment which is properly operated and approved by the health authority: Provided, *That milk products which have a higher milkfat content than milk and/or contain added sweeteners shall be heated to at least 150° F., and held continuously at or above this temperature for at least 30 minutes, or to at least 166° F., and held continuously at or above this temperature for at least 15 seconds,* Provided further, *That nothing in this definition shall be construed as barring any other pasteurization process which has been recognized by the United States Public Health Service to be equally efficient and which is approved by the State health authority.*

T. Sanitization.—Sanitization is the application of any effective method or substance to a clean surface for the destruction of pathogens, and of other organisms as far as is practicable. Such treatment shall not adversely affect the equipment, the milk or milk product or the health of consumers, and shall be acceptable to the health authority.

U. Milk Producer.—A milk producer is any person who operates a dairy farm and provides, sells, or offers milk for sale to a milk plant, receiving station, or transfer station.

V. Milk Hauler.—A milk hauler is any person who transports raw

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milk and/or raw milk products to or from a milk plant, receiving or transfer station.

W. Milk Distributor.—A milk distributor is any person who offers for sale or sells to another any milk or milk products.

X. Health Authority.—The health authority shall mean the ---------- of the ----------[1] or his authorized representative. The term, "Health Authority," wherever it appears in this Ordinance, *shall mean the appropriate agency having jurisdiction and control over the matters embraced within this* Ordinance.

Y. Dairy Farm.—A dairy farm is any place or premises where one or more cows or goats are kept, and from which a part or all of the milk or milk product(s) is provided, sold, or offered for sale to a milk plant, transfer station, or receiving station.

Z. Milk Plant and/or Receiving Station.—A milk plant and/or receiving station is any place, premises, or establishment where milk or milk products are collected, handled, processed, stored, pasteurized, bottled, or prepared for distribution.

Z-1. Transfer Station.—A transfer station is any place, premises, or establishment where milk or milk products are transferred directly from one transport tank to another.

AA. Official Laboratory.—An official laboratory is a biological, chemical, or physical laboratory which is under the direct supervision of the State or a local health authority.

BB. Officially Designated Laboratory.—An officially designated laboratory is a commercial laboratory authorized to do official work by the supervising agency, or a milk industry laboratory officially designated by the supervising agency for the examination of producer samples of Grade A raw milk for pasteurization.

CC. Person.—The word "person" shall mean any individual, plant operator, partnership, corporation, company, firm, trustee, or association.

DD. And/or.—Where the term "and/or" is used, "and" shall apply where appropriate, otherwise "or" shall apply.

SECTION 2. ADULTERATED OR MISBRANDED MILK OR MILK PRODUCTS

No person shall, within the municipality of ---------- of ----------;[1] or its police jurisdiction, produce, provide, sell, offer, or expose for sale, or have in possession with intent to sell any milk or milk product which is adulterated or misbranded: Provided, *That in an emergency, the sale of pasteurized milk and milk products which have not been graded, or the grade of which is unknown, may be authorized by the health authority, in which case such products shall be labeled "ungraded."*

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Any adulterated or misbranded milk or milk product may be impounded by the health authority and disposed of in accordance with applicable laws or regulations.

ADMINISTRATIVE PROCEDURES

This section of the *Ordinance* shall be used in impounding the products of, or preferring charges against, persons who adulterate or misbrand their milk or milk products or label them with any grade designation not authorized by the health authority under the terms of this *Ordinance*, or who sell or deliver ungraded milk or milk products except as may be permitted under this section in an emergency. An emergency is defined as a general and acute shortage in the milkshed, not simply one distributor's shortage.

SECTION 3. PERMITS

It shall be unlawful for any person who does not possess a permit from the health authority of the ---------- *of* ----------[1] *to bring into, send into, or receive into the* ---------- *of* ----------[1] *or its police jurisdiction, for sale, or to sell, or offer for sale therein, or to have in storage any milk or milk products defined in this* Ordinance: Provided, *That, grocery stores, restaurants, soda fountains, and similar establishments where milk or milk products are served or sold at retail, but not processed, may be exempt from the requirements of this section.*

Only a person who complies with the requirements of this Ordinance *shall be entitled to receive and retain such a permit. Permits shall not be transferable with respect to persons and/or locations.*

The health authority shall suspend such permit, whenever he has reason to believe that a public health hazard exists; or whenever the permit holder has violated any of the requirements of this Ordinance; *or whenever the permit holder has interfered with the health authority in the performance of his duties:* Provided, *That the health authority shall, in all cases except where the milk or milk product involved creates, or appears to create, an imminent hazard to the public health; or in any case of a willful refusal to permit authorized inspection, serve upon the holder a written notice of intent to suspend permit, which notice shall specify with particularity the violation(s) in question and afford the holder such reasonable opportunity to correct such violation(s) as may be agreed to by the parties, or in the absence of agreement, fixed by the health authority, before making any order of suspension effective. A suspension of permit shall remain in effect until the violation has been corrected to the satisfaction of the health authority.*

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Upon written application of any person whose permit has been suspended, or upon application within 48 hours of any person who has been served with a notice of intention to suspend, and in the latter case before suspension, the health authority shall within 72 hours proceed to a hearing to ascertain the facts of such violation or interference and upon evidence presented at such hearing shall affirm, modify, or rescind the suspension or intention to suspend.

Upon repeated violation(s), the health authority may revoke such permit following reasonable notice to the permit holder and an opportunity for a hearing. This section is not intended to preclude the institution of court action as provided in Sections 5 and 6.

ADMINISTRATIVE PROCEDURES

Issuance of Permits.—Every milk producer, milk distributor, milk hauler, and each milk plant, receiving station, and transfer station operator shall hold a valid permit. Milk producers who transport milk or milk products only from their own dairy farms and employees of a milk distributor or milk plant operator who possesses a valid permit, shall not be required to possess a hauler's permit. Grocery stores, restaurants, soda fountains, and similar establishments where milk or milk products are served or sold at retail but not processed, may be exempt from the requirements of this section.

Suspension of Permit.—When any requirement(s) of this *Ordinance* is violated, the permit holder is subject to the suspension of his permit.

The health authority may forgo suspension of the permit, provided the product or products in violation are not sold or offered for sale.

Hearings.—If a State or municipal administrative procedure act which provides procedures for administrative hearings and judicial review of administrative determinations is available, the act shall be made applicable by reference to the hearings provided for in the *Ordinance*. If such administrative procedure act is not available, appropriate procedures, including provision for notice, hearing officer, and his authority, record of hearing, rules or evidence, and court review shall be established by appropriate authority.

Reinstatement of Permits.—Any producer, distributor, hauler, or plant operator whose permit has been suspended may make written application for the reinstatement of his permit.

When the permit suspension has been due to a violation of any of the bacterial, coliform, or cooling-temperature standards, the health authority within 1 week after the receipt of a written application for reinstatement of permit, shall issue a temporary permit after determining by an inspection of the facilities and operating methods that

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the conditions responsible for the violation have been corrected. Samples shall then be taken at the rate of not more than two per week on separate days within a 3-week period, and the health authority shall reinstate the permit upon compliance with the appropriate standard as determined in accordance with Section 6 of this *Ordinance*.

Whenever the permit suspension has been due to a violation of a requirement other than the bacteriological, coliform, or cooling-temperature standards, the application shall contain a written statement to the effect that the violation(s) has been corrected. Within 1 week of the receipt of such an application, the health authority shall make an inspection of the applicant's establishment, and as many additional inspections thereafter as are deemed necessary, to determine that the applicant's establishment is complying with the requirements. When the findings justify, the permit shall be reinstated.

SECTION 4. LABELING

All bottles, containers, and packages enclosing milk or milk products defined in Section 1 of this Ordinance *shall be conspicuously labeled or marked with (1) the name of the contents as given in the definition in this* Ordinance; (2) the word "*reconstituted*" or "*recombined*" *if the product is made by reconstitution or recombination;*[8] *(3) the grade of contents; (4) the word "pasteurized" if the contents are pasteurized and the identity of the plant where pasteurized; (5) the word "raw" if the contents are raw and the name or other identity of the producer; (6) the designation "vitamin D" and the number of U.S.P. units per quart in the case of vitamin D milk or milk products; (7) the volume or proportion of water to be added for recombining in the case of concentrated milk or milk products; (8) the words "nonfat milk solids added" and the percentage added if such solids have been added, except that this requirement shall not apply to reconstituted or recombined milk or milk products; (9) the words "artificially sweetened" in the name if non-nutritive and/or artificial sweeteners are used; and (10) the common name of stabilizers, distillates, and ingredients:* Provided, *That (a) only the identity of the milk producer shall be required on cans delivered to a milk plant which receives only Grade A raw milk for pasteurization, and which immediately dumps, washes, and returns the cans to the milk producer; (b) the identity of both milk producer and the grade shall be required on cans delivered to a milk plant which receives both Grade A raw milk for pasteurization and ungraded raw milk, and which immediately dumps, washes, and returns the cans to the milk producer; (c) in the case of concentrated milk products, the specific name of the product shall be substituted for the generic term "concentrated milk products" e.g., "homogenized concentrated milk,"*

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"concentrated skim milk," "concentrated chocolate milk," "concentrated chocolate flavored lowfat milk"; (d) in the case of flavored milk or flavored reconstituted milk, the name of the principal flavor shall be substituted for the word "flavored",[b] and (e) in the case of cultured milk and milk products, the special type culture used may be substituted for the word "cultured," e.g., "acidophilus buttermilk," "bulgarian buttermilk," and "yogurt."

All vehicles and transport tanks containing milk or milk products shall be legibly marked with the name and address of the milk plant or hauler in possession of the contents.

Tanks transporting raw milk and milk products to a milk plant from sources of supply not under the routine supervision of the health authority are required to be marked with the name and address of the milk plant or hauler and shall be sealed; in addition, for each such shipment, a shipping statement shall be prepared containing at least the following information:

(1) Shipper's name, address, and permit number.
(2) Permit number of hauler, if not employee of shipper.
(3) Point of origin of shipment.
(4) Tanker identity number.
(5) Name of product.
(6) Weight of product.
(7) Grade of product.
(8) Temperature of product.
(9) Date of shipment.
(10) Name of supervising health authority at the point of origin.
(11) Whether the contents are raw, pasteurized, or otherwise heat treated.

Such statement shall be prepared in triplicate and shall be kept on file by the shipper, the consignee, and the carrier for a period of 6 months for the information of the health authority.

The labeling information which is required on all bottles, containers or packages of milk or milk products shall be in letters of an acceptable size, kind, and color satisfactory to the health authority and shall contain no marks or words which are misleading.

ADMINISTRATIVE PROCEDURES

Emergency Supplies—Labeling.—When the sale of ungraded milk or milk products is authorized during emergencies, under the terms of Section 2, the label must bear the designation "ungraded." When

[b] The Federal Food and Drug Administration considers the term "chocolate milk" misleading unless the flavoring ingredient used is "chocolate," "sweet chocolate," or "milk chocolate" complying with the appropriate standards of identity for these products. Milk and milk products flavored with "cocoa" may be labeled "chocolate flavored."

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such labeling is not available, the health authority shall take immediate steps to inform the public that the particular supply is ungraded, and that the supply will be properly labeled as soon as the distributor can obtain the required labels.

Identity Labeling.—"Identity," as used in this section, is defined as the name and address of the milk plant at which the pasteurization takes place. It is recommended that the voluntary national uniform coding system for identification of pasteurization plants at which milk and milk products are packaged, be adopted in order to provide a uniform system of codes throughout the country.

In cases where several pasteurization plants are operated by one firm, the common firm name may be utilized on milk bottles or containers: *Provided*, That the location of the plant at which the contents were pasteurized is also shown, either directly or by a code. This requirement is necessary in order to enable the health authority to identify the source of the pasteurized milk. The street address of the pasteurizing plant need not be shown when only one plant of a given name is located within the municipality.

The identity labeling requirement may be interpreted as permitting plants and persons to purchase and distribute, under their own label, milk and milk products processed and packaged at another plant, provided, that the label reads, "Processed at _____ (name and address)," or that the processing and packaging plant is identified by a proper code.

Misleading Labels.—The health authority shall not permit the use of any misleading marks, words, or endorsements upon the label. He may permit the use of registered trade designs or similar terms on the bottle cap or label when, in his opinion, they are not misleading and are not so used as to obscure the labeling required by the *Ordinance*. The use of super grade designations shall not be permitted. Grade designations such as "Grade AA Pasteurized," "Selected Grade A Pasteurized," "Special Grade A Pasteurized," "Premium," etc., give the consumer the impression that such a grade is significantly safer than Grade A pasteurized. Such an implication is false, because the *Ordinance* requirements for Grade A pasteurized milk, when properly enforced, will insure that this grade of milk will be as safe as milk can practicably be made.

Note.—Milk or milk products shall be labeled in accordance with the provisions of Section 4 of this *Ordinance* and, when shipped interstate, shall fulfill the applicable requirements of the Federal Food, Drug, and Cosmetic Act, as amended.

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SECTION 5. INSPECTION OF DAIRY FARMS AND MILK PLANTS

Each dairy farm, milk plant, receiving station, and transfer station whose milk or milk products are intended for consumption within ----------[1] *or its police jurisdiction shall be inspected by the health authority prior to the issuance of a permit. Following the issuance of a permit, each dairy farm and transfer station shall be inspected at lease once every 6 months and each milk plant and receiving station shall be inspected at least once every 3 months. Should the violation of any requirement set forth in Section 7 be found to exist on an inspection, a second inspection shall be required after the time deemed necessary to remedy the violation, but not before 3 days; this second inspection shall be used to determine compliance with the requirements of Section 7. Any violation of the same requirement of Section 7 on such second inspection shall call for permit suspension in accordance with Section 3 and/or court action.*

One copy of the inspection report shall be handed to the operator, or other responsible person, or be posted in a conspicuous place on an inside wall of the establishment. Said inspection report shall not be defaced and shall be made available to the health authority upon request. An identical copy of the inspection report shall be filed with the records of the health authority.

Every milk producer, hauler, distributor, or plant operator shall, upon request of the health authority, permit access of officially designated persons to all parts of his establishment or facilities to determine compliance with the provisions of this Ordinance. *A distributor or plant operator shall furnish the health authority, upon request, for official use only, a true statement of the actual quantities of milk and milk products of each grade purchased and sold, and a list of all sources of such milk and milk products, records of inspections, tests, and pasteurization time and temperature records.*

It shall be unlawful for any person who in an official capacity obtains any information under the provisions of this Ordinance *which is entitled to protection as a trade secret (including information as to quantity, quality, source or disposition of milk or milk products, or results of inspections or tests thereof) to use such information to his own advantage or to reveal it to any unauthorized person.*

ADMINISTRATIVE PROCEDURES

Inspection Frequency.—One producer inspection every 6 months or one plant inspection every 3 months is not a desirable frequency; it is instead a legal minimum. Dairy farms and milk plants expe-

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riencing difficulty meeting requirements should be visited more frequently. Inspections of dairy farms shall be made at milking time as often as possible, and of milk plants at different times of the day, in order to ascertain if the processes of equipment assembly, sanitizing, pasteurization, cleaning, and other procedures comply with the requirements of this *Ordinance*.

Enforcement Procedure.—This section provides that a dairy farm or milk plant shall be subject to suspension of permit, and/or court action, if two successive inspections disclose violation of the same requirement.

Experience has demonstrated that strict enforcement of the *Ordinance* leads to a better and friendlier relationship between the health authority and the milk industry than does a policy of enforcement which seeks to excuse violations and to defer penalty therefor. The sanitarian's criterion of satisfactory compliance should be neither too lenient nor unreasonably stringent. When a violation is discovered, the sanitarian should point out to the milk producer or plant operator the requirement that has been violated, discuss a method for correction, and set a time for correcting the violated requirement.

The penalties of suspension or revocation of permit, and/or court action, are provided to prevent continued violation of the provisions of this *Ordinance* but are worded to protect the dairy industry against unreasonable or arbitrary action. When a condition is found which constitutes an imminent health hazard, prompt action is necessary to protect the public health; therefore, the health authority is authorized, in Section 8, to suspend the permit immediately. However, except for such emergencies, no penalty is imposed on the producer or distributor upon the first violation of any of the sanitation requirements listed in Section 7. A producer or distributor found violating any requirement must be notified in writing and given a reasonable time to correct the violation(s) before a second inspection is made. The requirement of giving written notice shall be deemed to have been satisfied by the handing to the operator or by the posting of an inspection report, as required by this section. After receipt of a notice of violation, but before the allotted time has elapsed, the producer or distributor shall have an opportunity to appeal the sanitarian's interpretation to the health authority or for an extension of the time allowed for correction.

Certified Industry Inspection.—The health authority may certify industry personnel to carry out cooperatively the provisions of this *Ordinance* with respect to the supervision of dairy farms. Reports of all inspections conducted by such personnel to determine compliance with the provisions of this *Ordinance* shall be forwarded to the health authority. All punitive actions and all inspections for the issuance

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or reinstatement of permits shall be performed by the health authority. Industry personnel shall be certified annually by the health authority in accordance with the provisions of Appendix B, p. 99.

Inspection Reports.—A copy of the inspection report shall be filed by the health authority and retained for at least 12 months. The results shall be entered on appropriate ledger forms. The use of a computer or other information retrieval system may be used. Examples of field inspection forms are included in Appendix I, p. 167.

SECTION 6. THE EXAMINATION OF MILK AND MILK PRODUCTS

During any consecutive 6 months, at least four samples of raw milk for pasteurization shall be taken from each producer and four samples of raw milk for pasteurization shall be taken from each milk plant after receipt of the milk by the milk plant and prior to pasteurization. In addition, during any consecutive 6 months, at least four samples of pasteurized milk and at least four samples of each milk product defined in this Ordinance *shall be taken from every milk plant. Samples of milk and milk products shall be taken while in possession of the producer or distributor at any time prior to final delivery. Samples of milk and milk products from dairy retail stores, food service establishments, grocery stores, and other places where milk and milk products are sold shall be examined periodically as determined by the health authority; and the results of such examination shall be used to determine compliance with Sections 2, 4, 10. Proprietors of such establishments shall furnish the health authority, upon his request, with the names of all distributors from whom milk or milk products are obtained.*

Required bacterial counts and cooling temperature checks shall be performed on raw milk for pasteurization. In addition, antibiotic tests on each producer's milk or on commingled raw milk shall be conducted at least four times during any consecutive 6 months. When commingled milk is tested, all producers shall be represented in the sample. All individual sources of milk shall be tested when test results on the commingled milk are positive. Required bacterial counts, coliform determinations, phosphatase, and cooling temperature checks shall be performed on pasteurized milk and milk products.

Whenever two of the last four consecutive bacteria counts, coliform determinations, or cooling temperatures, taken on separate days, exceed the limit of the standard for the milk and/or milk product, the health authority shall send a written notice thereof to the person concerned. This notice shall be in effect so long as two of the last four consecutive samples exceed the limit of the standard. An additional sample shall be taken within 14 days of the sending of such notice, but not before

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the lapse of 3 days. Immediate suspension of permit in accordance with Section 3 and/or court action shall be instituted whenever the standard is violated by three of the last five bacteria counts, coliform determinations, or cooling temperatures.

Whenever a phosphatase test is positive, the cause shall be determined. Where the cause is improper pasteurization, it shall be corrected; and any milk or milk product involved shall not be offered for sale.

Samples shall be analyzed at an official or appropriate officially designated laboratory. All sampling procedures and required laboratory examinations shall be in substantial compliance with the ------ Edition of Standard Methods for the Examination of Dairy Products *of the American Public Health Association, and the ------ Edition of* Official Methods of Analyses *of the Association of Official Analytical Chemists. (Insert edition number current at time of adoption.) Such procedures and examinations shall be evaluated in accordance with the methods of evaluating milk laboratories recommended by the United States Public Health Service. Examinations and tests shall be conducted to detect adulterants, including pesticides, as the health authority shall require. Assays of vitamin D milk or milk products and/or fortified milk and milk products shall be made at least annually in a laboratory acceptable to the health authority.*

ADMINISTRATIVE PROCEDURES

Enforcement Procedures.—All violations of bacteria, coliform, and cooling temperature standards shall be followed promptly by inspection to determine and correct the cause. (See App. E, Examples of 3-out-of-5 Compliance Enforcement Procedures.)

Laboratory Techniques.—Procedures for the collection and holding of samples; the selection and preparation of apparatus, media and reagents; and the analytical procedures, incubation, reading, and reporting of results, shall be in substantial compliance with *Standard Methods for the Examination of Dairy Products* and the *Official Methods of Analyses.* The procedures shall be those specified therein for:

(1) Standard plate count at 32° C.
(2) Simplified methods for viable counts of raw milk at 32° C.
(3) Coliform test with solid media at 32° C.
(4) Disc assay methods for antibiotics
(5) APHA or AOAC phosphatase tests

The phosphatase test is an index of the efficiency of the pasteurization process. In the event the laboratory phosphatase test is positive, the cause shall be determined immediately. Where the cause is improper pasteurization, it shall be corrected. When a laboratory

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phosphatase test is positive, or if any doubt should arise as to the compliance of the equipment, standards or methods outlined in Section 7, item 16p., the health authority should immediately conduct field phosphatase tests at the plant (App. G, p. 133).

The direct microscopic count is useful as a screening test to detect suspicious tanker loads of milk for subsequent official examinations, and to determine the possible presence of abnormal milk.

Sampling Procedures.—When samples of raw milk for pasteurization are taken at a milk plant prior to pasteurization, they shall be drawn following adequate agitation from randomly selected storage tanks.

When bacterial counts and temperature determinations are made of several samples of the same milk or milk products collected from the same supply or processor, on the same day, these values are averaged arithmetically, and the results recorded as the count or temperature determinations of the milk or milk product for that day. All counts and temperatures should be recorded on the milk-ledger form PHS 1784 (or a similar form) for dairy farms, and form PHS 1782 (or a similar form) for milk plants as soon as reported by the laboratory.

A computer or other information retrieval system may be used.

See Appendix G, page 134, for a reference to antibiotics in milk and the conditions under which a positive phosphatase reaction may be encountered in properly pasteurized milk or cream.

Note.—The industry should be encouraged by the health authority to achieve day-to-day compliance with the foregoing standards by performing tests on each producer's milk, including platform tests for odors, temperature, and sediment. Bacterial counts should be conducted following laboratory pasteurization as a check for thermoduric organisms. Examinations for the presence of psychrophilic bacteria are also recommended. Periodic screening tests for presence of added water, antibiotics, and pesticide residues should be performed on producer milk. Plants should reject milk of abnormal odor and high temperature as well as milk that is found to be unsatisfactory by the sediment test. Followup inspections on the dairy farm should be made by the plant fieldman to determine the cause and to institute corrective measures whenever milk is rejected by the milk plant.

SECTION 7. STANDARDS FOR MILK AND MILK PRODUCTS

All Grade A raw milk for pasteurization and all Grade A pasteurized milk and milk products shall be produced, processed, and pasteurized to conform with the following chemical, bacteriological, and temperature standards, and the sanitation requirements of this section.

No process or manipulation other than pasteurization, processing methods integral therewith, and appropriate refrigeration shall be applied to milk and milk products for the purpose of removing or deactivating microorganisms.

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Chemical, Bacteriological, and Temperature Standards for Grade A Milk and Milk Products

Grade A raw milk for pasteurization.	Temperature	Cooled to 50° F., or less and maintained thereat until processed.
	Bacterial limits	Individual producer milk not to exceed 100,000 per ml. prior to commingling with other producer milk. Not exceeding 300,000 per ml. as commingled milk prior to pasteurization.
	Antibiotics	Less than 0.05 unit/ml. by the *Bacillus subtilis* method or equivalent.
Grade A pasteurized milk and milk products (except cultured products).	Temperature	Cooled to 45° F., or less and maintained thereat.
	Bacterial limits	Milk and milk products—20,000 per ml.
	Coliform limit	Not exceeding 10 per ml.
	Phosphatase	Less than 1 µg per ml. by Scharer Rapid Method (or equivalent by other means).
Grade A pasteurized cultured products.	Temperature	Same as above.
	Coliform limit	Do.
	Phosphatase	Do.
	Bacterial limits	Exempt.

SANITATION REQUIREMENTS FOR GRADE A RAW MILK FOR PASTEURIZATION

ITEM 1r. ABNORMAL MILK

Cows which show evidence of the secretion of abnormal milk in one or more quarters, based upon bacteriological, chemical, or physical examination, shall be milked last or with separate equipment; and the milk shall be discarded. Cows treated with, or cows which have consumed chemical, medicinal or radioactive agents which are capable of being secreted in the milk and which, in the judgment of the health authority, may be deleterious to human health, shall be milked last or with separate equipment, and the milk disposed of as the health authority may direct.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. Milk from cows being treated with medicinal agents, which are capable of being secreted in the milk, is not offered for sale for such period as is recommended by the attending veterinarian or as indicated on the package label of the medicinal agent.

2. Milk from cows treated with or exposed to insecticides not approved for use on dairy cattle by the U.S. Department of Agriculture is not offered for sale.

3. The health authority requires such additional tests for the detection of abnormal milk as he deems necessary (see App. A, p. 93).

4. Bloody, stringy, off-colored milk, or milk that is abnormal to sight or odor, is so handled and disposed of as to preclude the infection of other cows and the contamination of milk utensils.

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5. Cows secreting abnormal milk are milked last or in separate equipment which effectively prevents the contamination of the wholesome supply.

6. Equipment, utensils, and containers used for the handling of abnormal milk are not used for the handling of milk to be offered for sale, unless they are first cleaned and effectively sanitized.

ITEM 2r. MILKING BARN, STABLE, OR PARLOR—CONSTRUCTION

A milking barn, stable, or parlor shall be provided on all dairy farms in which the milking herd shall be housed during milking time operations. The areas used for milking purposes shall (1) have floors constructed of concrete or equally impervious material; (2) have walls and ceilings which are smooth, painted or finished in an approved manner, in good repair, ceiling dusttight; (3) have separate stalls or pens for horses, calves, and bulls; (4) be provided with natural and/or artificial light, well distributed for day and/or night milking; (5) provide sufficient air space and air circulation to prevent condensation and excessive odors; (6) not be overcrowded; and (7) have dusttight covered boxes or bins, or separate storage facilities for ground, chopped, or concentrated feed.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. A milking barn, stable, or parlor is provided on all dairy farms.

2. Gutters, floors, and feed troughs are constructed of good quality concrete or equally impervious material. Floors shall be easily cleaned (brushed surfaces permitted) and shall be graded to drain and maintained in good repair and free of excessive breaks or worn areas that may create pools.

3. Walls and ceilings are finished with wood, tile, smooth-surfaced concrete, cement plaster, brick, or other equivalent materials with light colored surfaces. Walls, partitions, doors, shelves, windows, and ceilings shall be kept in good repair; and surfaces shall be refinished whenever wear or discoloration is evident.

Whenever feed is stored overhead, ceilings shall be constructed to prevent the sifting of chaff and dust into the milking barn, stable or parlor. If a hay opening is provided from loft into the milking portion of the barn, such opening shall be provided with a dusttight door which shall be kept closed during milking operations.

4. Bull pens, maternity and calf stalls, and horse stalls are partitioned from the milking portion of the barn. Such portions of the

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barn that are not separated by tight partitions shall comply with all requirements of this item.

5. The milking barn is provided with natural and/or artificial light to insure that all surfaces and particularly the working areas will be plainly visible. The equivalent of at least 10 foot-candles of light in all working areas shall be provided.

6. Air circulation is sufficient to minimize odors and to prevent condensation upon walls and ceilings.

7. Overcrowding is not evidenced by the presence of calves, cows, or other barnyard animals in walks or feed alleys. Inadequate ventilation and excessive odors may also be evidence of an overcrowded barn.

8. Dry feed storage rooms and silo approaches are separated from the milking portion of the barn by tight partitions. Direct openings into the milking barn shall have tight-fitting doors which are kept closed. Metal or wooden feed storage containers shall be of tight construction with dusttight covers.

ITEM 3r. MILKING BARN, STABLE, OR PARLOR—CLEANLINESS

The interior shall be kept clean. Floors, walls, windows, pipelines, and equipment shall be free of filth and/or litter, and shall be clean. Swine and fowl shall be kept out of the milking barn.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. The interior of the milking barn, stable, or parlor is kept clean.

2. Leftover feed in feed mangers appears fresh and is not wet or soggy.

3. The bedding material, if used, does not contain more manure than has accumulated since the previous milking.

4. Outside surfaces of pipeline systems located in the milking barn, stable, or parlor are reasonably clean.

5. Gutter cleaners are reasonably clean.

6. All pens, calf stalls, and bull pens, if not separated from the milking barn, stable, or parlor, are clean.

7. Swine and fowl are kept out of the milking barn.

ITEM 4r. COWYARD

The cowyard shall be graded and drained and shall have no standing pools of water or accumulations of organic wastes: Provided, *That in loafing or cattle-housing areas, cow droppings and soiled bedding*

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shall be removed, or clean bedding added, at sufficiently frequent intervals to prevent the soiling of the cow's udder and flanks. Waste feed shall not be allowed to accumulate. Manure packs shall be properly drained and shall provide a reasonably firm footing. Swine shall be kept out of the cowyard.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. The cowyard, which is the enclosed or unenclosed area adjacent to the milking barn, in which the cows may congregate, including cattle-housing areas and feed lots, is graded and drained; depressions and soggy areas are filled; cow lanes are reasonably dry.

2. Approaches to the barn door and the surroundings of stock watering and feeding stations are solid to the footing of the animal.

3. Wastes from the barn or milkhouse are not allowed to pool in the cowyard. Cowyards which are muddy due to recent rains should not be considered as violating this item.

4. Manure, soiled bedding, and waste feed are not stored or permitted to accumulate therein in such a manner as to permit the soiling of cows' udders and flanks. Cattle-housing areas (stables without stanchions, such as loose-housing stables, pen stables, resting barns, holding barns, loafing sheds, wandering sheds, free-stall housing) shall be considered a part of the cowyard. Manure packs shall be solid to the footing of the animal (see App. B, p. 94).

5. Cowyards are kept reasonably free of cattle droppings. Cattle droppings shall not be allowed to accumulate in piles that are accessible to the animals.

ITEM 5r. MILKHOUSE OR ROOM—CONSTRUCTION AND FACILITIES

A milkhouse or room of sufficient size shall be provided, in which the cooling, handling, and storing of milk and the washing, sanitizing, and storing of milk containers and utensils shall be conducted.

The milkhouse shall be provided with a smooth floor constructed of concrete or equally impervious material graded to drain and maintained in good repair. Liquid waste shall be disposed of in a sanitary manner; all floor drains shall be accessible and shall be trapped if connected to a sanitary sewer system.

The walls and ceilings shall be constructed of smooth material, in good repair, well painted, or finished in an equally suitable manner.

The milkhouse shall have adequate natural and/or artificial light and be well ventilated.

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The milkhouse shall be used for no other purpose than milkhouse operations; there shall be no direct opening into any barn, stable, or into a room used for domestic purposes: Provided, *That a direct opening between the milkhouse and milking barn, stable, or parlor is permitted when a tight-fitting self-closing solid door(s) hinged to be single or double acting is provided.*

Water under pressure shall be piped into the milkhouse.

The milkhouse shall be equipped with a two-compartment wash vat and adequate hot water heating facilities.

When a transportation tank is used for the cooling and storage of milk on the dairy farm, such tank shall be provided with a suitable shelter for the receipt of milk. Such shelter shall be adjacent to, but not a part of, the milkroom and shall comply with the requirements of the milkroom with respect to construction, light, drainage, insect and rodent control, and general maintenance.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. A separate milkhouse of sufficient size is provided for the cooling, handling, and storing of milk and the washing, sanitizing, and storing of milk containers and utensils.

2. The floors of all milkhouses are constructed of good quality concrete (float finish permissible), or equally impervious tile, or brick laid closely with impervious material, or metal surfacing with impervious joints, or other material the equivalent of concrete and maintained free of breaks, depressions, and surface peelings.

3. The floor slopes to drain so that there are no pools of standing water. The joints between the floor and the walls shall be watertight.

4. The liquid wastes are disposed of in a sanitary manner; all floor drains are accessible and are trapped if connected to a sanitary sewer.

5. Walls and ceilings are constructed of smooth dressed lumber or similar material, well painted with a light-colored washable paint, and are in good repair. Surfaces and joints shall be tight and smooth. Sheet metal, tile, cement block, brick, concrete, cement plaster, or similar materials of light color may be used; the surfaces and joints shall be smooth.

6. A minimum of 20 foot-candles of light is provided at all working areas from natural and/or artificial light for milkhouse operations.

7. Windows and solid doors are closed during dusty weather.

8. The milkhouse is adequately ventilated to minimize odors and condensation on floors, walls, ceilings, and clean utensils.

9. Vents, if installed, and lighting fixtures are located to preclude the contamination of bulk milk tanks or clean utensil storage areas.

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10. The milkhouse is used for no other purpose than milkhouse operations.

11. There is no direct opening into any barn, stable, or room used for domestic purposes; except that an opening between the milkhouse and milking barn, stable, or parlor is permitted when a tight-fitting self-closing solid door(s) hinged to be single or double acting is provided.

12. A vestibule is used, it complies with the applicable milkhouse construction requirements.

13. The transfer of milk from a bulk-holding/cooling tank to a transport tank is through a hose port located in the milkhouse wall. The port shall be fitted with a tight door, which shall be in good repair. It shall be kept closed except when the port is in use.

14. Water under pressure is piped into the milkhouse.

15. Each milkhouse is provided with facilities for heating water in sufficient quantity and to such temperatures for the effective cleaning of all equipment and utensils (see App. B, p. 95).

16. The milkhouse is equipped with a wash-and-rinse vat having at least two compartments. Each compartment must be of sufficient size to accommodate the largest utensil or container used. The cleaning-in-place vat for milk pipelines and milk machines may be accepted as one part of the two-compartment vat: *Provided*, That the cleaning-in-place station rack in or on the vat and the milking machine inflations and appurtenances are completely removed from the vat during the washing, rinsing, and/or sanitizing of other utensils and equipment.

17. A suitable shelter is provided for a transportation truck used for cooling and storing milk. Such shelter shall be adjacent to, but not a part of, the milkroom and shall comply with the requirements of the milkroom with respect to construction, light, drainage, insect and rodent control, and general maintenance. See Appendix B, page 94 for suggested plans and information on size, construction, operation, and maintenance of milkhouses.

ITEM 6r. MILKHOUSE OR ROOM—CLEANLINESS

The floors, walls, ceilings, windows, tables, shelves, cabinets, wash vats, non-product contact surfaces of milk containers, utensils, and equipment, and other milkroom equipment shall be clean. Only articles directly related to milkroom activities shall be permitted in the milkroom. The milkroom shall be free of trash, animals, and fowl.

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ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. The milkroom structure, equipment, and other milkroom facilities used in its operation or maintenance are clean at all times.

2. Insecticides, rodenticides, antibiotics, medicinals, etc., are not stored in the milkroom.

3. Vestibules, if provided, are kept clean.

4. Animals and fowl are kept out of the milkroom.

ITEM 7r. TOILET

Every dairy farm shall be provided with one or more toilets, conveniently located and properly constructed, operated, and maintained in a sanitary manner. The waste shall be inaccessible to flies and shall not pollute the soil surface or contaminate any water supply.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. There is at least one flush toilet connected to a public sewer system or to an individual sewage-disposal system or a chemical toilet, earth pit privy, or other type of privy. Such sewerage systems shall be constructed and operated in accordance with plans and instructions of the State health authority and comply with the standards outlined in Appendix C.

2. A toilet or privy is convenient to the milking barn and the milkroom. There shall be no evidence of human defecation or urination about the premises.

3. No privy opens directly into the milkroom.

4. The toilet room, including all fixtures and facilities, is kept clean and free of flies and odors.

5. Where flush toilets are used, doors to toilet rooms are tight and self-closing. All outer openings in toilet rooms shall be screened or otherwise protected against the entrance of flies.

6. Vents of earth pits are screened.

ITEM 8r. WATER SUPPLY

Water for milkhouse and milking operations shall be from a supply properly located, protected, and operated, and shall be easily accessible, adequate, and of a safe, sanitary quality.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. The water supply for milkhouse and milking operations is

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approved as safe by the State health authority, and, in the case of individual water systems, complies with the specifications outlined in Appendix D and the bacteriological standards outlined in Appendix G, page 133.

2. No cross-connection exists between a safe water supply and any unsafe or questionable water supply, or any other source of pollution.

3. There are no submerged inlets through which a safe water supply may be contaminated.

4. The well or other source of water is located and constructed in such a manner that neither underground nor surface contamination from any sewerage systems, privy, or other source of pollution can reach such water supply.

5. New individual water supplies and water supply systems which have been repaired or otherwise become contaminated are thoroughly disinfected before being placed in use (see App. D, p. 116). The supply shall be made free of the disinfectant by pumping to waste before any sample for bacteriological testing shall be collected.

6. All containers and tanks used in the transportation of water are sealed and protected from possible contamination. These containers and tanks shall be subjected to a thorough cleaning and a bacteriological treatment prior to filling with potable water to be used at the dairy farm. To minimize the possibility of contamination of the water during its transfer from the potable tanks to the elevated or ground-water storage at the dairy farm, a suitable pump, hose, and fittings shall be provided. When the pump hose and fittings are not being used, the outlets shall be capped and stored in a suitable dustproof enclosure so as to prevent their contamination. The storage tank at the dairy farm shall be constructed of impervious material provided with a dust and rainproof cover, and also provided with an approved-type vent and roof hatch. All new reservoirs or reservoirs which have been cleaned shall be disinfected prior to placing them into service (see App. D, p. 116).

7. Samples for bacteriological examination are taken upon the initial approval of the physical structure based upon the requirements of this *Ordinance* and when any repair or alteration of the water supply system has been made: *Provided*, That when water is hauled to the dairy farm such water shall be sampled for bacteriological examination at the point of use and submitted to a laboratory each month. Bacteriological examinations shall be conducted in a laboratory acceptable to the health authority.

8. Current records of water test results are retained on file with the health authority or as the health authority directs.

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ITEM 9r. UTENSILS AND EQUIPMENT—CONSTRUCTION

All multiuse containers, equipment, and utensils used in the handling, storage, or transportation of milk shall be made of smooth, nonabsorbent, corrosion-resistant, nontoxic materials, and shall be so constructed as to be easily cleaned. All containers, utensils, and equipment shall be in good repair. All milk pails used for hand milking and stripping shall be seamless and of the hooded type. Multiple-use woven material shall not be used for straining milk. All single-service articles shall have been manufactured, packaged, transported, stored, and handled in a sanitary manner and shall comply with the applicable requirements of item 11p of this section. Articles intended for single-service use shall not be reused.

Farm holding/cooling tanks, welded sanitary piping, and transportation tanks shall comply with the applicable requirements of items 10p and 11p of this section.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. The milk-contact surfaces of all multiuse containers, utensils, equipment, piping, and fittings are smooth and constructed of:

a. Stainless steel of the AISI (American Iron and Steel Institute) 300 series, or

b. Equally corrosion-resistant, nontoxic metal; or

c. Heat-resistant glass; or

d. Plastic or rubber and rubberlike materials which are relatively inert, resistant to scratching, scoring, decomposition, crazing, chipping, and distortion, under normal use conditions; are nontoxic, fat resistant, relatively nonabsorbent, relatively insoluble, do not release component chemicals or impart flavor or odor to the product, and which maintain their original properties under repeated-use conditions.

2. Single-service articles have been manufactured, packaged, transported, stored, and handled in a sanitary manner and comply with the applicable requirements of item 11p.

3. Articles intended for single service use are not reused.

4. All containers, equipment, and utensils are free of breaks and corrosion.

5. All joints in such containers, equipment, and utensils are smooth and free from pits, cracks, or inclusions.

6. Cleaned-in-place milk pipelines and return-solution lines are self-draining. If gaskets are used, they shall be self-positioning and of material meeting specifications described in (1) (d) above, and shall be of such design, finish, and application as to form a smooth, flush

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interior surface. If gaskets are not used, all fittings shall have self-positioning faces designed to form a smooth, flush interior surface. All interior surfaces of welded joints in pipelines shall be smooth and free of pits, cracks, and inclusions.

7. Detailed plans for cleaned-in-place pipeline systems are submitted to the health authority for written approval prior to installation. No alteration or addition shall be made to any milk pipeline system without prior written approval of the health authority.

8. Strainers, if used, are of perforated metal design, or so constructed as to utilize single-service strainer media.

9. Seamless hooded pails having an opening not exceeding one-third the area of that of an open pail of the same size are used.

10. All milking machines, including heads, milk claws, milk tubing, and other milk-contact surfaces can be easily cleaned and inspected.

11. Milk cans have umbrella-type lids.

12. Farm holding/cooling tanks, welded sanitary piping, and transportation tanks comply with the applicable requirements of items 10p and 11p of this section.

Note.—*3-A Sanitary Standards.*—3-A Sanitary Standards for dairy equipment are promulgated jointly by the Sanitary Standards Subcommittee of the Dairy Industry Committee, the Committee on Sanitary Procedure of the International Association of Milk, Food and Environmental Sanitarians, Inc., and the Milk and Food Branch, Division of Environmental Engineering and Food Protection, Public Health Service, Department of Health, Education, and Welfare. Equipment manufactured in conformity with 3-A Sanitary Standards complies with the sanitary design and construction standards of this *Ordinance*.

ITEM 10r. UTENSILS AND EQUIPMENT—CLEANING

The product-contact surfaces of all multiuse containers, equipment, and utensils used in the handling, storage, or transportation of milk shall be cleaned after each usage.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. The product-contact surfaces of all multiuse containers, equipment, and utensils used in the handling, storage, or transportation of milk are cleaned after each usage.

ITEM 11r. UTENSILS AND EQUIPMENT—SANITIZATION

The product-contact surfaces of all multiuse containers, equipment, and utensils used in the handling, storage, or transportation of milk shall be sanitized before each usage.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. All product-contact surfaces of multiuse containers, utensils, and

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equipment used in the handling, storage, or transportation of milk are sanitized before each usage by one of the following methods, or by any method which has been demonstrated to be equally effective:

a. Exposure to steam for at least 15 minutes at a temperature of at least 170° F., or for at least 5 minutes at a temperature of at least 200° F., in a steam cabinet equipped with an indicating thermometer which is located in the coldest zone.

b. Exposure to an enclosed jet of steam for not less than 1 minute.

c. Complete immersion in hot water at a temperature of at least 170° F. for at least 5 minutes, or exposure to a flow of hot water at a temperature of at least 170° F. as determined by use of a suitable accurate thermometer (at the outlet) for at least 5 minutes.

d. Exposure to hot air at a temperature of at least 180° F. for at least 20 minutes in a properly designed oven or hot-air cabinet which is equipped with an acceptable indicating thermometer located in the coldest zone.

e. Complete immersion for at least 1 minute in, or exposure for at least 1 minute to a flow of a chemical sanitizer of acceptable strength. All product-contact surfaces must be wetted by the sanitizing solution, and piping so treated must be filled. Sanitizing sprays may be used. Chemical solutions, once used, shall not be reused for sanitizing but may be reused for other purposes.

(See App. F, p. 126, for further discussion of approved sanitizing procedures.)

ITEM 12r. UTENSILS AND EQUIPMENT—STORAGE

All containers, utensils, and equipment used in the handling, storage, or transportation of milk, unless stored in sanitizing solutions, shall be stored to assure complete drainage, and shall be protected from contamination prior to use.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. All milk containers, utensils, and equipment, including milking machine vacuum hoses, are stored in the milkhouse in a steam or hot-air cabinet, in a sanitizing solution, or on racks, until used. Pipeline milking systems which are cleaned-in-place may be stored in place when such pipelines and appurtenances terminate in the milkhouse or are closed to the atmosphere during storage.

2. Means are provided to effect complete drainage of equipment when such equipment cannot be stored to drain freely.

3. Clean cans or other containers are stored in the milkhouse within a reasonable time after delivery to the dairy farm.

4. Strainer pads, parchment papers, gaskets, and similar single-

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ITEM 13r. UTENSILS AND EQUIPMENT—HANDLING

After sanitization, all containers, utensils, and equipment shall be handled in such manner as to prevent contamination of any product-contact surface.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. Sanitized product-contact surfaces, including farm cooling holding tank openings and outlets, are protected against contact with unsanitized equipment and utensils, hands, clothing, splash, condensation, and other sources of contamination.

2. Any sanitized product-contact surface, which has been otherwise exposed to contamination, is again cleaned and sanitized before being used.

ITEM 14r. MILKING—FLANKS, UDDERS, AND TEATS

Milking shall be done in the milking barn, stable, or parlor. The flanks, udders, bellies, and tails of all milking cows shall be free from visible dirt. All brushing shall be completed prior to milking. The udders and teats of all milking cows shall be cleaned and treated with a sanitizing solution just prior to the time of milking, and shall be relatively dry before milking. Wet hand milking is prohibited.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. Milking is done in a milking barn, stable, or parlor.

2. Brushing is completed prior to milking.

3. Flanks, bellies, tails, and udders are clipped as often as necessary to facilitate cleaning of these areas and are free from dirt.

4. Udders and teats of all milking cows are cleaned and treated with a sanitizing solution and are relatively dry just prior to milking.

5. Wet hand milking is prohibited.

ITEM 15r. MILKING—SURCINGLES, MILK STOOLS, AND ANTIKICKERS

Surcingles, milk stools, and antikickers shall be kept clean and stored above the floor.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. Milk stools are not padded and are constructed to be easily cleaned.

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2. Milk stools, surcingles, and antikickers are kept clean and are stored above the floor in a clean place, either in the milking barn, stable, parlor, or milkhouse, when not in use.

ITEM 16r. MILKING—TRANSFER AND PROTECTION OF MILK

Each pail or container of milk shall be transferred immediately from the milking barn, stable, or parlor to the milkhouse. No milk shall be strained, poured, transferred, or stored unless it is properly protected from contamination.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. The receiving receptacle is raised above the floor (as on a dolly or cart), or placed at a distance from the cows to protect it against manure and splash when milk is poured and/or strained in the milking barn. Such receptacle shall have a tight-fitting cover which shall be closed except when milk is being poured.

2. Each pail or container of milk is transferred immediately from the milking barn, stable, or parlor to the milkhouse.

3. Pails, cans, and other equipment containing milk are properly covered during transfer and storage.

ITEM 17r. PERSONNEL—HAND-WASHING FACILITIES

There shall be provided adequate hand-washing facilities, including running water, soap or detergent, and individual sanitary towels, in the milkhouse and in or convenient to the milking barn, stable, or parlor.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. Hand-washing facilities are located in the milkhouse and in or convenient to the milking barn, stable or parlor.

2. Hand-washing facilities include soap or detergent, running water, individual sanitary towels, and a lavatory fixture or separate water tap. Utensil wash and rinse vats shall not be considered as hand-washing facilities.

ITEM 18r. PERSONNEL—CLEANLINESS

Hands shall be washed clean and dried with an individual sanitary towel immediately before milking, before performing any milkhouse function, and immediately after the interruption of any of these activities. Milkers and milk haulers shall wear clean outer garments

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while milking or handling milk, milk containers, utensils, or equipment.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. Hands are washed clean and dried with an individual sanitary towel immediately before milking, before performing any milkhouse function, and immediately after the interruption of any of these activities.

2. Milkers and milk haulers wear clean outer garments while milking or handling milk, milk containers, utensils, or equipment.

ITEM 19r. COOLING

Raw milk for pasteurization shall be cooled to 50° F. or less within 2 hours after milking and shall be maintained at that temperature until delivered.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. Raw milk for pasteurization is cooled to 50° F. or less within 2 hours after milking and maintained at that temperature until delivered.

ITEM 20r. VEHICLES

Vehicles used to transport milk in cans from the dairy farm to the milk plant or receiving station shall be constructed and operated to protect their contents from sun, freezing, and contamination. Such vehicles shall be kept clean, inside and out; and no substance capable of contaminating milk shall be transported with milk.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. Vehicles used to transport milk in cans from the dairy farm to the milk plant or receiving station are constructed and operated to protect their contents from sun, freezing, and contamination.

2. Vehicles have bodies with solid enclosures and tight, solid doors.

3. Vehicles are kept clean, inside and out.

4. No substance capable of contaminating the milk is transported with the milk.

See items 9r and 10r for information on the construction of transportation tanks.

ITEM 21r. INSECT AND RODENT CONTROL

Effective measures shall be taken to prevent the contamination of

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milk, containers, equipment, and utensils by insects and rodents, and by chemicals used to control such vermin. Milkrooms shall be free of insects and rodents. Surroundings shall be kept neat, clean, and free of conditions which might harbor or be conducive to the breeding of insects and rodents.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. Surroundings are kept neat, clean, and free of conditions which might harbor or be conducive to the breeding of insects and rodents. During fly season, manure shall be spread directly on the fields; or stored for not more than 4 days in a pile on the ground surface, and then spread on the fields; or stored for not more than 7 days in an impervious-floored bin, or on an impervious-curbed platform and then spread; or stored in a tight-screened and trapped manure shed; or effectively treated with larvicides; or disposed of in any other manner which controls insect breeding.

2. Manure packs in loafing areas, stables without stanchions, pen stables, resting barns, wandering sheds, and free-stall housing are properly bedded and managed to prevent fly breeding.

3. Milkrooms are free of insects and rodents.

4. Milkrooms are effectively screened or otherwise protected against the entrance of vermin.

5. Outer milkhouse doors are tight and self-closing. Screen doors shall open outward.

6. Effective measures are taken to prevent the contamination of milk, containers, utensils, and equipment by insects and rodents, and by chemicals used to control such vermin.

7. Only pesticides approved for use by the health authority and/or registered with the U.S. Department of Agriculture are used for insect and rodent control. (See App. B, p. 97, for further information about insect and rodent control.)

8. Pesticides are used only in accordance with manufacturer's directions and are used so as to prevent the contamination of milk, milk containers, equipment, utensils, feed, and water.

Note.—A convenient inspection form for producer dairy farms, which summarizes the applicable sanitation requirements, is found in Appendix L, page 107.

SANITATION REQUIREMENTS FOR GRADE A PASTEURIZED MILK AND MILK PRODUCTS

A receiving station shall comply with items 1p to 15p, inclusive, and 17p, 20p, and 22p, except that the partitioning requirement of item 5p shall not apply.

A transfer station shall comply with items 1p, 4p, 6p, 7p, 8p, 9p,

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10p, 11p, 12p, 14p, 15p, 20p, and 22p; and as climatic and operating conditions require, the applicable provisions of items 2p and 3p: Provided, *That in every case, overhead protection shall be provided. Facilities for the cleaning and sanitizing of bulk transport tanks shall comply with items 1p, 4p, 6p, 7p, 8p, 9p, 10p, 11p, 12p, 14p, 15p, 20p, and 22p; and as climatic and operating conditions require, the applicable provisions of items 2p and 3p:* Provided, *That in every case, overhead protection shall be provided.*

ITEM 1p. FLOORS—CONSTRUCTION

The floors of all rooms in which milk or milk products are processed, handled, or stored, or in which milk containers, equipment, and utensils are washed, shall be constructed of concrete or other equally impervious and easily cleaned material; and shall be smooth, properly sloped, provided with trapped drains, and kept in good repair: Provided, *That cold-storage rooms used for storing milk and milk products need not be provided with floor drains when the floors are sloped to drain to one or more exits:* Provided further, *That storage rooms for storing dry ingredients and/or packaging materials need not be provided with drains: and the floors may be constructed of tightly joined wood.*

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. The floors of all rooms in which milk is handled, processed, or stored, or in which milk containers or utensils are washed, are constructed of good quality concrete, or equally impervious tile or brick laid closely with impervious joint material, or metal surfacing with impervious joints, or other material which is the equivalent of good quality concrete. The floors of storage rooms for dry ingredients and/or packaging materials may be constructed of tightly joined wood.

2. The floor surface is smooth and sloped, so that there are no pools of standing water after flushing; and the joints between the floor and the walls are impervious.

3. The floors are provided with trapped drains. Cold-storage rooms used for storing milk and milk products need not be provided with floor drains when the floors are sloped to drain to one or more exits. Storage rooms for dry ingredients and/or packaging materials need not be provided with drains.

ITEM 2p. WALLS AND CEILINGS—CONSTRUCTION

Walls and ceilings of rooms in which milk or milk products are handled, processed, or stored, or in which milk containers, utensils, and equipment are washed, shall have a smooth, washable, light-colored surface, in good repair.

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ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. Walls and ceilings are finished with smooth, washable, light-colored painted wood, tile, smooth-surface concrete, cement plaster, brick, or other equivalent materials with washable, light-colored surfaces.

2. Walls, partitions, windows, and ceilings are kept in good repair and refinished as often as the finish wears off or becomes discolored.

ITEM 3p. DOORS AND WINDOWS

Effective means shall be provided to prevent the access of flies and rodents. All openings to the outside shall have solid doors or glazed windows which shall be closed during dusty weather.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. All openings to the outer air are effectively protected by (a) screening; or (b) effective electric screen panels; or (c) fans or air curtains which provide sufficient air velocity so as to prevent the entrance of flies; or (d) properly constructed flaps where it is impractical to use self-closing doors or air curtains; or (e) any effective combination of (a), (b), (c), or (d), or by any other method which prevents the entrance of flies.

2. All outer doors are tight and self-closing. Screen doors shall open outward.

3. All outer openings are rat proofed to the extent necessary to prevent the entry of rodents.

Note.—The evidence of insects and/or rodents in the plant shall be considered under Item 9p.

ITEM 4p. LIGHTING AND VENTILATION

All rooms in which milk or milk products are handled, processed, or stored and/or in which milk containers, equipment, and utensils are washed shall be well lighted and well ventilated.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. Adequate light sources are provided (natural, artificial, or a combination of both) which furnish at least 20 foot-candles of light in all working areas. This shall apply to all rooms where milk or milk products are handled, processed, or stored, or where utensils, containers, and/or equipment are washed. Dry storage and cold storage rooms shall be provided with at least 5 foot-candles of light.

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2. Ventilation in all rooms is sufficient to keep them reasonably free of odors and excessive condensation on equipment, walls, and ceilings.

3. Pressurized ventilating systems, if used, have a filtered air intake.

ITEM 5p. SEPARATE ROOMS

There shall be separate rooms for (1) pasteurising, processing, cooling, and packaging; and (2) cleaning of milk cans and bottles. In addition, plants receiving milk in bulk transport tanks shall provide for cleaning and sanitising facilities.

Unless all milk and milk products are received in bulk transport tanks, a receiving room, separate from rooms (1) and (2) above, shall be required. Rooms in which milk or milk products are handled, processed, or stored, or in which milk containers, utensils, and equipment are washed or stored, shall not open directly into any stable or any room used for domestic purposes.

ADMINISTRATIVE PROCEDURES[9]

This item is deemed to be satisfied when:

1. Pasteurizing, processing, cooling and packaging are conducted in a single room(s), but not in the same room(s) used for the cleaning of milk cans and bottles. All rooms shall be of sufficient size for their intended purposes.

2. All bulk milk storage tanks are vented into a room used for pasteurization, processing, cooling, or packaging operations, or into a storage tank gallery room, provided that vents located elsewhere which are adequately equipped with air filters so as to preclude the contamination of the milk, shall be considered satisfactory.

3. Solid doors installed in required partitions are self-closing.

4. Facilities for the cleaning and sanitizing of bulk transport tanks are properly equipped for manual and/or mechanical operations. When such facilities are not provided on the plant premises, these operations shall be performed at a receiving station, transfer station, or separate tank washing installation. (Items relating to facilities for cleaning and sanitizing bulk transport tanks are listed on p. 55.)

5. Rooms in which milk or milk products are handled, processed, or stored, or in which milk containers, utensils, and equipment are washed or stored, do not open directly into any stable or any room used for domestic purposes.

[9] Communities desiring to regulate cottage cheese and creamed cottage cheese under the terms of this *Ordinance* should include the following in the administrative procedures of Item 5p.: Cottage cheese vats shall be located in a separate room, maintained free from flies and other vermin, and kept in a clean condition: *Provided*, That in existing installations, cottage cheese vats may be located in the processing room when there is no evidence of overcrowding, excessive traffic, condensation, or splash. Cottage cheese vats located in processing rooms shall be equipped with multi-service or single-service covers which shall be kept in place at all times during the "setting" operation.

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ITEM 6p. TOILET-SEWAGE DISPOSAL FACILITIES

Every milk plant shall be provided with toilet facilities conforming with the ordinances of the _____ of _____.[1] Toilet rooms shall not open directly into any room in which milk and/or milk products are processed. Toilet rooms shall be completely enclosed and shall have tight-fitting, self-closing doors. Dressing rooms, toilet rooms, and fixtures shall be kept in a clean condition, in good repair, and shall be well ventilated and well lighted. Sewage and other liquid wastes shall be disposed of in a sanitary manner.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. The milk plant is provided with toilet facilities conforming with the ordinances of the _____ of _____.[1]
2. Toilet rooms do not open directly into any room in which milk and/or milk products are processed.
3. Toilet rooms are completely enclosed and have tight-fitting self-closing doors.
4. Dressing rooms, toilet rooms, and fixtures are kept in a clean condition, in good repair, and are well ventilated and well lighted.
5. Toilet tissue and easily cleanable covered waste receptacles are provided in toilet rooms.
6. All plumbing is installed to meet the applicable provisions of the State or local plumbing code.
7. Sewage and other liquid wastes are disposed of in a sanitary manner.
8. Non-water-carried sewage disposal facilities are not used, except where the health authority determines that the use of water-carried-sewage facilities is impractical.
9. A chemical toilet, earth pit privy, other type privy, or sewage-disposal facility is provided, they are constructed and operated in accordance with plans and instructions of the health authority. Such facilities shall comply with the standards outlined in Appendix C.

ITEM 7p. WATER SUPPLY

Water for milk plant purposes shall be from a supply properly located, protected, and operated and shall be easily accessible, adequate, and of a safe, sanitary quality.

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ADMINISTRATIVE PROCEDURES[5]

This item is deemed to be satisfied when:

1. Water for milk plant purposes is from an adequate supply, properly located, protected, and operated. It shall be easily accessible and of a safe, sanitary quality.

2. The water supply is approved as safe by the State health authority, and, in the case of individual water systems, complies with at least the specifications outlined in Appendix D and the bacteriological standards in Appendix G, page 133.

3. There is no cross-connection between the safe water supply and any unsafe or questionable water supply, or any source of pollution through which the safe water supply might become contaminated. A connection between the water supply piping and a make-up tank (such as for cooling or condensing), unless protected by an air gap or effective backflow preventor, constitutes a violation of this requirement.

4. Condensing water for milk evaporators, and water used to produce vacuum and/or to condense vapors in vacuum heat processing equipment, is from a source complying with 2 above: *Provided*, That when approved by the health authority, water from sources not complying with 2 above may be used when the evaporator or vacuum heat equipment is constructed and operated to preclude contamination of such equipment or its contents by condensing water or by water used to produce vacuum. (Appendix D describes means of precluding contamination when noncomplying sources of water are used.)

5. New individual water supplies and water supply systems, which have been repaired or otherwise become contaminated, are disinfected before being placed in use (see App. D, p. 116). The supply shall be made free of the disinfectant by pumping to waste before any sample for bacteriological testing shall be collected.

6. Samples for bacteriological testing of individual water supplies are taken upon the initial approval of the physical structure, semiannually thereafter, and when any repair or alteration of the water supply system has been made. Bacteriological examinations shall be conducted in a laboratory acceptable to the health authority.

7. Current records of water test results are retained on file with the health authority or as the health authority directs.

[5] Communities desiring to regulate cottage cheese and creamed cottage cheese under the terms of this *Ordinance* should include the following in the administrative procedures of Item 7p.: "Water supply outlets are provided immediately available to the cottage cheese vats. The hose for transport of water for washing cottage cheese curd shall be arranged in such a way as to preclude the possibility of the hose touching the floor or the product."

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ITEM 8p. HAND-WASHING FACILITIES

Convenient hand-washing facilities shall be provided, including hot and cold and/or warm running water, soap, and individual sanitary towels or other approved hand-drying devices. Hand-washing facilities shall be kept in a clean condition and in good repair.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. Convenient hand-washing facilities are provided, including hot and cold and/or warm running water, soap, and individual sanitary towels or other approved hand-drying devices.

2. Hand-washing facilities are convenient to all toilets and to all rooms in which milk plant operations are conducted.

3. Hand-washing facilities are kept in a clean condition and in good repair.

4. Steam-water mixing valves and vats used for washing bottles, cans, and similar equipment are not used as hand-washing facilities.

ITEM 9p. MILK PLANT CLEANLINESS

All rooms in which milk and milk products are handled, processed, or stored, and/or in which containers, utensils, or equipment are washed or stored, shall be kept clean, neat, and free of evidence of insects and rodents. Pesticides shall be safely used. Only equipment directly related to processing operations or to handling of containers, utensils, and equipment shall be permitted in the pasteurising, processing, cooling, packaging, and bulk milk storage rooms.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. Only equipment directly related to processing operations or the handling of containers, utensils, and equipment is permitted in the pasteurizing, processing, cooling, packaging, and bulk milk storage rooms.

2. All piping, floors, walls, ceilings, fans, shelves, tables, and the nonproduct-contact surfaces of other facilities and equipment are clean.

3. No trash or solid waste is stored within the plant, except in covered containers. Waste containers at the packaging machine or bottle washer may be uncovered during operation of such equipment.

4. All rooms in which milk and milk products are handled, processed, or stored, and/or in which containers, utensils, or equipment are washed or stored, are kept clean, neat, and free of evidence of insects and rodents.

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5. Pesticides are used safely.

6. Only pesticides approved by the health authority and/or registered with the U.S. Department of Agriculture shall be used for insect and rodent control. Such pesticides shall be used only in accordance with the manufacturers' directions and shall be prevented from contaminating milk, containers, equipment, and utensils.

ITEM 10p. SANITARY PIPING

All sanitary piping, fittings, and connections which are exposed to milk or milk products, or from which liquids may drip, drain, or be drawn into milk or milk products, shall consist of smooth, impervious, corrosion-resistant, nontoxic, easily cleanable material. All piping shall be in good repair. Pasteurized milk and milk products shall be conducted from one piece of equipment to another only through sanitary piping.[1]

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. All sanitary piping, fittings, and connections which are exposed to milk or milk products, or from which liquids may drip, drain, or be drawn into milk products, consist of smooth, impervious, corrosion-resistant, nontoxic, easily cleanable material.

2. All sanitary piping, connections, and fittings consist of:

a. Stainless steel of the AISI (American Iron and Steel Institute) 300 series, or

b. Equally corrosion-resistant metal which is nontoxic and nonabsorbent, or

c. Heat resistant glass, or

d. Plastic, or rubber and rubberlike materials which are relatively inert, resistant to scratching, scoring, decomposition, crazing, chipping, and distortion under normal use conditions; which are nontoxic, fat resistant, relatively nonabsorbent; which do not impart flavor or odor to the products; and which maintain their original properties under repeated use conditions.

3. Sanitary piping, fittings, and connections are designed to permit easy cleaning, kept in good repair, and free of breaks or corrosion.

4. All interior surfaces of demountable piping, including valves, fittings, and connections are designed, constructed, and installed to permit inspection and drainage.

5. All cleaned-in-place milk pipelines and return-solution lines are rigid, self-draining, and so supported to maintain uniform slope and alinement. Return solution lines shall be constructed of material meet-

[1] Communities desiring to regulate cottage cheese and creamed cottage cheese under the terms of this *Ordinance* should add the following: "*Provided*, That cottage cheese, cheese dressings, or cheese ingredients may be transported by other methods which protect the product from contamination."

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ing the specifications of 2 above. If gaskets are used, they shall be self-positioning, of material meeting the specifications outlined in 2d above, and designed, finished, and applied to form a smooth, flush interior surface. If gaskets are not used, all fittings shall have self-positioning faces designed to form a smooth, flush interior surface. All interior surfaces of welded joints in pipelines shall be smooth and free from pits, cracks, or inclusions.

In the case of welded lines, all welds shall be inspected by the use of a borescope or other appropriate available inspection device as they are made; and such welds shall be approved by the health authority.

Each cleaning circuit shall have access points for inspection in addition to the entrances and exits. These may be valves, removable sections, fittings, or other means or combinations that are adequate for inspection of the interior of the line. These access points shall be located at sufficient intervals to determine the general condition of the interior surfaces of the line.

Detailed plans for welded pipeline systems shall be submitted to the health authority for written approval prior to installation. No alteration or addition shall be made to any welded milk pipeline system without prior written approval from the health authority.

6. Pasteurized milk and milk products are conducted from one piece of equipment to another only through sanitary milk piping. The health authority may waive this piping requirement for specific milk products when small quantities are handled as to make the requirement impractical, and when such handling is performed so as to preclude product contamination.

ITEM 11p. CONSTRUCTION AND REPAIR OF CONTAINERS AND EQUIPMENT

All multiuse containers and equipment with which milk or milk products come into contact shall be of smooth, impervious, corrosion-resistant, nontoxic material; shall be constructed for ease of cleaning; and shall be kept in good repair. All single-service containers, closures, gaskets, and other articles with which milk or milk products come in contact shall be nontoxic, and shall have been manufactured, packaged, transported, and handled in a sanitary manner. Articles intended for single-service use shall not be reused.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. All multiuse containers and equipment with which milk or milk products come into contact are of smooth, impervious, corrosion-resistant, and nontoxic material.

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2. All milk-contact surfaces of multiuse containers and equipment consist of:

a. Stainless steel of the AISI (American Iron and Steel Institute) 300 series, or

b. Equally corrosion-resistant metal which is nontoxic and nonabsorbent, or

c. Heat resistant glass, or

d. Plastic or rubber and rubberlike materials which are relatively inert, resistant to scratching, scoring, decomposition, crazing, chipping, and distortion under normal use conditions; which are nontoxic, fat resistant, relatively nonabsorbent, and do not impart flavor or odor to the product; and which maintain their original properties under repeated use conditions.

3. All joints in containers, equipment, and utensils are flush and finished as smooth as adjoining surfaces. Where a rotating shaft is inserted through a surface with which milk or milk products come into contact, the joint between the moving and stationary surfaces shall be close-fitting. Where a thermometer or temperature sensing element is inserted through a surface with which milk or milk products come into contact, a pressure-tight seal shall be provided ahead of all threads and crevices.

4. All openings in covers of tanks, vats, separators, etc., are protected by raised edges, or otherwise to prevent the entrance of surface drainage. Condensation-diverting aprons shall be provided as close to the tank or vat as possible on all pipes, thermometers, or temperature sensing elements, and other equipment extending into a tank, bowl, vat, or distributor, unless a watertight joint is provided.

5. All surfaces with which milk or milk products come into contact are easily accessible or demountable for manual cleaning or are designed for mechanical cleaning. All product-contact surfaces shall be readily accessible for inspection and shall be self-draining. Wing nuts, bayonet locks, and similar devices shall be used whenever possible in lieu of bolts and nuts, to promote easy disassembly.

6. There are no threads used in contact with milk or milk products except where needed for functional and safety reasons, such as in clarifiers, pumps, and separators. Such threads shall be of a sanitary type.

7. All multiuse containers and other equipment have rounded corners, are in good repair and free from breaks, crevices, and corrosion. Milk cans shall have umbrella-type covers.

8. Strainers, if used, are of perforated metal design, and so constructed as to utilize single-service strainer media. Multiple-use woven material shall not be used for straining milk.

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9. All single-service containers, closures, gaskets, and other articles, with which milk or milk products come in contact, are nontoxic.

10. The manufacture, packing, transportation, and handling of single-service containers, closures, caps, gaskets, and similar articles comply with the requirements of Appendix J, Sanitation Guidelines for the Manufacture of Single-Service Containers for Milk and Milk Products, prepared by the Division of Environmental Engineering and Food Protection of the U.S. Public Health Service. Inspections and tests shall be made by the health authority or by any agency authorized by him.

Note.—*3-A Sanitary Standards.*—3-A Sanitary Standards for Dairy equipment are promulgated jointly by the Sanitary Standards Subcommittee of the Dairy Industry Committee, the Committee on Sanitary Procedure of the International Association of Milk, Food, and Environmental Sanitarians, Inc., and the Milk and Food Branch, Division of Environmental Engineering and Food Protection, Public Health Service, Department of Health, Education, and Welfare. Equipment manufactured in conformity with 3-A Sanitary Standards complies with the sanitary design and construction standards of this *Ordinance*.

ITEM 12p. CLEANING AND SANITIZING OF CONTAINERS AND EQUIPMENT

The product-contact surfaces of all multiuse containers, utensils, and equipment used in the transportation, processing, handling, and storage of milk or milk products shall be effectively cleaned and shall be sanitized before each use.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. All multiuse containers and utensils are thoroughly cleaned after each use, and all equipment is thoroughly cleaned at least once each day used: *Provided*, That storage tanks shall be cleaned when emptied and shall be emptied at least every 72 hours.

2. Pipelines and/or equipment designed for mechanical cleaning meet the following requirements:

a. An effective cleaning and sanitizing regimen for each separate cleaning circuit shall be followed.

b. During processing, pipelines and equipment used to contain or conduct milk and milk products shall be effectively separated from tanks or circuits containing cleaning and/or sanitizing solutions.

c. A temperature recording device, complying with the specifications in Appendix H, page 151, shall be installed in the return solution line to record the temperature and time during which the line or equipment is exposed to cleaning and sanitizing.

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d. Temperature recording charts shall be identified, dated, and retained for 3 months.

e. During each official inspection, the health authority shall examine and initial temperature recording charts to verify the time of exposure to solutions and their temperatures.

3. Plants in which containers are washed manually are equipped with a two-compartment wash-and-rinse vat for this purpose. Such plants shall also provide a steam cabinet or individual steam-jet plate with hood for sanitizing of cleaned containers, or, if sanitizing is done with chemicals, a third treatment vat.

4. All multiuse containers, equipment, and utensils are sanitized before use, employing one or a combination of the methods prescribed under item 11r. Assembled equipment must be sanitized immediately prior to each day's run. At least once each 3 months, the health authority shall determine the efficiency of sanitization in compliance with the procedures of Appendix G, page 133. (See App. F, p. 126, for a more complete discussion of sanitizers and sanitizing techniques.)

5. The residual bacteria count of multiuse and single-service containers used for packaging pasteurized milk and milk products shall not exceed one per ml. of capacity or not over 50 colonies per 3 square inches (one per square centimeter) of product-contact surface in 3-out-of-4 samples taken at random on a given day. All multiuse and single-service containers shall be free of coliform organisms.

ITEM 13p. STORAGE OF CLEANED CONTAINERS AND EQUIPMENT

After cleaning, all multiuse milk or milk product containers, utensils, and equipment shall be transported and stored to assure complete drainage, and shall be protected from contamination before use.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. All multiuse containers, equipment, and utensils, after cleaning, are transported and/or stored on metal racks or in clean cases elevated above the floor. Containers shall be stored inverted on racks or in cases constructed of relatively nonabsorbent, corrosion-resistant, nontoxic materials, or otherwise protected from contamination.

2. Floors are not flushed or washed when crates of clean bottles are stacked on them.

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ITEM 14p. STORAGE OF SINGLE-SERVICE CONTAINERS, UTENSILS AND MATERIALS

Single-service caps, cap stock, parchment paper, containers, gaskets, and other single-service articles for use in contact with milk and milk products shall be purchased and stored in sanitary tubes, wrappings, or cartons; shall be kept therein in a clean, dry place until used; and shall be handled in a sanitary manner.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. Single-service caps, cap stock, parchment paper, containers, gaskets, and other single-service articles for use in contact with milk and milk products are purchased and stored in sanitary tubes, wrappings, or cartons; are kept in a clean, dry place until used; and are handled in a sanitary manner.

2. Paperboard containers used to enclose plastic bags are used only once.

3. Tubes or cartons are not refilled with spilled caps, gaskets, or parchment papers.

4. Cartons or boxes from which contents have been partially removed are kept closed.

5. Suitable cabinets are provided for storage of tubes after removal from the large outer box, and for storage of opened cartons, unless other satisfactory means are approved by the health authority.

ITEM 15p. PROTECTION FROM CONTAMINATION

Milk plant operations, equipment, and facilities shall be located and conducted to prevent any contamination of milk or milk products, ingredients, equipment, containers, and utensils. All milk or milk products or ingredients which have been spilled, overflowed, or leaked shall be discarded. The processing or handling of products other than milk and milk products in the pasteurization plant shall be performed to preclude the contamination of such milk and milk products.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. Equipment and operations are so located within the plant as to prevent overcrowding and contamination of cleaned and sanitized containers, equipment, and utensils by splash, condensation, or manual contact.

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2. All milk and milk products which have overflowed, leaked, been spilled, or improperly handled are discarded. Milk and milk products drained from processing equipment at the end of a run, or collected from a defoamer system which does not continuously return such product to the filler bowl, shall be repasteurized only if such milk or milk products are handled in a sanitary manner and maintained at 45° F. or less. When the handling and/or refrigeration of such milk and milk products are not in compliance with this requirement, they shall be discarded. Returned packaged milk and milk products shall not be repasteurized for Grade A use.

3. All product contact surfaces of containers, equipment, and utensils are covered or otherwise protected to prevent the access of insects, dust, condensation, and other contamination. All openings, including valves and piping attached to milk storage and transport tanks, pumps, or vats, etc., shall be capped or otherwise properly protected. The application of suitable filters to the manholes of transport tanks during unloading shall be considered satisfactory.

Receiving and dump vats shall be completely covered, except during washing and sanitizing, and when milk is being dumped. Where strainers are used, the cover for the vat opening shall be designed to cover the opening with the strainer in place.

4. Whenever air under pressure is used for the agitation or movement of milk, or is directed at a milk-contact surface, it is free of oil, dust, rust, excessive moisture, extraneous materials, and odor, and shall otherwise comply with the applicable standards of Appendix H. The use of steam containing toxic substances is expressly prohibited. Whenever steam is used in contact with milk or milk products, it shall be of culinary quality and shall comply with the applicable standards of Appendix H.

5. Standardization is done before the pasteurization process is started, unless pasteurized milk or milk products are used for standardization. Such pasteurized milk products shall be protected against contamination. In no case shall pasteurized milk or milk products be standardized with unpasteurized milk unless the standardized product is subsequently pasteurized. Standardization of Grade A milk and milk products with milk and milk products of other than Grade A quality is prohibited. This *Ordinance* permits standardization as a process of adjusting the butterfat of milk in a milk plant by the addition or removal of cream or skim milk.

6. The processing of foods and/or drinks other than Grade A milk and milk products are performed to preclude the contamination of such milk and milk products.

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7. Means are provided to prevent contamination of milk containers, utensils, and equipment by drippings, spillage, and splash from overhead piping, platforms, or mezzanines.

8. All ingredients and nonproduct-contact materials used in the preparation or packaging of milk and milk products are stored in a clean place and are so handled as to prevent their contamination.

9. Pasteurized milk is not strained or filtered except through a perforated metal strainer. Multiple-use woven material shall not be used for straining milk.

ITEM 16p. PASTEURIZATION

Pasteurization shall be performed as defined in Section 1, Definition (S), of this Ordinance.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. All milk or milk products are heated to at least 145° F. and are held continuously at or above this temperature for at least 30 minutes, or to at least 161° F. and held continuously at or above this temperature for at least 15 seconds in properly designed and operated equipment which is approved by the health authority: *Provided*, That milk products which have a higher milkfat content than milk and/or contain added sweeteners shall be heated to at least 150° F. and held continuously at or above this temperature for at least 30 minutes, or to at least 166° F. and held continuously at or above this temperature for at least 15 seconds: *Provided further*, That nothing in this definition shall be construed as barring any other pasteurization process which has been recognized by the United States Public Health Service to be equally efficient and which is approved by the State health authority.

2. The design and the operation of pasteurization equipment and all appurtenances thereto comply with the applicable specifications and operational procedures of subitems (A) through (D), as follows:

16p(A). BATCH PASTEURIZATION

All indicating and recording thermometers used in connection with the batch pasteurization of milk or milk products shall comply with the applicable specifications set forth in Appendix H. (Specifications for test thermometers and other test equipment appear in App. I, p. 152.)

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1. *Time and Temperature Controls for Batch Pasteurizers*

a. Temperature Difference.—The pasteurizer shall be so designed that the simultaneous temperature difference between the milk or milk product at the center and the coldest milk or milk product in the vat will not exceed 1° F. at any time during the holding period.

The vat shall be provided with adequate agitation, operating throughout the holding period. No batch of milk or milk product shall be pasteurized unless it covers a sufficient area of the agitator to insure adequate agitation.

b. Location and Required Readings of Indicating and Recording Thermometers.—Each batch pasteurizer shall be equipped with both an indicating and a recording thermometer.

The thermometers shall read not less than the required pasteurization temperature throughout the required holding period. The plant operator shall check daily the temperature shown by the recording thermometer against the temperature shown by the indicating thermometer; this comparison shall be noted on the recording thermometer chart. The recording thermometer shall not read higher than the indicating thermometer. No batch of milk or milk products shall be pasteurized unless it is sufficient to cover the bulbs of both the indicating and the recording thermometers.

c. Insurance of Minimum Holding Periods.—Batch pasteurizers shall be so operated that every particle of milk or milk product will be held at not less than the minimum pasteurization temperature continuously for at least 30 minutes. When milk or milk products are raised to pasteurization temperature in the vat, and cooling is begun in the vat, simultaneously with or before the opening of the outlet valve, the recorder chart shall show at least 30 minutes at not less than minimum pasteurization temperature. When milk or milk products are preheated to pasteurization temperature before entering the vat, the recorder chart shall show a holding period of at least 30 minutes at not less than the minimum pasteurization temperature plus the time of filling from the level of the recorder bulb. When cooling is begun in the holder after the opening of the outlet valve, or is done entirely outside the holder, the chart shall show at least 30 minutes at not less than the minimum pasteurization temperature plus the time of emptying to the level of the recording-thermometer bulb.

When the recorder time interval on the recorder chart at the pasteurization temperature includes filling and/or emptying time, such intervals shall be indicated on the recorder chart by the operator, by removing the recording-thermometer bulb from the milk for a sufficient time to depress the pen, or by turning cold water into the vat

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jacket at the end of the holding period, or by inscribing the holding time on the chart. The filling time and the emptying time for each holder so operated shall be determined by the health authority, initially and after any change which may affect these times.

No milk shall be added to the holder after the start of the holding period.

2. *Airspace Heating*

a. Means shall be provided and used in batch pasteurizers to keep the atmosphere above the milk and milk products at a temperature not less than 5° F. higher than the minimum required temperature of pasteurization during the holding period (App. H, p. 147).

b. Each batch pasteurizer shall be equipped with an airspace thermometer. The surface of the milk or milk product shall be at least 1 inch below the bottom of the thermometer bulb when the vat is in operation.

c. The temperature shown by the airspace thermometer shall be recorded on the recording thermometer chart each time the pasteurizer is in operation.

3. *Inlet and Outlet Valves and Connections*

a. The following definitions shall apply to inlet and outlet valves and connections:

(1) "Valve stop" shall mean a guide which permits turning the valve plug to, but not beyond, the fully closed position.

(2) "90° stop" shall mean a stop so designed as to prevent turning the plug more than 90°.

(3) "120° stop" shall mean a stop which prevents turning the plug more than 120°.

(4) "180° stop" shall mean a stop which prevents turning the plug more than 180°, but which permits two fully closed positions, each diametrically opposite the other.

(5) "Valve with an irreversible plug" shall mean one in which the plug cannot be reversed in the shell.

(6) "Single-quadrant stop" shall mean a 90° stop in a valve with an irreversible plug.

(7) "The fully open position" shall mean that position of the valve seat which permits the maximum flow into or out of the pasteurizer.

(8) "The closed position" shall mean any position of the valve seat which stops the flow of milk into or out of the pasteurizer.

(9) "The fully closed position" shall mean that closed position of the valve seat which requires the maximum movement of the valve to reach the fully open position.

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(10) "The just-closed position" shall mean that closed position of a plug-type valve in which the flow into or out of the holder is barely stopped, or any closed position within five sixty-fourths inch thereof as measured along the maximum circumference of the valve seat.

(11) "Leakage" shall mean the entrance of unpasteurized milk into a batch pasteurizer during the holding or emptying period, or the entrance of unpasteurized milk into any pasteurized milk line at any time.

(12) "Leak-protector valve" shall mean a valve provided with a leak-diverting device, which, when the valve is in any closed position, will prevent leakage of milk past the valve or, in the case of batch pasteurizers filled or emptied by suction or compressed air, will prevent leakage of milk past the valve or the leakage of milk due to the leakage of air past the suction valve or the compressed air valve, as the case may be.

(13) "Closed-coupled valve" shall mean a valve, the seat of which is either flush with the inner wall of the pasteurizer, or so closely coupled that no milk in the valve inlet is more than 1° F. colder than the milk at the center of the pasteurizer at any time during the holding period.

A close-coupled valve which is not truly flush, shall be considered as satisfying this requirement when (a) the vat outlet is so flared that the smallest diameter of the large end of the flare is not less than the diameter of the outlet line, plus the depth of the flare, and (b) the greatest distance from the valve seat to the small end of the flare is not greater than the diameter of the outlet line, and (c) in the case of batch pasteurizers, the outlet and the agitator are so placed as to insure that milk currents will be swept into the outlet.

4. Design and Installation of Valves and Connections

All valves and connections shall comply with the following requirements:

a. Valves and pipeline connections shall meet the requirements of item 10p.

b. All pipelines and fittings shall be so constructed and so located that leakage will not occur. Dependence shall not be placed on soldered joints to prevent leakage.

c. To prevent clogging, and to promote drainage, all leak-protection grooves shall be at least three-sixteenths inch wide, and at least three thirty-seconds inch deep at the center. Mating grooves shall provide these dimensions throughout their combined length whenever the valve is in, or approximately in, the fully closed position. All single-leak grooves, and all mating leak grooves when mated, shall extend

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throughout the entire depth of the seat, so as to divert leakage occurring at all points throughout the depth of the seat, and so as to prevent air bindings. Washers or other parts shall not obstruct leak-protector grooves.

d. A stop shall be provided on all plug-type outlet valves and on all plug-type inlet valves in order to guide the operator in closing the valve so that unpasteurized milk may not inadvertently be permitted to enter the outlet line or the holder, respectively. The stop shall be so designed that the plug will be irreversible when the plug is provided with any grooves or their equivalent, unless duplicate, diametrically opposite grooves are also provided. In the case of 2-way, plug-type valves (i.e., those having only one inlet and one outlet), a 180 degree stop, or any combination of stops permitting two fully closed positions, may be substituted for a 90 degree stop, provided that there are no air-relief grooves in the plug and that all leak grooves are located symmetrically with respect to the valve inlet. Stops shall be so designed that the operator cannot turn the valve beyond the stop position, either by raising the plug or by any other means.

e. Outlet valves, in addition to the requirements listed above, shall be so designed as to prevent the accumulation of unpasteurized milk in the milk passages of the valve when the valve is in any closed position.

f. All inlet pipelines and outlets from vat pasteurizers shall be equipped with leak-protector valves:

Provided, That installations not equipped with leak-protector inlet valves shall be accepted when the piping is so arranged that only one vat can be connected to the inlet line at a time, and such piping is disconnected during the holding and emptying periods.

g. Inlet and outlet connections other than through close-coupled valves shall not enter or leave the pasteurizer below the level of the milk therein.

h. In cases where the inlet line enters the holder above the milk level, and in which the inlet line may be submerged and thus prevent its complete emptying when the inlet valve is closed, the inlet line shall be provided with an automatic air-relief, or vent located either at the valve or elsewhere, and so designed as to function in every closed position of the valve. A vent may be provided by drilling a hole at least one-eighth inch in diameter in the vat pipe, below the vat cover, but above the maximum milk level.

i. All leak-protector valves shall be installed in the proper position to insure the function of the leak-diverting device. Inlet valves shall not be located in vertical pipelines, unless they can be so installed

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that one of the groove systems is at the lowest level of the valve; and pipelines between the inlet valve and the pasteurizer shall be as short as practicable and shall be sloped to drain.

j. All outlet valves shall be kept fully closed during filling, heating, and holding periods; and all inlet valves shall be kept fully closed during holding and emptying periods.

5. Recording Charts

All recording thermometer charts shall comply with all the applicable requirements of item 16p (D), page 79.

ITEM 16p(B). HIGH-TEMPERATURE, SHORT-TIME, CONTINUOUS-FLOW PASTEURIZATION

1. All indicating thermometers and recorder/controller instruments and devices used in connection with the high-temperature, short-time, continuous-flow pasteurization of milk or milk products shall comply with the applicable specifications set forth in Appendix H, page 147.

2. Each high-temperature, short-time, continuous-flow pasteurization system shall be equipped with an automatic milkflow control of the diversion type, which complies with the following definition, specifications, and performance requirements:

a. The term automatic milkflow controls shall mean those safety devices which control the flow of milk in relation to the temperature of the milk, or heating medium and/or pressure, vacuum, or other auxiliary equipment. Milkflow controls shall not be considered as part of the temperature control equipment. Milkflow controls include (1) milk pump stops; (2) milk pump stops and spring-operated valves which automatically start and stop the flow of milk at legal and sublegal pasteurization temperatures, respectively; and (3) flow-diversion devices which automatically cause the diversion of the milk in response to a sublegal pasteurization temperature. At sublegal temperatures, flow-diversion devices return the milk to the raw milk side of the heating system continuously until legal pasteurization temperatures are obtained; at which time, the device restores forward-flow through the pasteurizer.

b. All flow-diversion valves and other milkflow stops used in continuous pasteurizers shall comply with the following or equally satisfactory specifications:

(1) *Flow-Diversion Valves.*—(a) Forward flow of subtemperature milk, due to the omission or looseness of the connecting clip, shall be prevented by making the valve and its actuating mechanism integral; or, where there is a connecting device, by making it impossible to assemble the valve and its actuating mechanism, except in such

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manner that it will function properly; or, where there is a connecting device which may be omitted or shaken loose by providing for pushing, instead of pulling, the valve to the diverted position; or by providing that the pump will shut down when the milk is below the pasteurization temperature and the valve is not in the fully diverted position; or by any other equally satisfactory means.

(b) It shall be impossible to tighten the stem packing nut to such an extent as to prevent the valve from assuming the fully diverted position.

(c) A leak escape shall be installed on the forward-flow side of the valve seat. However, when back pressure is exerted on the forward-flow side of the valve seat, while the milkflow is being diverted, the leak escape should lie between two valve seats, or between two portions of the same seat, one upstream and the other downstream from the leak escape. The leak escape shall be so designed and the valve so installed as to drain all leakage to the outside.

(d) The closure of the forward-flow seat shall be sufficiently tight so that leakage past it will not exceed the capacity of the leak escape device, as evidenced when the forward-flow line is disconnected; and, in order that proper seating may not be disturbed, the length of the connecting rod shall not be adjustable by the user.

(e) The flow-diversion valve shall be so designed and installed that failure of the primary motivating power shall automatically divert the flow of milk.

(f) The flow-diversion valve shall be located downstream from the holder. The flow-control sensor shall be located in the milk line not more than 18 inches upstream from the flow-control device.

(g) The pipeline from the diversion port of the flow-diversion valve shall be self-draining, and shall be free of restrictions or valves, unless such restrictions or valves are so designed that stoppage of the diversion line cannot occur.

(2) ***Milk-Flow Controller Instrumentation.***—The following requirements shall be met with respect to the instrumentation of the milk-flow controller:

(a) The thermal limit controller shall be set and sealed so that forward flow of product cannot start unless the temperature at the controller sensor is above 161° F. nor continue during descending temperatures when the temperature is below 161° F. The seal shall be applied by the health authority after test, and shall not be removed without immediately notifying the health authority. The system shall be so designed that no milk can be bypassed around the controller sensor which shall not be removed from its proper position

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during the pasteurization process. The cut-in and cut-out milk temperatures, as shown by the indicating thermometer, shall be determined at the beginning of each day's operation and entered upon the recorder chart daily by the plant operator.

(b) Manual switches for the control of pumps, homogenizers, or other devices which produce flow through the holder, shall be wired so that the circuit is completed only when the milk is above 161° F. or when the diversion valve is in the fully diverted position.

(3) ***Holding Tube.***—(a) Holders shall be designed to provide for the holding of every particle of milk or milk product for at least 15 seconds.

(b) The holder shall be so designed that the simultaneous temperature difference between the hottest and coldest milk in any cross section of flow at any time during the holding period will not be greater than 1° F. This requirement may be assumed to have been satisfied without test in tubular holders of 7 inches or smaller diameter which are free of any fittings through which the milk may not be thoroughly swept.

(c) No device shall be permitted for short circuiting a portion of the holder to compensate for changes in rate of milkflow. Holding tubes shall be installed so that sections of pipe cannot be left out, resulting in a shortened holding time.

(d) The holding tube shall be arranged to have a continuously upward slope in the direction of flow of not less than one-fourth inch per foot.

(e) Supports for tubes shall be provided to maintain all parts of holding tubes in a fixed position, free from any lateral or vertical movement.

(f) The holder shall be so designed that no portion between the inlet and the flow-control temperature sensor is heated.

(4) ***Indicating and Recording Thermometers.***—(a) An indicating thermometer shall be located as near as practicable to the temperature sensor of the recorder controller, but may be located a short distance upstream from the latter where milk between the two thermometers does not differ significantly in temperature.

(b) The temperature shown by the recorder controller shall be checked daily by the plant operator against the temperature shown by the indicating thermometer. Readings shall be recorded on the chart. The recorder controller shall be adjusted to read no higher than the indicating thermometer.

(c) The recorder controller charts shall comply with the applicable provisions of item 16p (D), page 79.

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(5) *Flow-Promoting Devices.*—(a) The pump, or pumps, and other equipment which may produce flow through the holder shall be located upstream from the holder, provided that pumps and other flow-promoting devices may be located downstream from the holder if means are provided to eliminate negative pressure between the holder and the inlet to such equipment. When vacuum equipment is located downstream from the holder, an effective vacuum breaker, plus an automatic means of preventing a negative pressure in the line between the flow-diversion valve and the vacuum chamber, shall be acceptable.

(b) The speed of pumps or other flow-promoting devices governing the rate of flow through the holder shall be so controlled as to insure the holding of every particle of milk for at least 15 seconds. In all cases, the motor shall be connected to the metering pump by means of a common driveshaft, or by means of gears, pulleys, or a variable-speed drive, with the gear box, the pulley box, or the setting of the variable-speed protected in such a manner that the holding time cannot be shortened without detection by the health authority. This shall be accomplished by the application of a suitable seal(s) after tests by the health authority and such seal shall not be broken without immediately notifying the health authority. The provision shall apply to all homogenizers used as timing pumps.

Variable-speed drives used in connection with the metering pump shall be so constructed that wearing or stretching of the belt results in a slowdown, rather than a speedup, of the pump.

The metering or timing pump shall be of the positive displacement type.

(c) The holding time shall be taken to mean the flow time of the fastest particle of milk, at or above 161° F., throughout the holder section; i.e., that portion of the system that is outside of the influence of the heating medium, and slopes continuously upward in the downstream direction, and is located upstream from the flow-diversion valve. Tests for holding time shall be made when all equipment and devices are operated and adjusted to provide for maximum flow. When a homogenizer is located upstream from the holder, the holding time shall be determined with the homogenizer in operation with no pressure on the homogenizer valves. Where bypass lines are provided, either upstream or downstream from the the metering pump, the holding time shall be tested with both the regular and bypass line open, unless the bypass valve is so designed that both lines cannot be open at the same time.

The holding time shall be tested during both forward and diverted flow. If necessary to lengthen the holding time during diverted flow,

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an identifiable restriction may be placed in the vertical portion of the diversion pipeline.

When vacuum equipment is located downstream from the holder, the holding time shall be tested with the metering pump operating at maximum flow, and the vacuum equipment adjusted to provide for the maximum vacuum.

The holding time shall be tested in both forward and diverted flow by the health authority initially, semiannually thereafter, after any alteration or replacement that may affect the holding time, and whenever the seal of the speed setting has been broken.

(6) ***Prevention of Product Adulteration With Added Water.***—(a) When culinary steam is introduced directly into the milk or milk product downstream from the flow-diversion valve, means shall be provided to preclude the addition of steam to the product, unless the flow-diversion valve is in the forward-flow position. This provision may be satisfied by the use of an automatic steam control valve with temperature sensor located downstream from the steam inlet, or by the use of an automatic solenoid valve installed in the steam line and so wired through the flow-diversion valve controls that steam cannot flow unless the flow-diversion valve is in the forward-flow position.

(b) When culinary steam is introduced directly into the milk or milk product, automatic means shall be provided to maintain a proper temperature differential between incoming and outgoing milk to preclude dilution with water.

(c) Where a water feed line is connected to a vacuum condenser and the vacuum condenser is not separated from the vacuum chamber by a physical barrier, means shall be provided to preclude the backup and overflow of water from the vacuum condenser to the vacuum chamber. This provision may be satisfied by the use of a safety shutoff valve, located on the water feed line to the vacuum condenser, automatically actuated by a control which will shut off the inflowing water, if for example, the condensate pump stops and the water level rises above a predetermined point in the vacuum condenser. This valve may be actuated by water, air, or electricity, and shall be so designed that failure of the primary motivating power will automatically stop the flow of water into the vacuum condenser.

ITEM 16p (C). PASTEURIZERS EMPLOYING MILK-TO-MILK REGENERATIVE HEATING

Pasteurizers employing milk-to-milk regenerative heating with both sides closed to the atmosphere shall comply with the following or equally satisfactory specifications:

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1. Regenerators shall be constructed, installed, and operated so that pasteurized milk in the regenerator will automatically be under greater pressure than raw milk in the regenerator at all times.

2. The pasteurized milk, between its outlet from the regenerator and the nearest point downstream open to the atmosphere, shall rise to a vertical elevation of 12 inches above the highest raw milk level downstream from the constant-level tank and shall be open to the atmosphere at this or a higher elevation.

3. The overflow of the top rim of the constant-level raw milk tank shall always be lower than the lowest milk level in the regenerator.

4. No pump or flow-promoting device which can affect the proper pressure relationships within the regenerator shall be located between the pasteurized milk outlet from the regenerator and the nearest downstream point open to the atmosphere.

5. No pump shall be located between the raw milk inlet to the regenerator and the raw milk supply tank, unless it is designed and installed to operate only when milk is flowing through the pasteurized milk side of the regenerator, and when the pressure of the pasteurized milk is higher than the maximum pressure produced by the pump. This may be accomplished by wiring the booster pump so that it cannot operate unless (a) the metering pump is in operation, (b) the flow-diversion valve is in forward-flow position, and (c) the pasteurized milk pressure exceeds, by at least 1 pound per square inch, the maximum pressure developed by the booster pump. Pressure gages shall be installed at the raw milk inlet to the regenerator and the pasteurized milk outlet of the regenerator or the outlet of the cooler. The accuracy of required pressure gages shall be checked by the health authority on installation, quarterly thereafter, and following repair or adjustment (see App. I, Test 9, p. 159).

6. The motor, casing, and impeller of the booster pump shall be identified, and such records thereof maintained as directed by the health authority.

7. All raw milk in the regenerator will drain freely back into the constant-level raw milk tank when the raw milk pump(s) are shut down and the raw milk outlet from the regenerator is disconnected.

8. When vacuum equipment is located downstream from the flow-diversion valve, means shall be provided to prevent the lowering of the pasteurized milk level in the regenerator during periods of diverted flow or shutdown. An effective vacuum breaker, plus an automatic means of preventing a negative pressure, shall be installed in the line between the vacuum chamber and the pasteurized milk inlet to the regenerator.

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(See Appendix H, page 137 for further discussion concerning methods of achieving the required pressure relationships within the regenerator.)

ITEM 16p(D). TEMPERATURE RECORDING CHARTS EQUIPMENT TESTS AND EXAMINATIONS

1. All temperature recording charts shall be preserved for a period of 3 months. The use of such charts shall not exceed the time limit for which they are designed. Overlapping of recorded data shall be a violation of this item. The following information shall be entered on the charts as applicable:

(a) ***Batch Pasteurizers:***

(1) Date.

(2) Number or location of recorder when more than one is used.

(3) Extent of holding period, including filling and emptying times when required (item 16p(A)).

(4) Reading of airspace thermometer within the holding period at a given time or reference point as indicated on the chart (item 16p(A)).

(5) Reading of indicating thermometer within the holding period at a given time or reference point as indicated on the chart (item 16p(A)).

(6) Quarterly, the initials of the health authority opposite the required readings of the indicating thermometer and airspace thermometer (item 16p(A)).

(7) Quarterly, the time accuracy of the recorder, as determined by the health authority (App. I, Test 3, p. 155).

(8) Amount and name of pasteurized milk or milk product represented by each batch or run on the chart.

(9) Record of unusual occurrences.

(10) Signature or initials of operator.

(11) Name of milk plant.

(b) ***High-Temperature, Short-Time Pasteurizers.***—Recording thermometer charts shall contain all the information specified in (a) above, except (3), (4), and reference to airspace thermometers in item (6), and in addition, shall include the following:

(1) A record of the time during which the flow diversion valve is in the forward flow position.

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(2) The cut-in and cut-out milk temperatures recorded daily by the operator at the beginning of the run, and initialed quarterly by the health authority (item 16p(B)).

Note.—The recorded temperature shown on the controller chart shall be used to determine that the required temperature for milk products containing higher fat and/or sweeteners has been achieved.

2. *Equipment Tests and Examinations.*—The health authority shall perform the indicated tests on the following instruments and devices initially on installation, and at least once each 3 months thereafter, and whenever any alteration or replacement is made which may affect the proper operation of the instrument or device: *Provided*, That the holding time test shall be conducted semiannually.

Instrument or device	Appendix I Test No.	Page	Test objective
Batch pasteuriser indicating thermometer	1	153	Accuracy.
Batch pasteuriser recording thermometer	2	154	Temperature accuracy.
	3	155	Time accuracy.
	4	155	Check reading of recording thermometer against indicating thermometer.
Airspace thermometer	1	153	Accuracy.
Valves	6	157	Leakage in plug type leak-protector valves and poppet type valves.
HTST indicating thermometer	1	153	Accuracy.
	7	158	Thermometric response.
HTST recording thermometer	2	154	Temperature accuracy.
	3	155	Time accuracy.
HTST recorder controller	2	154	Temperature accuracy.
	4	155	Check reading of recorder controller against indicating thermometer.
	8	158	Thermometric response.
	10	161	Confirm cut-in and cut-out temperatures.
HTST flow diversion valve	5	156	Assembly and function.
HTST auxiliary (booster) pump	9	159	Function of automatic control devices.
	9	159	Accuracy of pressure gauges.
HTST systems	11	162	Check holding time.

ITEM 17p. COOLING OF MILK

All raw milk and milk products shall be maintained at 50° F. or less until processed. All pasteurized milk and milk products, except those to be cultured, shall be cooled immediately prior to filling or packaging in approved equipment to a temperature of 45° F. or less. All pasteurized milk and milk products shall be stored at a temperature of 45° F. or less. On delivery vehicles the temperature of milk and milk products shall not exceed 50° F. Every room or tank in which milk or milk products are stored shall be equipped with an accurate thermometer.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. All raw milk and milk products are maintained at 50° F. or less until processed.

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2. All pasteurized milk and milk products, except those to be cultured, are cooled immediately in approved equipment prior to filling and packaging to a temperature of 45° F. or less. All pasteurized milk and milk products shall be stored at a temperature of 45° F. or less. On delivery vehicles the temperature of milk and milk products shall not exceed 50° F.

3. Each refrigerator room in which milk or milk products are stored is equipped with a thermometer which complies with the applicable specifications of Appendix H, page 150. Such thermometer shall be located in the warmest zone of the refrigerator room.

Each storage tank shall be equipped with a thermometer, the sensor of which shall be located to permit the registering of the temperature of the contents when the tank contains no more than 20 percent of its calibrated capacity. Such thermometer shall comply with the applicable specifications of Appendix H, page 150.

4. All surface coolers comply with the following specifications:

a. The sections of open-surface coolers shall be so installed as to leave a gap of at least one-quarter inch between the header sections to permit easy cleaning.

b. Where header ends are not completely enclosed within the cooler covers, condensation or leakage from the headers shall be prevented from entering the milk or milk products by so shaping the exposed header faces, above and below all gaps, that condensation is directed away from the tubes, and by using deflectors at the bottom of the headers, or by shortening the bottom trough, or by some other approved method.

c. The location of supports of cooler sections shall prevent drip from entering the milk or milk products.

d. All open surface coolers shall be provided with tight-fitting shields which protect the milk and milk products from contamination by flies, dust, drip, splash, or manual contact.

5. Recirculated cold water which is used in coolers and exchangers is from a safe source and protected from contamination. Such water shall be tested semiannually and shall comply with the bacteriological standards of Appendix G, page 133. Recirculated water systems which become contaminated through repair work or otherwise shall be properly treated and tested before being returned to use. Freezing point depressants, when used in recirculating systems, shall be nontoxic.

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ITEM 18p. BOTTLING AND PACKAGING

Bottling and packaging of milk and milk products shall be done at the place of pasteurization in approved mechanical equipment.[1]

ADMINISTRATIVE PROCEDURES[2]

This item is deemed to be satisfied when:

1. All milk and milk products, including concentrated milk and milk products are bottled and packaged at the plant where final pasteurization is performed. Such bottling and packaging shall be done without undue delay following final pasteurization.

2. All bottling or packaging is done on approved mechanical equipment. The term "approved mechanical equipment" shall not be interpreted to exclude manually operated machinery but is interpreted to exclude methods in which the bottling and capping devices are not integral in one system.

3. Bottling or packaging machines are designed to minimize the need for adjustment during operation. All pipes, connections, defoaming devices, and similar appurtenances shall comply with items 10p and 11p.

4. Bottling or packaging machine supply tanks and bowls have covers which are constructed to prevent any contamination from reaching the inside of the filler tank or bowl. All covers shall be in place during operation.

5. A drip deflector is installed on each filler valve. Such drip deflector shall be designed and adjusted to divert condensation away from the open container.

6. Container infeed conveyors to automatic bottling or packaging machines have overhead shields to protect the bottles or packages from contamination. Such shields shall extend from the bottle washer discharge to the bottle feed star or, in the case of single service packaging machines, from the forming unit discharge to the filling unit and from the filling unit to the closure unit. Overhead shields shall be required on can infeed conveyors when the cans are fed to the filler with covers off.

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[1] Communities desiring to regulate the sale of cottage cheese and creamed cottage cheese under the terms of this *Ordinance* should add the following: *Provided*, That cottage cheese and creamed cottage cheese may be transported in sealed containers in a protected, sanitary manner from one plant to another for creaming and/or packaging.

[2] Communities desiring to regulate the sale of cottage cheese and creamed cottage cheese under the terms of this *Ordinance* should add the following to the Administrative Procedures of Item 18p:

"Cottage cheese and creamed cottage cheese are protected in a sanitary manner; they may be transported in sealed containers from one plant to another for creaming and/or packaging."

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7. Container fabricating materials, such as paper stock, foil, wax, plastic, etc., are handled in a sanitary manner and protected against undue exposure during the package assembly operation.

8. Bottling and packaging machine floats are designed to be adjustable without removing the cover.

9. The filler pipe of all bottling and packaging machines have an apron or other approved device as close to the filler bowl as possible to prevent condensation or drip from reaching the inside of the filler bowl.

10. Filling cylinders on packaging machines are protected from contamination by the use of overhead shields. When any lubricant is applied to the filler pistons, cylinders, or other milk contact surfaces, the lubricant shall be nontoxic, sterile, and shall be sparingly applied in a sanitary manner.

ITEM 19p. CAPPING

Capping or closing of milk and milk product containers shall be done in a sanitary manner by approved mechanical capping and/or closing equipment. The cap or closure shall protect the pouring lip to at least its largest diameter.

ADMINISTRATIVE PROCEDURES[1]

This item is deemed to be satisfied when:

1. The capping or closing of milk and milk product containers is done in a sanitary manner on approved mechanical capping/closing equipment. The term "approved mechanical capping and/or closing equipment" shall not exclude manually operated machinery. Hand-capping shall be prohibited: *Provided*, That if suitable mechanical equipment for the capping or closing of specific container(s) of 3 gallons or more is not available, other methods which eliminate all possibility of contamination may be approved by the health authority.

2. All mechanical capping or closure mechanisms are designed to minimize the need for adjustment during operation.

[1] Communities desiring to regulate the sale of cottage cheese and creamed cottage cheese under the terms of this *Ordinance* should add the following to the indicated administrative procedures of item 19p:

1. *Provided further*, That if suitable equipment is not available for capping cottage cheese and creamed cottage cheese, other methods of capping which eliminate possible chance of contamination may be approved by the health authority.
4. Closures for cottage cheese and creamed cottage cheese containers shall extend over the top edges of the container so as to protect the product from contamination during subsequent handling.
5. *Provided*, That this requirement(s) shall not apply to cottage cheese and creamed cottage cheese container closures, when such closures are supplied in a totally enclosed package, or wrapped so as to protect the closures.

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3. Bottles and packages which have been imperfectly capped or closed are emptied immediately into approved sanitary containers. Such milk or milk products shall be protected from contamination, maintained at 45° F. or less, and subsequently repasteurized or discarded.

4. All caps or closures protect the pouring lip of multiuse containers to at least the greatest diameter. Single-service containers shall be so constructed that the product and the pouring and opening areas are protected from contamination during handling, storage, and when the containers are initially opened.

5. Caps and closures are handled in a sanitary manner. The first cap from each tube, the first lap(s) from each roll of cap or cover stock, and the first sheet of parchment or cover paper shall be discarded. The subsequent use of loose caps which are left in the cappers at the end of an operating period after removal from the cap tubes shall be a violation of this item.

ITEM 20p. PERSONNEL—CLEANLINESS

Hands shall be thoroughly washed before commencing plant functions and as often as may be required to remove soil and contamination. No employee shall resume work after visiting the toilet room without thoroughly washing his hands. All persons engaged in the processing, pasteurization, handling, storage, or transportation of milk, milk products, containers, equipment, and utensils shall wear clean outer garments. The use of tobacco by any person engaged in the processing of milk or milk products is prohibited.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. Hands are thoroughly washed before commencing plant functions and as often as may be required to remove soil and contamination.

2. Each employee washes his hands following a visit to the toilet room and prior to resuming work.

3. All persons engaged in the processing, pasteurization, handling, storage, or transportation of milk, milk products, containers, equipment, and utensils wear clean outer garments.

4. Tobacco is not used by any person while engaged in the processing of milk or milk products.

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ITEM 21p. VEHICLES

All vehicles used for transportation of pasteurized milk and milk products shall be constructed and operated so that the milk and milk products are maintained at 45° F. or less, and are protected from sun, from freezing, and from contamination.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. All vehicles are kept clean.
2. Material which is capable of contaminating milk or milk products is not transported with milk or milk products.
3. Vehicles have fully enclosed bodies with well-fitted solid doors.

ITEM 22p. SURROUNDINGS

Milk plant surroundings shall be kept neat, clean, and free from conditions which might attract or harbor flies, other insects and rodents, or which otherwise constitute a nuisance.

ADMINISTRATIVE PROCEDURES

This item is deemed to be satisfied when:

1. There is no accumulation of trash, garbage, or similar waste in areas adjacent to the milk plant. Waste material stored in suitable covered containers shall be considered in compliance.
2. Driveways, lanes, and areas serving milk plant vehicular traffic are graded, drained, and free from pools of standing water.
3. Outdoor areas for transport tank unloading are constructed of smooth concrete or equally impervious material, properly sloped to drain, and equipped with trapped drains of sufficient size.
4. Only pesticides approved for use by the health authority and/or registered with the U.S. Department of Agriculture shall be used for insect and rodent control.

Note.—A convenient inspection form for milk plants, receiving stations, and transfer stations, which summarizes the applicable sanitation requirements, is found in Appendix L, page 167.

SECTION 8. ANIMAL HEALTH

All milk for pasteurization shall be from herds which are located in a Modified Accredited Tuberculosis Area as determined by the U.S. Department of Agriculture: Provided, *That herds located in an area that fails to maintain such accredited status shall have been*

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accredited by said Department as tuberculosis free, or shall have passed an annual tuberculosis test.

All milk for pasteurization shall be from herds under a brucellosis eradication program which meets one of the following conditions:

1. Located in a Certified Brucellosis-Free Area as defined by the U.S. Department of Agriculture and enrolled in the testing program for such areas; or

2. Located in a Modified Certified Brucellosis Area as defined by the U.S. Department of Agriculture and enrolled in the testing program for such areas; or

3. Meet U.S. Department of Agriculture requirements for an individually certified herd; or

4. Participating in a milk ring testing program which is conducted on a continuing basis at intervals of not less than every 3 months or more than every 6 months, with individual blood tests on all animals in herds showing suspicious reactions to the milk ring test; or

5. Have an individual blood agglutination test annually with an allowable maximum grace period not exceeding 2 months.

For diseases other than brucellosis and tuberculosis, the health authority shall require such physical, chemical, or bacteriological tests as he deems necessary. The diagnosis of other diseases in dairy cattle shall be based upon the findings of a licensed veterinarian or a veterinarian in the employ of an official agency. Any diseased animal disclosed by such test(s) shall be disposed of as the health authority directs.

ADMINISTRATIVE PROCEDURES

Tuberculosis.—All tuberculin tests and retests shall be made, and any reactors disposed of, in accordance with the *Uniform Methods and Rules* for establishing and maintaining of Tuberculosis-Free Accredited Herds of Cattle and Modified Accredited Areas, as approved by the USDA at the time of the adoption of this *Ordinance*. For tuberculosis test purposes, the herd is defined as all adult cattle 24 months of age and over, including any commingled beef animals. Dairy cattle less than 2 years of age and already milking, shall be included in the herd test. A letter or other official correspondence attesting to the accreditation status of the locality in which the herd is located, including the date of accreditation, or a certificate identifying the animals tested, the date of injection, the date of reading of the test, and the results of the test signed by a U.S. Department of Agriculture accredited veterinarian, shall be evidence of compliance with the above requirements and shall be filed with the health authority (see App. A, p. 93).

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Brucellosis.—All brucellosis tests, retests, disposal of reactors, vaccination of calves, and certification of herds and areas shall be in accordance with the recommended *Uniform Methods and Rules* for brucellosis eradication. All reactors disclosed on blood agglutination tests shall be separated immediately from the milking herd; the milk of these reactors shall not be used for human consumption.

A certificate identifying each animal, signed by the veterinarian and the director of the laboratory making the test, shall be filed as directed by the health authority: *Provided*, That in the event the herd is subject to the milk ring test, the record shall be required to show only the date and results of such test. Within 30 days following the expiration of an official milk ring testing program or, in the case of a herd subject to annual blood tests, 13 months following the last annual blood test, the health authority shall notify the herd owner or operator of the necessity to comply with the brucellosis requirements. The failure of the herd owner or operator to comply with the brucellosis requirements within 30 days of written notice shall result in immediate suspension of the permit (see App. A, p. 93).

SECTION 9. MILK AND MILK PRODUCTS WHICH MAY BE SOLD

From and after 18 months from the date on which this Ordinance *is adopted, only Grade A pasteurized milk and milk products* [*] *shall be sold to the final consumer, or to restaurants, soda fountains, grocery stores, or similar establishments:* Provided, *That in an emergency, the sale of pasteurized milk and milk products which have not been graded, or the grade of which is unknown, may be authorized by the health authority; in which case, such milk and milk products shall be labeled "ungraded."*

SECTION 10. TRANSFERRING; DELIVERY CONTAINERS; COOLING

Except as permitted in this section, no milk producer or distributor shall transfer milk or milk products from one container or tank truck to another on the street, in any vehicle, store, or in any place except a milk plant, receiving station, transfer station, or milkhouse especially used for that purpose. The dipping or ladling of milk or fluid milk products is prohibited.

It shall be unlawful to sell or serve any milk or fluid milk product except in the individual, original container received from the dis-

[*] Communities wishing to provide for the sale of certified pasteurized milk should include such product in this section.

Note.—Certified pasteurized milk is derived from certified raw milk which meets the latest requirements of the American Association of Medical Milk Commissions, Inc., 405 Lexington Ave., New York, N.Y., 10017.

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tributor, or from an approved bulk dispenser: Provided, *That this requirement shall not apply to milk for mixed drinks requiring less than one-half pint of milk, or to cream, whipped cream, or half-and-half which is consumed on the premises and which may be served from the original container of not more than one-half gallon capacity, or from a bulk dispenser approved for such service by the health authority.*

It shall be unlawful to sell or serve any pasteurized milk or milk product which has not been maintained at a temperature of 45° F. or less. If containers of pasteurized milk or milk products are stored in ice, the storage container shall be properly drained.

ADMINISTRATIVE PROCEDURES

Transferring.—The dipping or ladling of milk and fluid milk products is expressly prohibited, except for immediate cooking purposes. Milk and milk product containers which have been filled and sealed at a milk plant shall be used for the delivery of milk or milk products. Caps, closures, or labels shall not be removed or replaced during transportation.

Bulk Dispensers.—Bulk dispensers, approved by the health authority, shall satisfy the following sanitary design, construction, and operation requirements:

1. All dispensers shall comply with the applicable requirements of Section 7 of this *Ordinance.*

2. Product-contact surfaces shall be inaccessible to manual contact, droplet infection, dust, or flies; but the delivery orifice may be exempted from this requirement.

3. All parts of the dispensing device with which milk or milk products come into contact, including any measuring device, shall be thoroughly cleaned and sanitized at the milk plant: *Provided,* That dispensing valves which are applied to the dispenser subsequent to its delivery to the retail vendor may be cleaned and sanitized at such establishments.

4. The dispensing container shall be filled at the milk plant and shall be so sealed that it is impossible to withdraw any part of its contents, or to introduce any substance without breaking the seal(s).

5. The milk or milk products shall be thoroughly and automatically mixed with each dispensing operation, except for milk or milk products which remain homogeneous.

6. All cans shall be thoroughly cleaned and sanitized. Milk and milk products shall be kept at or below 45° F. at all times. The dispenser tube shall be integral with the dispensing container, shall be

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protected, and shall be under adequate refrigeration during transportation and storage.

SECTION 11. MILK AND MILK PRODUCTS FROM POINTS BEYOND THE LIMITS OF ROUTINE INSPECTION

Milk and milk products from points beyond the limits of routine inspection of the _____ of _____,[1] or its police jurisdiction, may be sold in _____,[1] or its police jurisdiction, provided they are produced and pasteurized under regulations which are substantially equivalent to this Ordinance *and have been awarded an acceptable milk sanitation compliance and enforcement rating made by a State milk sanitation rating officer certified by the U.S. Public Health Service.*

ADMINISTRATIVE PROCEDURES

The health authority should accept, without his actual physical inspection, supplies of milk and milk products from an area or an individual shipper not under his routine inspection: *Provided*, That (1) upon arrival, each shipment of raw milk for pasteurization shall comply with the bacteriological, chemical, and temperature standards of Section 7; (2) after receipt, pasteurized milk and milk products shall comply with the bacteriological, chemical, and temperature requirements of Section 7 as determined in accordance with Section 6; (3) the milk or milk products are produced and processed under regulations substantially equivalent to those of this *Ordinance;* (4) the supplies are under routine official supervision; (5) the supplies have been awarded, by the State milk sanitation rating officer certified by the U.S. Public Health Service, a milk sanitation compliance and enforcement rating equal to that of the local supply or equal to 90 percent or higher; and (6) all ratings are made on the basis of procedures outlined in methods of making sanitation ratings of milksheds recommended by the Public Health Service.

Note.—Names of Interstate milk shippers and their ratings, as reported by State milk control authorities, are contained in *Sanitation Compliance and Enforcement Ratings of Interstate Milk Shippers*, issued quarterly by the Public Health Service for the information of interested persons. Copies of this list may be obtained from the State milk control authority or from the Public Health Service, Washington, D.C., 20201.

SECTION 12. FUTURE DAIRY FARMS AND MILK PLANTS

Properly prepared plans for all milk houses, milking barns, stables and parlors, transfer stations, receiving stations, and milk plants reg-

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vilated under this Ordinance *which are hereafter constructed, reconstructed, or extensively altered, shall be submitted to the health authority for written approval before work is begun.*

SECTION 13. PERSONNEL HEALTH

No person affected with any disease in a communicable form, or while a carrier of such disease, shall work at any dairy farm or milk plant in any capacity which brings him into contact with the production, handling, storage, or transportation of milk, milk products, containers, equipment, and utensils; and no dairy farm or milk plant operator shall employ in any such capacity any such person, or any person suspected of having any disease in a communicable form, or of being a carrier of such disease. Any producer or distributor of milk or milk products, upon whose dairy farm, or in whose milk plant any communicable disease occurs, or who suspects that any employee has contracted any disease in a communicable form, or has become a carrier of such disease, shall notify the health authority immediately.

SECTION 14. PROCEDURE WHEN INFECTION IS SUSPECTED

When reasonable cause exists to suspect the possibility of transmission of infection from any person concerned with the handling of milk and/or milk products, the health authority is authorized to require any or all of the following measures: (1) the immediate exclusion of that person from milk handling; (2) the immediate exclusion of the milk supply concerned from distribution and use; and (3) adequate medical and bacteriological examination of the person, of his associates, and of his and their body discharges.

SECTION 15. ENFORCEMENT

This Ordinance *shall be enforced by the health authority in accordance with the* Grade A Pasteurized Milk Ordinance with Administrative Procedures—1965 Recommendations of the United States Public Health Service, *a certified copy[1] of which shall be on file at the municipal clerk's office.[1] Where the mandatory compliance with provisions of the appendixes is specified, such provisions shall be deemed a requirement of the* Ordinance.

SECTION 16. PENALTY

Any person who shall violate any of the provisions of this Ordinance *shall be guilty of a misdemeanor and, upon conviction thereof, shall be punished by a fine of not more than $_____, and/or such persons*

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may be enjoined from continuing such violations. Each day upon which such a violation occurs shall constitute a separate violation.

SECTION 17. REPEAL AND DATE OF EFFECT

All ordinances and parts of ordinances in conflict with this Ordinance *shall be repealed 12 months after the adoption of this* Ordinance, *at which time this* Ordinance *shall be in full force and effect, as provided by law.*

SECTION 18. UNCONSTITUTIONALITY CLAUSE

Should any section, paragraph, sentence, clause, or phrase, of this Ordinance *be declared unconstitutional or invalid for any reason, the remainder of this* Ordinance *shall not be affected thereby.*

FOOTNOTES

In the interest of clarity and to provide easy access to their information, all numbered footnotes have been removed from the body of this publication and are assembled in this section. A numerical reference in the text will always relate to its like-numbered footnote in this section.

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[1] Substitute proper legal jurisdiction here and in all similar places throughout the *Ordinance*.

[2] Optional ingredients as defined in Section 1, Definition Q, may be used in this product.

[3] Where State law does not permit the sale of reconstituted or recombined milk and/or milk products, Definition D and other corresponding references should be omitted.

[4] Communities desiring to regulate cottage cheese and creamed cottage cheese under the terms of this *Ordinance* should insert the following definitions:

—— *Cottage Cheese:* Cottage cheese is the soft uncured cheese obtained by adding lactic-acid-producing bacteria, with or without enzymatic action, to pasteurized skim milk, pasteurized lowfat milk, or pasteurized reconstituted skim milk.[5] It shall contain not more than 80 percent moisture. Cottage cheese may be seasoned with salt.

—— *Creamed Cottage Cheese:* Creamed cottage cheese is prepared by mixing cottage cheese with a pasteurized creaming mixture consisting of pasteurized cream and milk, dry milk products, concentrated skim milk, skim milk, or lowfat milk, to which salt, lactic acid, and flavor producing bacteria, rennet, lactic acid, citric acid, phosphoric acid or stabilizer may be added. The quantity of milkfat added in the creaming mixture shall be not less than 4 percent by weight of the finished creamed cottage cheese. Dry milk products or concentrated skim milk may be added, provided the amount of added solids does not exceed 8 percent of the weight of the creaming mixture. Creamed cottage cheese shall contain not more than 80 percent moisture.

[5] A certified copy may be secured from the Department of Health, Education, and Welfare, Public Health Service, Washington, D.C.

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APPENDIX G. CHEMICAL AND BACTERIOLOGICAL TESTS

SINGLE-SERVICE AND MULTIUSE PASTEURIZED MILK AND MILK PRODUCT CONTAINERS—BACTERIOLOGICAL

Reference.—Item 12p.

Application.—To single-service and multiuse pasteurized milk and milk product containers and closures.

Frequency.—At least once each 3-month period.

Criteria.—All multiuse containers shall be effectively subjected to an acceptable bactericidal process, producing containers having a residual bacterial count of not more than 1 per ml. of capacity or not over 50 colonies per 8 square inches (1 per square centimeter), in 3-out-of-4 samples and shall be free of coliform organisms.

All single-service containers shall have, just prior to use, a bacterial count of not more than 1 per ml. of capacity, or not more than 1 colony per square centimeter of surface area in 3-out-of-4 samples, and shall be free of coliform organisms.

Method.—Bacteriological swab and/or rinse counts.

Apparatus and Procedure.—Conforms with *Standard Methods for Examination of Dairy Products* for required swab and rinse counts.

PRIVATE WATER SUPPLIES AND RECIRCULATED WATER—BACTERIOLOGICAL

Reference.—Items 8r, 7p, and 17p.

Application.—To private water supplies used by dairy farms, milk plants, receiving stations and transfer stations, and to recirculated cooling water used in milk plants.

Frequency.—Initially, and after repair, modification or disinfection of private water supplies of dairy farms and milk plants and thereafter, semiannually for all milk plant water supplies. Recirculated cooling water in milk plants shall be tested semiannually.

Criteria.—An MPN (Most Probable Number of coliform organisms) of less than 2.2/100 ml., or its membrane filter equivalent.

Apparatus, Method, and Procedure.—Conforms with *Standard Methods for Examination of Water and Wastewater.*

Corrective Action.—When the laboratory report on the sample is unsatisfactory, the water supply in question shall again be physically inspected and necessary corrections made until subsequent samples are bacteriologically satisfactory.

PASTEURIZATION EFFICIENCY—FIELD PHOSPHATASE TEST

Reference.—Section 6.

Frequency.—When any laboratory phosphatase test is positive, or any doubt arises as to the adequacy of pasteurization due to noncompliance with equipment, or standards of item 16p.

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Criteria.—Less than 1 µg., per ml, by Scharer Rapid Method (or equivalent by other means). See *Standard Methods for the Examination of Dairy Products.*

Apparatus.—Field phosphatase test kit (obtainable from Applied Research Institute, 2 East 23d St., New York 10, N.Y.; standards, extra test tubes, and stoppers, or other approved phosphatase equipment.

Method.—The test is based on the detection of the phosphatase enzyme, a constituent that is inactivated by pasteurization at 145° F. for 30 minutes or 161° F. for 15 seconds. When pasteurization is faulty, some phosphatase remains and is detected through its action on phosphoricphenyl esters, releasing phenol, which is measured quantitatively by the addition of dibromo or dichloroquinonechlorimide to form an indophenol blue color.

Procedure.—See *Standard Methods for Examination of Dairy Products* for details on phosphatase tests.

Corrective Action.—Whenever a phosphatase test is positive, the cause shall be determined. Where the cause is improper pasteurization, it shall be corrected; and any milk or milk products involved shall not be offered for sale.

PHOSPHATASE REACTIVATION IN HTST PASTEURIZED PRODUCTS

The presence of an appreciable quantity of phosphatase in milk and cream after heat treatment has been traditionally regarded as evidence of inadequate pasteurization. However, with the advent of modern high-temperature short-time methods, evidence has been accumulating that under certain conditions, the relationship between inadequate pasteurization and the presence of phosphatase does not hold.

A number of investigators who have studied high-temperature short-time pasteurizing methods have concluded that while a negative test can be obtained immediately after pasteurization, the same sample may yield a positive test after a short period of storage, particularly if the product is not continuously or adequately refrigerated.

This phenomenon has come to be known as reactivation.

Reactivation may occur in HTST pasteurized products after storage at temperatures as low as 50° F. although 63° F. is optimum. Products of high fat content generally produce relatively more reactivatable phosphatase.

Reactivation is greatest in products pasteurized at about 230° F. but may occur in products pasteurized at much higher temperatures and as low as 163° F.

It has been noted that an increase in holding time during pasteurization will reduce reactivation.

The addition of magnesium chloride to HTST processed milk or cream, after pasteurization but before storage, accelerates reactivation. The difference in activity between an adequately pasteurized sample stored with and without magnesium and an inadequately pasteurized sample stored with and without magnesium, forms the basis of a test for differentiating reactivated from residual (inadequately pasteurized) phosphatase.*

DETECTION OF ANTIBIOTICS IN MILK

The problem of antibiotics in milk is associated with their use in the treatment of mastitis and other diseases. Failure to withhold milk from the market for sufficient length of time after treatment is responsible for the presence of antibiotics in milk. Such milk is undesirable for two reasons; first, it originates in an unhealthy cow, and second, it is adulterated.

* Campbell, J. E., and McFarren, E. F., *Collaborative Test for Reactivated and Residual Phosphatase in Dairy Products.* Journal of the Association of Official Agricultural Chemists, 44 : 8 August 1961.

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The allergenic properties of certain antibiotics in common use make their presence in milk potentially hazardous to consumers. Also, substantial losses of byproducts may be sustained by the milk industry each year because of the inhibitory effects of antibiotics on the culturing process.

DETECTION OF PESTICIDES IN MILK

Any health agency which has adopted this *Ordinance* should operate under a control program which will insure that milk supplies are free from pesticide contamination, in conformance with Definitions R and R-1, Section 1, "Adulterated Milk and Milk Products" and "Misbranded Milk and Milk Products."

Pesticide compounds gain access to milk by various routes. Insecticide contamination may result from any of the following: (1) Application to the cows; (2) inhalation of toxic vapors by the animals following application of insecticides to their environment; (3) ingestion of residues in feed and water; and (4) accidental contamination of milk, feed, and utensils. Herbicide contamination may result from residues on the cows' feed and in their water supply; rodenticides may be present in milk as a result of accidental contamination.

At the present time, chlorinated hydrocarbon pesticides are the chief concern. While there are other pest control compounds which are more toxic than the chlorinated hydrocarbons, many of the agents in this latter group tend to accumulate in the body fat of both cows and human beings, and are secreted in the milk of contaminated cows. The accumulation of these toxic agents in persons continually consuming contaminated milk may reach hazardous concentrations.

Recent advances in residue analyses have resulted in a radical decrease in the use of paper chromatographic screening procedure for milk because of its rather limited sensitivity. Regulatory agencies can now routinely detect residues as low as 0.01 p.p.m. of many of the chlorinated organic pesticides. Satisfactory screening procedures should, therefore, attain this level of sensitivity which usually necessitates the use of gas chromatography or thin layer chromatography.

General screening procedures of the latter two types are described and discussed in Volume 1 of the *Pesticide Analytical Manual* published by the Federal Food and Drug Administration.

The need for closer scrutiny of milk supplies for pesticide residues has stimulated considerable research in detection technology.[b] The health authority entering upon a surveillance program should carefully check the available equipment in relation to its adaptability to the indicated need.

While a schedule of testing comparable to that for microorganisms (four tests of individual producers milk during any consecutive 6 months) would be desirable, broad spectrum procedures are too time consuming to render such a schedule feasible. As a more practical approach, the following procedure is suggested:

(1) Test one load of milk from each tank truck route every 6 months by a broad spectrum method, and trace positive samples, or

(2) Test each producer's milk four times every 6 months for the most common chlorinated hydrocarbon pesticides, by available instrumental methodology.

Note.—The above testing disciplines may be applied conveniently to can milk supplies. Where plan (1) is used, samples of commingled milk from known sources are drawn from receiving station storage tanks. Sampling for plan (2) may be done directly from the weigh tank.

[b] Schafer, M. L., Bush, K. A., and Campbell, J. E., *Rapid Screening Method for DDT in Milk With Gas Chromatography*. J. Dairy Science, 43 : 1025 (1963).

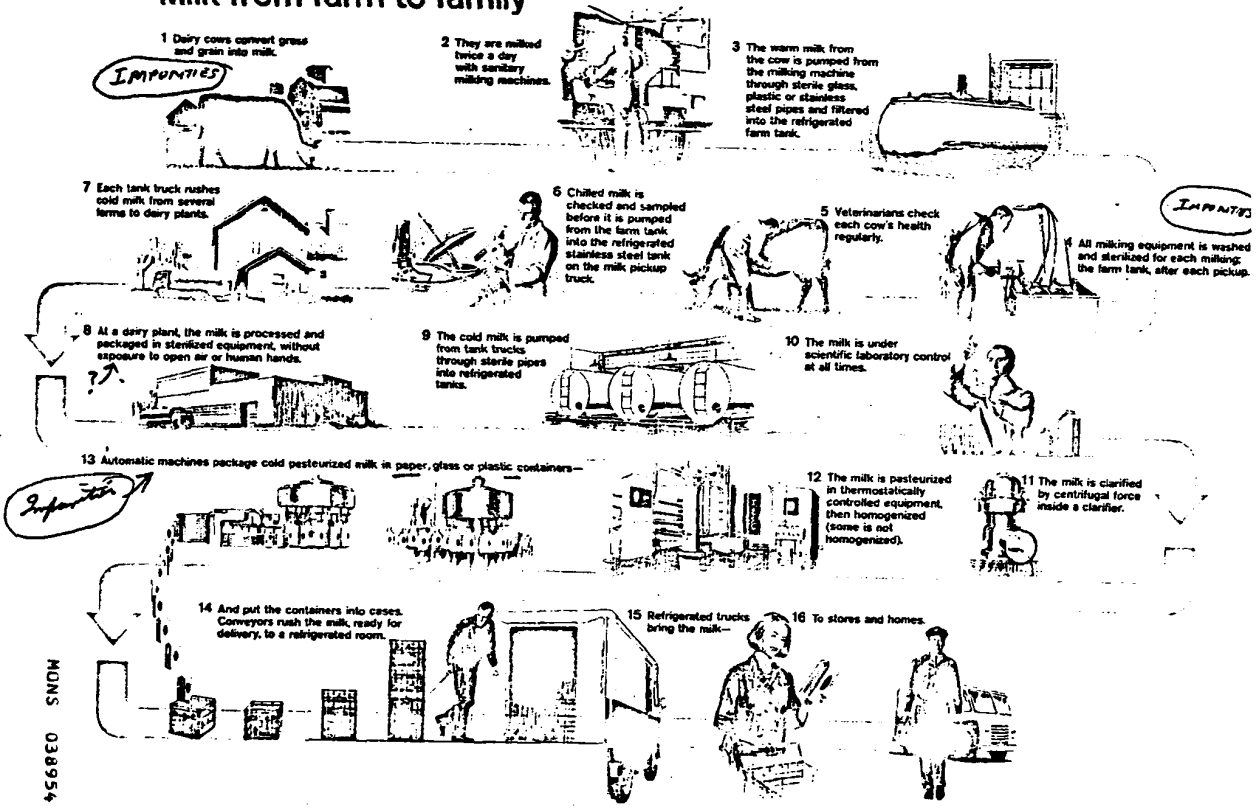
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Milk from farm to family



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The Cow

Everyone knows that cows give us the milk we drink, but can you imagine what a cow is really like? A cow is gentle and makes very little noise.

She moves about leisurely and spends most of her time browsing and resting. Still, her body is always busy making the milk you drink. A rather large animal, a good milk cow weighs about 1200 pounds.

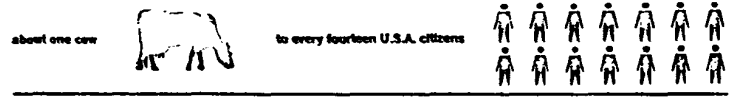
Each day a cow drinks from 10 to 20 gallons of water. In a year she eats about 3100 pounds of mixed grains and concentrated feeds such as seed oil cake. Added to this are 2½ tons of hay and 6½ tons of silage, mostly made of chopped green corn and grasses. She also eats the grass from two or more acres of pasture.

A cow has not one, but four stomachs to help her digest all this feed. When a cow tears off grass, she swallows it only half chewed. This partly chewed feed goes to her first stomach. Here the feed is softened by liquids. It then moves to her second stomach. In her second stomach the feed is softened more and formed into small balls. Each ball of feed is called a cud and is about the size of a hen egg.

Later, the cow gulps the cud back up into her mouth. She chews the cud 40 to 60 times before she swallows it again. This finely chewed feed goes into her third stomach and is broken up still more. Finally the feed passes to the fourth stomach and is digested.

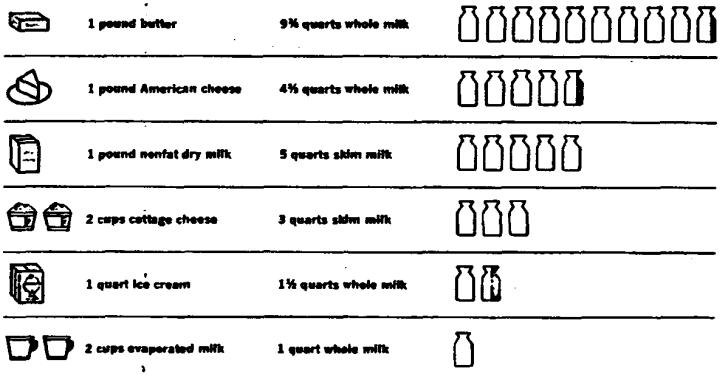
In return for all a cow eats, she will give around 3500 quarts of milk in a year. Of the 305 days each year she is milked, she gives about 11 quarts of milk a day. A cow is not milked 60 days of the year for a good reason. This period gives her time to rest her body and to store body materials just before her calf is born. She gives birth to one calf yearly.

Besides giving milk and having calves, the cow has created jobs for thousands of men and women. Perhaps you know someone who works in the dairy industry or helps manufacture equipment or products used in a dairy plant or on a dairy farm.



When you realize what a cow can do, you will know that she is quite a special animal. The story of milk begins with the cow. Do you know what happens to her milk on the dairy farm and in the dairy plant? To start you on your search, first study the chart on the other side. This will answer some questions you have. You will find other questions you want answered.

About how much milk it takes to make:



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ts. Compartment 1
and of the com
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depot fat. The rate
ause of the constant

intake, whereas the remaining rates are assumed to be first order.

In this type of system the amount of a compound excreted in the milk after the end of intake would follow the form of the equation

$$C = Ae^{-m_1 t} + Be^{-m_2 t}$$

where C is the amount of compound excreted into milk on any day, A and B are constants describing the amount excreted into milk on day 0, m_1 and m_2 are rate constants, t is the time in days following the end of intake, and e is the base of the natural logarithms. While the equation is derived for the amounts of the compounds, the results can be expressed in terms of the concentration of the compounds, provided the pool sizes and the milk fat production do not vary significantly over the time period in question.

The constants were estimated graphically (10) and are presented in Table 2. The values are based on the milk concentrations, to conform to FDA regulation and the usual practices. Since the decline in milk fat production was small, basing the values on amount would not have made a significant difference. Values of A and B are normalized so that $C_0 = A + B = 1.00$ mg/kilogram.

The behaviors of *p,p'*-DDT and *p,p'*-DDE, both with respect to the rates of decline in milk concentration and in the partial concentrations related to the two terms of the equation, are practically identical. The only difference was the value for m_1, but this difference is of little significance. The first term contributes little to the total projected excretion and the number of observations used in estimating m_1 are small and the errors in estimations may be large.

The behavior of *p,p'*-DDD differs markedly from the behavior of the other compounds. The first term of the equation provides a much greater contribution to the total concentration in milk and the second term has a greater rate of decline than is the case with *p,p'*-DDT and *p,p'*-DDE. The lower rate of decline of the

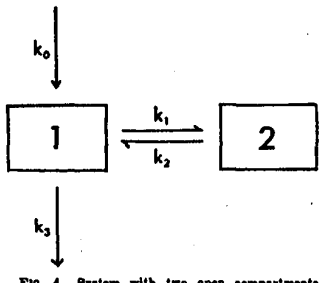


FIG. 4. System with two open compartments and constant rate of introduction.

second term for *p,p'-DDD* formed from *p,p'*-DDT, relative to the rate of decline for performed *p,p'*-DDD, is probably due to the continuing formation of small amounts of *p,p'*-DDD from *p,p'*-DDT as the *p,p'*-DDT is removed from the body fat.

The rate constant m_2 for *p,p'*-DDT and *p,p'*-DDE of our work is similar to analogous values reported for the total residue decline. The value 0.013 day^{-1} corresponds to a $t_{1/2}$ of 53 days. Laben et al. (8) and Crosby et al. (4) reported declines of the total residue from technical grade DDT as 10% per week, which corresponds to a $t_{1/2}$ of 49 days. In contrast, Witt et al. (12) reported a $t_{1/2}$ of 23 days, but the cows had received *p,p'*-DDT for only a six-day period. It is also of interest to note that Braund et al. (2) found $t_{1/2}$'s of 47 to 60 days for the decline of dieldrin in body fat of cows.

The practical significance of these values is to provide estimates of the time required for milk to return to a concentration below FDA tolerances after the cows have been fed feeds producing a higher concentration. Some estimates are presented (Table 3) for two conditions. These are the situation when cows are

TABLE 2. Constants for the normalized equations describing the decline in milk fat concentration of DDT analogs.

Compound [sic]	Compound in milk	A	m_1	B	m_2
		(mg/kg)	(day^{-1})	(mg/kg)	(day^{-1})
[sic]	DDT	0.41	0.67	0.59	0.013
[sic]	DDD	0.91	0.48	0.09	0.013
[sic]	DDD	0.91	0.41	0.09	0.026
[sic]	DDE	0.41	0.31	0.59	0.013

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TABLE 3. Estimated time required to reduce various initial milk fat concentrations of DDT analogs to less than 1.25 mg/kg when cows are fed uncontaminated feed.

Initial concentration	Time since cows consumed contaminated feed			
	0 days		> 14 days	
	DDE or DDT	DDD	DDE or DDT	DDD
(mg/kg)	(days)			
2	4	2	36	18
3	27	3	67	34
4	49	3	89	45
5	68	4	107	54
10	119	7	160	80
15	150	9	191	96
20	174	14	213	107

consuming the contaminated feed and when the consumption of contaminated feed has ended at least 14 days previously. In the second case, the first term of the equation is insignificant and the decline is described by the second term. The estimates for *p,p'*-DDT and *p,p'*-DDD were practically identical and have been combined.

The time required for any realistic initial concentration of *p,p'*-DDD to decline to less than the FDA tolerance is short. Therefore, the amount of time required to reduce total DDT-ROC will depend almost completely upon the sum of the concentrations of *p,p'*-DDT and *p,p'*-DDE. If the total DDT-ROC concentration is less than twice the FDA tolerance, and the cows are consuming contaminated feed, the time required for the return to the FDA tolerance will be a few days. On the other hand, when the total concentration is much greater than twice the FDA tolerance, or when the cows are not consuming contaminated feed, greatly extended periods of time will be required because of the low rate of removal of the pesticide from the body fat.

The limited data on the concentration of the compounds in body fat during the experiment are presented in Figures 1, 2, and 3. In general, the results parallel results from milk with the concentrations of *p,p'*-DDE considerably greater than the other compounds. The increase of compound concentration in body fat was slower than in milk. It would appear that the cows were not to equilibrium at the time that the intake ended at 60 days. Similarly, the decline in body fat concentrations of the compounds did not show the initial rapid drop which occurred with milk fat concentrations. The decline in body fat concentrations from 60 to 120 days paralleled the decline in milk fat concentration during the second phase of the decline. The observations are consistent with the model (Fig. 4), if one assumes that Compartment 2 represents body fat and k_2 is large compared to k_1 and k_3.

The relationships between the concentrations of DDT-ROC in milk fat and in body fat have been positive but quite variable (8, 9). The predictive usefulness of this type of comparison would be limited except at two times. The first would be when the cows are on a continuous intake and are at equilibrium. The second would be when the cows are on a ration feed and the time of rapid decline of milk fat concentration has passed. Under any other situation, the concentrations of milk fat and body fat would be changing at different rates so that the relationship between them would be continuously changing.

References

(1) Association of Official Analytical Chemists. 1966. Changes in the Official Methods of Analysis. J. Ass. Offic. Agr. Chem. 49: 222.

(2) Braund, D. G., L. D. Brown, J. T. Huber, N. C. Leeling, and M. J. Zabik. 1967. Excretion and storage of dieldrin in dairy cows fed thyroprotein and different levels of energy. J. Dairy Sci., 52: 172.

(3) Brown, W. H., J. M. Witt, F. M. White, and J. W. Stull. 1966. Secretion of DDT in milk by fresh cows. Bull. Environ. Contam. and Toxicol., 1: 21.

(4) Crosby, D. G., T. E. Archer, and R. Laben. 1967. DDT contamination of milk following a single feeding experiment. J. Dairy Sci., 50: 40.

(5) Fries, G. F., W. P. Flatt, and L. A. Mann. 1969. Energy balance and the excretion of DDT into milk. J. Dairy Sci., 52:

(6) Fries, G. F., and E. A. Kane. 1967. E

(7) Fries, G. F., Gordon. 19 *p,p'*-DDT b Agr. Food C

(8) Laben, R. C., and S. A. P put of DD cattle. J. D

(9) Laben, R. C., and S. A. I nation from

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MONS 038629

tention of DDE and DDT by the bovine. J. Dairy Sci., 50: 1512.
(7) Fries, G. F., G. S. Marrow, and C. H. Gordon. 1969. Metabolism of o,p'- and p,p'-DDT by rumen microorganism. J. Agr. Food Chem., 17: 800.
(8) Laben, R. C., T. E. Archer, D. G. Crosby, and S. A. Peoples. 1965. Lactational output of DDT fed preparation to dairy cattle. J. Dairy Sci., 48: 701.
(9) Laben, R. C., T. E. Archer, D. G. Crosby, and S. A. Peoples. 1966. Milk contamination from low levels of DDT in dairy rations. J. Dairy Sci., 49: 1488.
(10) Roseigno, Aldo, and Giorgio Segre. 1966. Drug and tracer kinetics. pp. 32-35. Blaisdell Publishing Co., Waltham, Mass.
(11) Williams, S., P. A. Mills, and R. E. McDowell. 1964. Residues in milk of cows fed rations containing low concentrations of five chlorinated hydrocarbon pesticides. J. Ass. Offic. Agr. Chemists, 47: 1124.
(12) Witt, J. W., F. M. Whiting, W. H. Brown, and J. W. Stull. 1966. Contamination of milk from different routes of animal exposure to DDT. J. Dairy Sci., 49: 870.

MONS 038630

J. Ass. Off. Agr. Chem. 47 (1964)

M., *Botyu-Kajaku*, 18, 61 (1953); thru *Chem. Abstr.*, 47, 9180 (1953).
(3) Keller, H., Hochweber, M., and Halban, H., *Helv. Chim. Acta*, 29, 512 (1946).
(4) Kemula, W., and Krzeminski, K., *Chim. Analit. Warsaw*, 5, 611 (1960).
(5) Kosmatyi, E. S., and Shlyapak, S. I., *Vop. pitan*, 22, 83 (1963); thru *Dairy Sci. Abstr.*, 25, #3625 (1963).
(6) Meltzer, H., *Nachrittbl. Deutsch Pflanzenschzid.*, 8, 86 (1954).
(7) Romanovich, N. P., and Berasina, K. G., *Zavod Lab.*, 27, 1453 (1963); thru *Anal. Abstr.*, 9, 2957 (1962).
(8) Johnson, L., *This Journal*, 45, 303 (1962).
(9) Kovacs, M. F., Jr., *ibid.*, 46, 884 (1963).
(10) Burke, J., and Giuffrida, L., *ibid.*, 47, 32 (1964).
(11) Watts, J., and Klein, A. K., *ibid.*, 45, 10 (1962).
(12) *Official Methods of Analysis*, 9th Ed., Association of Official Agricultural Chemists, Washington, D.C., 1960, sec. 24.109(d)

Residues in Milk of Cows Fed Rations Containing Low Concentrations of Five Chlorinated Hydrocarbon Pesticides

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A feeding study involving 16 lactating dairy cows was carried out in which mixtures of 5 pesticides (heptachlor epoxide, dieldrin, endrin, lindane, and DDT) were fed at levels of approximately 0.05, 0.15, and 0.30 ppm of each pesticide based on total feed consumption. Analyses showed that heptachlor epoxide and dieldrin transferred to the milk in much higher concentrations than did the other pesticides. Next in order of concentration were endrin and lindane. Small but definite increases of DDT and TDE in the milk were noted with increased feeding levels of DDT, but the DDE concentration was apparently not affected by the feeding of DDT at these levels.

A number of studies have been made of the transfer of chlorinated pesticide residues from the feed to the milk of cows. Gannon, *et al.* (1) fed dieldrin to cows at levels of 0.1 to 2.25 ppm, and, using a colorimetric analytical procedure, found dieldrin in their milk. Gannon, *et al.* (2) also analyzed milk from cows fed aldrin, dieldrin, heptachlor, DDT, and methoxychlor at levels of 1 to 7000 ppm and again found residues of the pesticides or their metabolites in the milk.

Zweig, *et al.* (3) fed DDT to cows at levels of 0.5, 1.0, 2.0, 3.0, and 5.0 ppm. Using a colorimetric method sensitive to about 0.05 ppm they did not find any DDT in milk from the cows fed at the 0.5 ppm level, but did find DDT in the milk of the cows fed at the higher concentrations.

Hardee, *et al.* (4) added heptachlor epoxide and Telodrin® to the feed of cows at levels of 5 and 20 ppb (0.005 and 0.02 ppm) and, using electron affinity gas chromatography, found measurable residues of each in the milk.

The present study was undertaken to provide additional information on the transfer of chlorinated pesticide residues from feed to milk, when fed at low concentrations. The pesticides used were lindane, heptachlor epoxide, dieldrin, *p,p'*-DDT, and endrin. These were chosen because of their frequent occurrence in dairy animal feeds and feeds and/or because of their toxicity. Feeding levels were set at 0.05, 0.15, and 0.30 ppm on the basis of anticipated total feed consumption.

This paper was presented at the Seventy-eighth Annual Meeting of the Association of Official Agricultural Chemists, Oct. 19-22, 1964, at Washington, D.C.

Procedure

Sixteen Holstein cows, a
animals and in the 100th-20
tion, were *divided into* 4
4 cows each. All animals
consisting of *approximately*
concentrate, 10% hay, 8½%
55% *corn silage*. The *dai*
tion of each cow was dete
2-week period prior to the
and this figure was used
amount of pesticide to be
in Group A were used as c
ing the feeding period Gr
fed an added 0.05 ppm, G
and Group D, 0.30 ppm
pesticides.

An alcohol solution of
was added to the grain
at the morning and even

Group A:
Controls

Group B:
0.05 ppm Feeding Level

Group C:
0.15 ppm Feeding Level

Group D:
0.30 ppm Feeding Level

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Procedure

Sixteen Holstein cows, all first lactation animals and in the 100th–200th day of lactation, were divided into 4 similar groups of 4 cows each. All animals were fed a diet consisting of approximately 20½% grain concentrate, 10% hay, 8½% hay pellets, and 55% corn silage. The daily feed consumption of each cow was determined during a 2-week period prior to the start of the study, and this figure was used in calculating the amount of pesticide to be added. The 4 cows in Group A were used as controls, while during the feeding period Group B cows were fed an added 0.05 ppm, Group C, 0.15 ppm, and Group D, 0.30 ppm of each of the 5 pesticides.

An alcohol solution of the five pesticides was added to the grain ration of each cow at the morning and evening feeding. After the entire grain ration was consumed, the cow was given the rest of its feed and any remaining unconsumed feed was removed and weighed. The entire grain ration was always consumed but some of the roughage was at times rejected. Since the feed consumption varied somewhat during the course of this study, the actual level of added pesticides in ppm was not identical for all cows in each group. Table 1 shows the body weight, average daily feed consumption, actual level of added pesticides, and average daily milk production with fat content for each cow.

A sample of each feed ingredient was taken at each feeding, and weekly composites of each ingredient were analyzed for pesticide residues. Table 2 shows the pesticide content of the total feed calculated from the analyses of the individual components.

Milk samples from each cow were collected

Table 1. Data for individual cows

	Cow No.	Body Weight, lb	Average Feed Consumption, lb/day	Level of Added Pesticides, ppm	Average Milk Production, lb/day	Milk, Average % Butterfat
Group A:	670	1148	66	0	27.3	4.6
Controls	660	1104	58	0	28.4	4.7
	667	1136	70	0	36.0	4.2
	668	1020	61	0	35.0	4.4
	Group Av.	1102	64	0	31.7	4.5
Group B:	677	1148	60	0.057	41.4	4.2
0.05 ppm Feeding Level	660	1070	40	0.051	28.5	4.1
	459	1050	54	0.051	31.1	3.7
	662	1004	64	0.051	38.5	4.2
	Group Av.	1100	56	0.052	34.0	4.0
Group C:	664	1250	63	0.139	33.3	4.1
0.15 ppm Feeding Level	402	1082	64	0.142	33.2	4.5
	673	1018	65	0.139	37.6	4.1
	665	1138	61	0.146	39.6	4.0
	Group Av.	1123	64	0.142	35.0	4.2
Group D:	654	1056	60	0.306	35.8	3.6
0.30 ppm Feeding Level	457	1140	84	0.288	47.0	4.0
	666	1140	70	0.249	28.7	4.4
	659	1080	60	0.318	19.8	4.3
	Group Av.	1104	68	0.302	32.8	4.1

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Table 2. Pesticide content in ppm of total feed before addition of pesticides (calculated from analyses of individual feed components—weekly composites)

Pesticide	Prefeeding		Feeding Period					Post-Feeding		
	1st Week	2nd Week	1st Week	2nd Week	3rd Week	4th Week	5th Week	1st Week	2nd Week	3rd Week
Heptachlor epoxide	0.005	0.006	0.005	0.001	—	0.001	—	0.002	—	
Dieldrin	0.005	0.002	0.003	0.005	0.003	0.003	0.003	0.003	0.001	
Endrin	—	—	—	0.002	—	0.002	—	—	<0.001	
Lindane	—	<0.001	<0.001	0.001	<0.001	0.002	0.001	—	<0.001	
o,p'-DDT	0.001	0.002	0.004	0.004	0.010	0.014	0.022	0.020	0.009	
p,p'-DDT	0.007	0.009	0.010	0.013	0.021	0.015	0.023	0.040	0.011	
p,p'-TDE	—	—	—	0.002	0.002	0.003	0.002	0.002	0.002	
p,p'-DDE	0.003	0.005	0.004	0.004	0.004	0.005	0.004	0.004	0.004	

Not Analyzed

every Sunday and Wednesday. Milk from the morning and evening milkings was composited, fat content determined, and the milk then analyzed for pesticide residues. Milk samples were extracted and cleaned up by the rapid procedure of Onley (5), feed samples by the procedure of Mills, *et al.* (6). All samples were examined by the electron capture gas chromatographic procedure of Burke and Giuffrida (7), which is capable of detecting as little as 0.001 ppm of these pesticide residues. Most of the milk samples were also checked by the microcoulometric gas chromatographic procedure of Burke and Johnson (8) and the thin-layer chromatographic method of Kovacs (9). These latter determinations were made on the sample extract used for the electron capture gas chromatographic determinations. Analyses were made for the entire duration of the study, which consisted of a 2-week prefeeding period, a 5-week feeding period, and a 3-week post-feeding period. Thus, a total of 320 milk samples were analyzed, each being examined for 7 pesticide residues (the 5 pesticides that were fed, as well as TDE and DDE).

Results and Discussion

Although all analyses were made on milk from individual cows, the results for each sample day have been averaged by groups of four according to feeding level. Tabulations have been based on the electron capture gas chromatographic determination except for about 1% of the results; in these cases because of interference or obvious errors, the electron capture result was discarded and the microcoulometric gas chromatographic and/or thin-layer chromatographic result was used. No corrections have been made in any of the reported results for the residues found in the milk of the control animals.

During the prefeeding period, residues found in the milk of all groups, including the controls, were about the same.

Figures 1–4 show changes with time in the concentration in the milk of residues of heptachlor epoxide, dieldrin, endrin, and lindane, plotted on semilogarithmic graph paper. It is apparent that for any one feeding level considerably more heptachlor epoxide than dieldrin carried through to the milk than did the other pesticides. At the 0.30 ppm feeding level, heptachlor epoxide in the milk had reached a concentration of about 0.07 ppm and appeared to be still increasing at the end of 35 days' feeding.

Residues of both heptachlor epoxide and dieldrin, averaging about 0.005 ppm, were found in all samples of milk from the control animals. There appeared to be a gradual decrease from about 0.006 ppm during the prefeed period to about 0.001 ppm at the end of the feeding period. It is possible that these residues were not specifically related to the intake during the study

could have been due to earlier ingestion of feed contaminated.

Residues of endrin in the milk at all levels, though at lower concentration than dieldrin epoxide and lindane was found in the control animals.

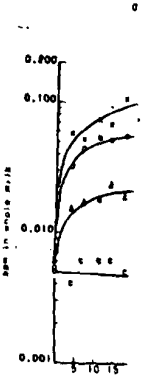


Fig. 1—Changes in concentration in

Table 3 lists the for each of the two heptachlor epoxide ing levels, the com in milk had appear by the end of the

The residues of the milk were so l be informative. A were small but de of both *p,p'*-DDT feeding levels. Hos found were still m DDE residues a for the controls throughout the en

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...illion of pesticides ...weekly composites)

...ch	Post-Feeding 1st Week	2nd Week	3rd Week
...	0.002	—	
...03	0.003	0.001	Not Analyzed
...	—	<0.001	
...08	—	<0.001	
...22	0.020	0.009	
...23	0.040	0.011	
...72	0.002	0.002	
...04	0.001	0.004	

...raphic determination ex... of the results; in these ...interference or obvious ...capture result was dis... ...erage ...bunetric gas chro... ...or (...-layer chromato... ...used. No corrections have ...d the reported results for ...in the milk of the control

...feeding period, residues ... of all groups, including ...about the same.

...w changes with time for ...n the milk of residues of ...dieldrin, endrin, and lin... ...nomogarithmic graphs. It ...r any one feeding level, ...heptachlor epoxide and ...rough to the milk than ...ides. At the 0.30 ppm ...ldrin epoxide in the milk ...centration of about 0.14 ...to be still increasing at ...eeding.

...heptachlor epoxide and ...about 0.005 ppm each. ...mples of milk from the ...there appeared to be a ...an about 0.006 ppm dur... ...ced to about 0.001 ppm ...eding period. It is possi... ...e not specifically ...ed, ...ng the study, but

could have been due, at least in part, to earlier ingestion of feeds that may have been contaminated.

Residues of endrin and lindane were found in the milk at all three feeding levels, although at lower concentrations than heptachlor epoxide and dieldrin. No endrin or lindane was found in the milk of the control animals.

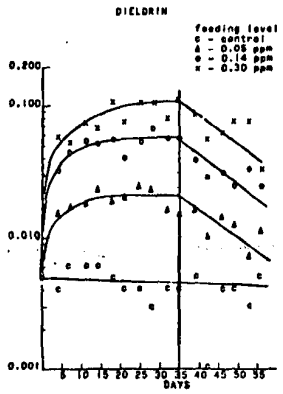


Fig. 1—Changes in concentration of heptachlor epoxide in milk with time.

Table 3 lists the "plateau" concentration for each of the residues in milk. Except for heptachlor epoxide at the two higher feeding levels, the concentration of each residue in milk had apparently reached a maximum by the end of the 35-day feeding period.

The residues of DDT, DDE, and TDE in the milk were so low that graphs would not be informative. As shown in Table 3, there were small but definite increases in residues of both *p,p'*-DDT and TDE at the higher feeding levels. However, the highest residues found were still under 0.01 ppm.

DDE residues averaged about 0.001 ppm for the controls and for all feeding levels throughout the entire study. Apparently the

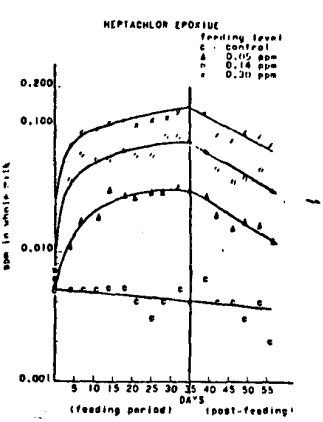


Fig. 2—Changes in concentration of dieldrin in milk with time.

Table 3. "Plateau" levels: pesticide residues in milk at end of feeding period, ppm

Pesticide	Feeding Levels, ppm 0	0.052	0.142	0.302
Heptachlor epoxide	0.004	0.031	0.072*	0.14*
Dieldrin	0.004	0.021	0.058	0.11
Endrin	0	0.004	0.010	0.018
Lindane	0	0.002	0.006	0.015
p,p'-DDT	0.002	0.004	0.004	0.007
p,p'-TDE	0.001	0.002	0.003	0.004
p,p'-DDE	0.004	0.004	0.004	0.004

* Appeared to be still increasing at end of feeding period.

pesticides added to the feed did not affect the DDE concentration in the milk.

Feed consumption and milk production were very uniform for the entire duration of this study. Although the individual cows showed some daily variation, no changes could be correlated with the level of pesticide intake.

It should be pointed out that the results presented were obtained by feeding mix

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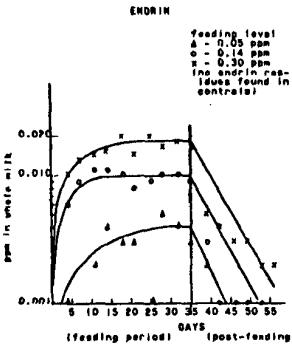


Fig. 3—Changes in concentration of endrin in milk with time.

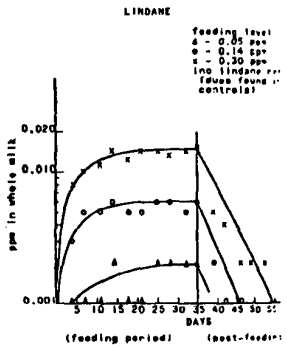


Fig. 4—Changes in concentration of lindane in milk with time.

tures of five pesticides. It is possible that the transfer rate of each individual pesticide was influenced by the presence of the other four, and that different results might be obtained by feeding only one pesticide to a cow. Also, although the curves in Figs. 1–4 were drawn to the end of the study period, the 3-week post-feeding period during which milk samples were analyzed is too short to permit accurate determination of the rates of decay.

Summary

This study has shown that even very low concentrations of heptachlor epoxide or dieldrin in a cow's feed will result in measurable residues in its milk. To a lesser degree, this is also true of endrin and lindane, and to a still smaller degree of DDT and its metabolite, TDE.

Acknowledgments

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The tremendous amount of analytical work involved was carried out by the following Food and Drug Administration chemists: D. C. Bostwick, W. Holswade, L. Kovarik, M. F. Kovacs, Jr., J. H. Onley, H. Sinemus and H. Wiseman.

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References

(1) Gannon, N., Link, R. P., and Decker G. C., *J. Agr. Food Chem.*, 7, 824 (1959)
(2) *Gannon, N., Link, R. P., and Decker G. C., ibid.*, 7, 829 (1959).
(3) Zweig, G., Smith, L. M., Peoples, S. A., and Cox R., *ibid.*, 9, 481 (1961).
(4) Hardee, D. D., *et al., J. Econ. Entom.* 56, 401 (1964).
(5) Onley, J. H., *This Journal*, 47, 317 (1964).
(6) Mills, P. A., Onley, J. H., and Gaither, R. A., *ibid.*, 46, 186 (1963).
(7) Burke, J., and Giuffrida, L., *ibid.*, 47, [illegible] (1964).
(8) Burke, J., and Johnson, L., *ibid.*, 45 [illegible] (1962).
(9) Kovacs, M. F., Jr., *ibid.*, 46, 881 (1963)

KLEIN, *ET AL.*

Metabolite Isomeric 7

By A. K. KL
(Food and Dru

Feeding *p,p'* rately at a le of rate cause of DDT to *D* was found in volved in the ing *o,p'*-DDT conversion to The proporti to the *o,p'*-is mately 7:1.

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J. Dairy Sci. 49 (1966)

Secretion of Heptachlor Epoxide in Milk

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and
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Abstract

Twelve cows, fed alfalfa hay containing 0.08 or 0.29 ppm heptachlor and heptachlor epoxide for 35 days, secreted into their milk an average of 17 and 9% of the intake, respectively, all in the form of the epoxide. A log-log relationship with a correlation coefficient of 0.97 was found between the amount of heptachlor plus its epoxide consumed and the concentration of the epoxide in the milk fat. Cows in early lactation secreted slightly more of their intake into their milk than cows in late lactation. However, cows in late lactation produced milk and milk fat with a slightly higher concentration of the epoxide than cows in early lactation. Jersey cows had a higher concentration of the epoxide per kilogram of milk than did Holsteins, but the Jersey milk fat had a lower concentration than did Holstein milk fat.

Heptachlor has been used in several states for the control of alfalfa weevil, but when the heptachlor epoxide was found to be present in milk from cows fed alfalfa from the treated fields, the movement of such milk into the regular marketing channels was prohibited (1). Although sale of the heptachlor for this purpose is no longer permitted in the United States, one report (13) indicates toxic residues, mostly epoxide, will persist in the soil for as long as 5 yr. The possibility thus exists for contamination of crops from these fields. For this reason the secretion pattern of heptachlor and its epoxide into milk is of public health significance.

The amount of heptachlor intake secreted into the milk as the epoxide has been reported by several investigators (2-7, 12) and ranges up to about 25% of the intake (7). Feeding of the epoxide to cows resulted in a log-log relationship between the concentration of epoxide in the diet and the concentration in the butter fat, with a greater per cent of the intake going into the milk when the intake was small (3).

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The present study was undertaken to determine the secretion pattern of heptachlors (heptachlor and its epoxide) in milk from animals in different stages of lactation when fed hay containing different amounts of the heptachlors.

Experimental Procedure

Six Jersey and six Holstein cows were fed alfalfa hay containing 0.08 or 0.29 ppm heptachlors for 5 wk. Hay was limited on some animals and grain was fed according to milk production. At the end of the feeding trial all cows were given a standard ration of clean hay, silage ad lib., and grain according to milk production. Milk samples were collected from each cow at every milking during the feeding trial and for six days after completion of the trial.

Residues of heptachlor and its epoxide in the hays fed in the trials were determined by a modified procedure, based on that used in the Nutrition and Biochemistry Laboratory of Virginia Polytechnic Institute and at the Virginia Department of Agriculture Laboratory at Richmond, later published by Samuel (11).

The hay was prepared for analysis by chopping, mixing, drying, and grinding in a Wiley mill, using a 2-mm screen. A 15-g sample was transferred into a Waring Blendor jar, mixed with 50 ml of 95% ethanol, then again mixed after addition of 50 ml water. Ninety milliliters of purified hexane (8) was added and the mixture agitated for 3 min at high speed. The blended sample was centrifuged for 15 min at 2,000 rpm in a 17.8-cm-diameter centrifuge. The hexane layer was withdrawn by aspiration and transferred into a 400-ml beaker. The residue was resuspended with 60 ml of hexane, centrifuged, and this extract removed and combined with the first. A 100-ml aliquot of the combined extract, equivalent to the extract from 10 g of hay, was concentrated to about 10 ml, and placed on a chromatographic column that contained 10 g activated Florex (10), covered by about 2 cm of sodium sulfate. After elution with 225 ml of a mixture of six parts ethyl ether and 94 parts petroleum ether, the

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eluate was evaporated to near dryness and adjusted to exactly 10 ml with hexane. This extract, containing 1 g of sample per milliliter, was analyzed for heptachlor and heptachlor epoxide residues by electron-capture gas chromatography, using a 0.3-cm by 1,500-cm Pyrex column packed with 5% Dow 11 silicone grease on 80-90-mesh Chromosorb W.

The instrument used was a Wilkens Aerograph HiFi Model 600. Typical operating parameters were: oven temperature 185 C, injector 235 C, standing current 368 MV, range 1, attentuation 16, nitrogen carrier gas 50 ml/minute. The recorder was a Leeds and Northrup Model H (Speedomax). Recovery factors of 90 to 100% were obtained against alfalfa hay spiked with heptachlor and heptachlor epoxide.

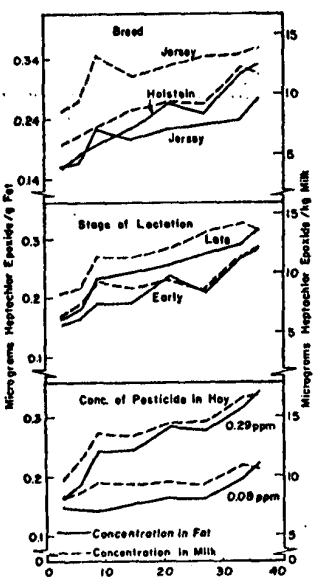


FIG. 1. Concentration of heptachlor epoxide in milk and milk fat as related to breed, stage of lactation, and concentration of heptachlors in the feed.

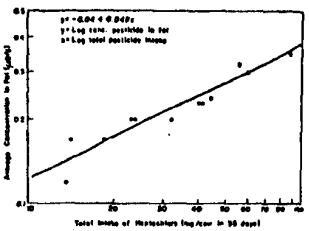


FIG. 2. Relationship between intake of heptachlor and its epoxide and secretion of heptachlor epoxide in milk fat.

The pesticide residue content of the milk was determined by a modification of the method of Longlois et al. (9). A glass chromatographic column 51 cm by 3.6 cm was packed with 25 g florisil supported by a small plug of Pyrex glass wool. The florisil was covered by a layer of 5 g of anhydrous sodium sulfate. The column was washed with 50 ml of 3% ethyl ether–97% petroleum ether mixture, leaving enough of the liquid on top of the column to prevent it from drying. Ten milliliters of milk, 25 g of florisil, and 5 g anhydrous sodium sulfate were mixed in a beaker and poured onto the column, which was then eluted with 300 ml of the 3% ethyl ether–97% petroleum ether mixture. The eluant was then evaporated to 10 ml. Five microliters were injected into a gas chromatograph, using an electron-capture detector and a 0.62- by 122-cm column packed with 5% silicone grease DC 11 on 60 to 80 mesh Chromosorb W. Other conditions were: injection port temperature, 260 C; oven temperature, 185 C; detector temperature, 210 C; gas used, 95% argon, 5% methane.

To determine the precise secretion pattern of heptachlor and heptachlor epoxide given at relatively high dosages, a Holstein cow secreting about 10 kg of milk per day was given 50 mg of each chemical[1] (99.4% pure) per day for six days. The doses were dissolved in corn oil and administered orally in two capsules each day (Figure 3).

Results

The amount of heptachlors consumed in the hay during the 35-day feeding trial ranged from 13.8 to 87.8 mg per cow. The data so calculated on an average per day basis are listed in Table 1. Although the analytical techni-

[1] Product of Velsicol Chemical Company.

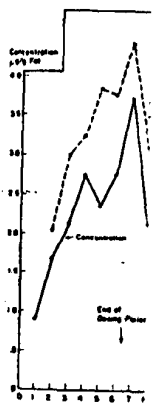


FIG. 3. Secretion pat in milk from a cow giv

Conc. heptachlor alfalfa (mg/g)	
Jerseys, late l	
0.29	
0.08	
0.29	
Average	
Jerseys, early	
0.29	
0.08	
0.29	
Average	
Average, all Jers	
Holsteins, late	
0.29	
0.08	
0.29	
0.29	
Average	
Holsteins, earl	
0.08	
0.29	
Average	
Average, all Hol	
Avg all cows	
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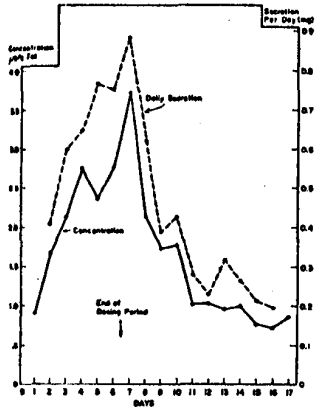


FIG. 2. Secretion pattern of heptachlor epoxide in milk from a cow given capsules of heptachlors.

used was suitable for both forms of heptachlor, only the epoxide was found in the milk. The percentage of the intake secreted into the milk ranged from 4 to 22, with an over-all average of 12%. Those cows on the alfalfa that contained 0.29 ppm heptachlors secreted an average of 9% of the intake in their milk, whereas those on the alfalfa with 0.08 ppm of the heptachlors secreted 17% of it into their milk. The difference in secretion rate as influenced by concentration in the feed has also been observed by other workers (3).

Concentration of the epoxide in the milk continued to increase as the cows continued to consume the contaminated alfalfa (Figure 1). Williams and co-workers (14) found the heptachlor epoxide concentration in milk to be about 0.14 ppm, with the trend still upward after 35 days of feeding his cows a diet containing 0.30 ppm heptachlor epoxide.

Those cows in the latter part of their lactation produced milk of slightly greater concentration of heptachlor epoxide than those in early and mid-lactation. Milk fat produced by Holsteins toward the latter part of the feeding trial contained a higher concentration of the

TABLE 1

Intake and secretion of heptachlor epoxide

Conc. of heptachlor in alfalfa	Average daily heptachlor				
	Consumption	Secretion in milk	Per cent	Avg in fat	Conc. in milk
(μg/g)	*(mg)*	*(mg)*		*(μg/g)*	*(μg/kg)*
Jerseys, late lactation					
0.29	1,247	50	4	0.24	12.9
0.08	400	70	17	0.17	9.7
0.29	1,624	197	12	0.32	17.9
Average	.....	.....	11	0.24	13.5
Jerseys, early lactation					
0.29	682	108	16	0.20	11.7
0.08	394	72	18	0.12	6.7
0.29	1,200	110	10	0.23	12.8
Average	.....	.....	14.7	0.18	10.4
Average, all Jerseys	.....	.....	.....	0.21	11.9
Holsteins, late lactation					
0.29	926	110	12	0.20	8.0
0.08	688	91	13	0.20	7.3
0.29	2,523	132	5	0.35	14.1
0.29	1,160	61	5	0.23	6.8
Average	.....	.....	9	0.24	9.0
Holsteins, early lactation					
0.08	535	120	22	0.17	6.7
0.29	1,740	189	11	0.30	11.0
Average	.....	.....	.....	0.23	8.8
Average, all Holsteins	.....	.....	.....	0.24	9.0
Avg all cows	.....	.....	12.1	0.23	10.5
Avg all late-lactation cows	.....	.....	9.7	0.24	11.0
Avg all early-lactation cows	.....	.....	15.4	0.20	9.8
Avg all cows on 0.08 ppm hay	.....	.....	17.5	0.16	7.6
Avg all cows on 0.29 ppm hay			9.4	0.26	11.9

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epoxide than did the Jersey milk fat. On the basis of concentration per kilogram of milk, the Jersey milk contained more heptachlor epoxide than the Holstein milk.

The average concentration of epoxide in the milk fat and the total amount consumed by an animal during the trial are shown in Figure 2. The logarithm of the average concentration in the fat and the logarithm of the total intake during the 35-day trial had a correlation coefficient of 0.97. Bruce and co-workers (3) showed a similar relationship between feed and concentration in the fat. In the present investigation, the correlation coefficient between the log of the average concentration of epoxide in the milk and the log of the total heptachlors intake was 0.65.

The data indicate that hay containing approximately 0.08 ppm heptachlors can be fed for a month without the milk fat exceeding 0.25 ppm, but hay containing 0.29 ppm of the heptachlors will cause the milk fat to exceed the 0.25 ppm level in about ten days.

Late-lactation cows secreted slightly more of the heptachlors intake into their milk than cows in early lactation. However, cows in late lactation produced milk and milk fat of a slightly lower concentration of the epoxide than cows in early lactation. Jersey milk had a *slightly higher concentration of the epoxide* than Holstein milk, but Holstein milk had a slightly higher concentration of the epoxide per gram of fat.

At the end of the feeding trial the milk fat from the high- and low-level intake groups contained 0.34 and 0.22 ppm epoxide, respectively. After completion of the feeding trial those cows still producing milk were supplied *a forage* of unknown, but supposedly low, concentration of heptachlor epoxide. Six days later levels of residue in the milk of the two groups were 0.27 and 0.14 ppm, respectively.

Figure 3 shows the gradual upward trend of the concentration of the epoxide in the milk fat during the dosing period, as well as the closely related curve of total heptachlor epoxide in the milk from the cow given capsules of heptachlors. Although equal amounts of heptachlor and its epoxide were administered (300 mg each), no heptachlor was found in the milk. Assuming the heptachlor to be converted into the epoxide in the cow, the portion secreted *into the milk during the 17-day* collection period was 1.2%. This relatively low secretion rate, compared to the heptachlor-treated alfalfa trial, might be due to the time over which the dose was given (six days, compared to 35 days in the alfalfa trials). The amount of the dose is also a likely factor. The administered dose was 600 mg total heptachlors, whereas in the hay trials the maximum consumed by any cow was 88 mg. Further evidence of the size of dose effect was found with the cows which received different amounts of the heptachlors from their feed. The ratio between the average concentration in the fat and the intakes of heptachlors was greater at the low levels of intake. The low concentration of the epoxide on Day 5 (Figure 3) probably is due to an abnormally high fat percentage in the milk, 3.2, compared to an overall average of 2.6%.

Acknowledgments

The authors are indebted to Marvis Fryer and Miss Julie Glover for their aid in analysis of heptachlors in the hays, to Clyde Holmes for handling the animals on the feeding trials, and to Mrs. Rachel Eskew for determining the concentration of epoxide in the milk samples.

References

(1) Anonymous. 1964. What Maryland Recommends to Prevent Pesticide Residues. Hoard's Dairyman, 109:1304.

(2) Bache, C., Gyrisco, G. G., Fertig, S. N., Huddleston, E. W., Lisk, D. J., Fox, F. H., Trimberger, G. W., and Holland, R. F. 1960. Effects of Feeding Low Levels of Heptachlor Epoxide to Dairy Cows on Residues and Off-Flavors in Milk. J. Agr. Food Chem., 8:408.

(3) Bruce, W. N., Link, R. P., and Decker, G. C. 1965. Storage of Heptachlor Epoxide in the Body Fat and Its Excretion in Milk of Dairy Cows Fed Heptachlor in Their Diets. J. Agr. Food Chem., 13:03.

(4) Davidow, B., Radomski, J. L., and Ely, R. 1953. Excretion of Heptachlor Epoxide in Milk of a *Dairy Cow Fed Heptachlor*. Science, 118:383.

(5) Ely, R. E., Moore, L. A., Hubanks, P. E., Carter, R. H., and Poos, F. W. 1955. Excretion of Heptachlor Epoxide in the Milk of Dairy Cows Fed Heptachlor-Sprayed Forage and Technical Heptachlor. J. Dairy Sci., 38:669.

(6) Hardee, D. D., Gutenmann, W. H., Kwolek, G. I., Gyrisco, G. G., Lisk, D. J., Fox, F. H., Trimberger, G. W., and Holland, R. F., 1964. Residues of Heptachlor Epoxide and Telodrin in Milk from Cows Fed Part per Billion Insecticide Levels. Econ. Entomol., 50:404.

(7) Huber, J. T., and Bishop, J. L. 1962. Excretion of Heptachlor Epoxide in the Milk of Cows Fed Field-Cured Hay from Soil Treated with Heptachlor. J. Dairy Sci., 45:70.

(8) Jorgensen, P. S. 1957. Report on Heptachlor in Foods. J. A.O.A.C., 40:246.

(9) Langlois, B. E. 1964. [illegible] nets for Analysis of Residue [illegible] matography.

(10) Polen, P. B. Private comm[illegible]

(11) Samuel, B. L. Method for [illegible] Organic Ins[illegible] J. A.O.A.C.,

(12) Storherr, R. J. F. 1960.

MONS 038639

epoxide than did the Jersey milk fat. On the basis of concentration per kilogram of milk, the Jersey milk contained more heptachlor epoxide than the *Holstein* milk.

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The data indicate that hay containing approximately 0.03 ppm heptachlors can be fed for a month without the milk fat exceeding 0.25 ppm, but hay containing 0.29 ppm of the heptachlors will cause the milk fat to exceed the 0.25 ppm level in about ten days.

Late-lactation cows secreted slightly more of the heptachlors intake into their milk than cows in early lactation. However, cows in late lactation produced milk and milk fat of a slightly lower concentration of the epoxide than cows in early lactation. Jersey milk had a slightly higher concentration of the epoxide than Holstein milk, but Holstein milk had a slightly higher concentration of the epoxide per grain of fat.

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References

(1) Anonymous. 1964. What Maryland Recommends to Prevent Pesticide Residues. Hoard's Dairyman, 109:1304.

(2) Bache, C., Gyrisco, G. G., Fertig, S. N., Huddleston, E. W., Lisk, D. J., Fox, F. H., Trimberger, G. W., and Holland, R. F. 1960. *Effects of Feeding Low Levels of Heptachlor Epoxide to Dairy Cows on Residues and Off-Flavors in Milk.* J. Agr. Food Chem., 8:408.

(3) Bruce, W. N., Link, R. P., and Decker, G. C. 1965. *Storage of Heptachlor Epoxide in the Body Fat and Its Excretion in Milk of Dairy Cows Fed Heptachlor in Their Diets.* J. Agr. Food Chem., 13:03.

(4) Davidow, B., Radomski, J. L., and Ely, F. 1953. Excretion of Heptachlor Epoxide in Milk of a Dairy Cow Fed Heptachlor. Science, 118:383.

(5) Ely, R. E., Moore, L. A., Hubanks, P. L., Carter, R. H., and Poos, F. W. 1955. Excretion of Heptachlor Epoxide in the Milk of Dairy Cows Fed Heptachlor-Sprayed Forage and Technical Heptachlor. J. Dairy Sci., 38:669.

(6) Hardee, D. D., Gutenmann, W. H., Keeler, G. L., Gyrisco, G. G., Lisk, D. J., Fox, F. H., Trimberger, G. W., and Holland, R. F., 1964. Residues of Heptachlor Epoxide and Telodrin in Milk from Cows Fed Part per Billion Insecticide Levels. Econ. Entomol., 50:404.

(7) Huber, J. T., and Bishop, J. L. 1962. Secretion of Heptachlor Epoxide in the Milk of Cows Fed Field-Cured Hay from Soil Treated with Heptachlor. J. Dairy Sci., 45:79.

(8) Jorgensen, P. S. 1957. Report on Heptachlor in Foods. J. A.O.A.C., 40:206.

(9) Langlois, B. E., [illegible] B. J. 1964. [illegible]nets for Analysis of Pesticide Residues by *Gas Chromatography.*

(10) Poles, P. B. [illegible] Private communication.

(11) Samuel, B. L. [illegible] Method for the Analysis of Organic Insecticides. J. A.O.A.C., [illegible]

(12) *Storherr, R. W.* [illegible] J. F. 1960.

MONS 038640

(9) Langlois, B. E., Stemp, A. R., and Liska, B. J. 1964. Rapid Cleanup of Dairy Products for Analysis of Chlorinated Insecticide Residue by Electron Capture Gas Chromatography. J. Agr. Food Chem., 12:243.
(10) Polen, P. B. (Velsicol Chemical Co.) 1962. Private communication.
(11) Samuel, B. L. 1966. An Improved Screening Method for Chlorinated and Thiophosphate Organic Insecticides in Foods and Feeds. J. A.O.A.C., 49:346.
(12) Storherr, R. W., Tighe, J. F., and Sykes, J. F. 1960. Residues in the Milk of Cows Orally Administered a Mixture of Heptachlor and Heptachlor Epoxide. J. Assoc. Offic. Agr. Chemists, 43:731.
(13) Wilkinson, A. T. S., Finlayson, D. G., and Morley, H. V. 1964. Toxic Residues on Soil 9 Years After Treatment with Aldrin and Heptachlor. Science, 143:681.
(14) Williams, S., Mills, P. A., and McDowell, R. E. 1964. Residues in Milk of Cows Fed Rations Containing Low Concentrations of Five Chlorinated Hydrocarbon Pesticides. J. Assoc. Offic. Agr. Chemists, 47:1124.

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J. Dairy Sci. 52 (1969)

Excretion and Storage of Dieldrin in Dairy Cows Fed Thyroprotein and Different Levels of Energy [1, 2]

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Abstract

Two trials investigated the effect of dietary energy and thyroprotein on retention and excretion of dieldrin fed to lactating cows and pregnant heifers. Sixteen Holstein cows (Trial I) and 18 heifers (Trial II) were contaminated for 56 to 60 days with about 0.1 mg/kilogram body weight of dieldrin.

In Trial I, treatments during decontamination furnished 75, 100, and 150% of the recommended allowance for total digestible nutrients. A fourth treatment included the highest nutrient level and 22 mg thyroprotein/kilogram body weight. In Trial II, heifers were contaminated starting 60 days prepartum. Postpartum treatments were: 1) medium energy, 2) high energy, and 3) high energy plus alfalfa pellets.

Varying dietary energy did not alter the rate of dieldrin decontamination, but thyroprotein decreased the time for residue in milk fat to reach 1.0 ppm (12 compared to 16 weeks). In both trials, concentrations dropped to one-half their initial levels after four weeks of decontamination and to one-third after six weeks. Dieldrin in whole milk did not change when milk fat was decreased by pelleted hay. Adipose in cows fed thyroprotein contained higher levels of dieldrin than the controls. The data suggest that the hormone mobilized body fat without stimulating release of a proportional amount of dieldrin.

Once a dairy animal is contaminated with chlorinated hydrocarbon pesticides, residues are found in the milk long after intake of t chemical has ceased (2, 4, 6, 8, 9). How little information is available concerning m agement practices which might enhance de tamination of lactating cows.

Increasing the rate of decontamination depleting body fat stores with low-energy d has been suggested (5). Conversely, ener intake in excess of requirements might m mize body fat turnover, thereby reducing p cide release and concentration in milk fat. I creasing the rate of fat turnover in the b with thyroprotein in conjunction with a hi energy intake also has been suggested. D designed to depress milk fat, thereby redu the rate of pesticide elimination in milk, pe ent another method for reducing concentr tions below detectable levels.

The objectives of these investigations w to establish a normal dieldrin excretion ra and ascertain whether excretion patterns c be altered by dietary changes.

Experimental Procedures

Trial I. Sixteen lactating Holstein cow averaging 39 months of age and 115 days p partum, were assigned to one of four outc groups based on daily milk production a stage of lactation.

For 56 days each animal was contamina with technical dieldrin in grain at the daily r of 0.11 mg/kilogram body weight. The te nical dieldrin contained 88.4% active ingre ent [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a 6,7,8,8a-octahydro-1, 4-endo-exo-5,8-dimetha naphthalene (HEOD)]. Because the analyti procedure measured HEOD, not dieldrin, i intake and analytical data reported herein will be expressed as HEOD equivalent. Inta of HEOD was equivalent to 1.94 ppm in t total diet or 3.25 ppm in the dry matter (DM consumed and was based on body weight cows obtained two consecutive days just be contamination.

During contamination, TDN was furnish to provide 100% of the National Rese Council (NRC) requirement (10) for ma tenance and milk production. The requirem for growth instead of maintenance was used calculate TDN needed by first-lactation hei

All cows received alfa-grass hay, 13.6 efficient concentrate pirement. Adjustme ade every two week ation for the pre eights were obtained e two-week intervals on and decontamina At the end of the eriod the four group andomly assigned ietary treatments:

a) 75% of the N
b) 150% of the N
c) 150% of the N plus 22 mg o mone)[5] daily p
d) 100% of the N (control)

Hay and corn ent throughout th nergy ration in w portionally to ach rain intakes were ditional energy r nts.

Gelatin capsules d thyroprotein we rnoon with a half als thyroprotein changes in body w

Aliquot milk s composited daily f amination, on the ntamination, an after until the 18 The milking mach ater after each ross contaminati n the Babcock Milk samples we xtracted the fol

Biopsies of ex g were remov ow cows in eac d contamination weeks of decon placed in plast otal extracted

During the t fecal feces and ues from two

[5] Supplied by Missouri.

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[2] Data taken from dissertation by the senior author in partial fulfillment of the requirements for the Ph.D. degree, Michigan State University, January, 1968.
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All cows received a ration of 4.5 kg of alfalfa-grass hay, 13.6 kg of corn silage, and sufficient concentrate to balance the TDN requirement. Adjustments in concentrate were made every two weeks based on the milk production for the preceeding seven days. Body weights were obtained on two consecutive days at two-week intervals throughout the contamination and decontamination periods.

At the end of the eight-week contamination period the four groups of four cows each were randomly assigned to one of the following dietary treatments:

a) 75% of the NRC requirement for TDN
b) 150% of the NRC requirement for TDN
c) 150% of the NRC requirement for TDN plus 22 mg of iodinated casein (Protamone)* daily per kilogram of body weight
d) 100% of the NRC requirement for TDN (control)

Hay and corn silage levels remained constant throughout the trial, except for the low-energy ration in which each was reduced proportionally to achieve 75% of requirement. Grain intakes were increased to furnish the additional energy required on the 150% treatments.

Gelatin capsules containing the daily dose of thyroprotein were delivered directly into the rumen with a balling gun. At biweekly intervals thyroprotein dosage was adjusted for changes in body weight.

Aliquot milk samples were collected and composited daily from each cow just before contamination, on the third and sixth day during contamination, and at weekly intervals thereafter until the 18th week of decontamination. The milking machine buckets were rinsed with water after each cow was milked, to reduce cross contamination. Milk fat was determined by the Babcock method after the PM milking. Milk samples were refrigerated overnight and extracted the following day for HEOD analysis.

Biopsies of external body fat weighing 5 to 10 g were removed from the shoulder area of two cows in each treatment group at the end of contamination and during the eighth and 16th weeks of decontamination. Fat samples were placed in plastic bags and stored at −15 C until extracted for HEOD analysis.

During the third week of decontamination total feces and urine were collected for five days from two cows in each treatment group. Feces were collected in metal pans, and urethral catheters were used for shunting urine to containers.

Prior to and at monthly intervals during the entire experiment, hay (1 kg), corn silage (2 kg), and grain (1 kg) were sampled for HEOD analysis. All samples were placed in plastic bags and refrigerated until extracted for HEOD analysis.

Concentration of HEOD in the various samples and tissues was determined by electron-capture gas chromatographic analysis. A detailed description of procedures is given by Braund (2).

Trial II. Eighteen pregnant heifers utilized in this trial were fed technical dieldrin in grain at the daily dose of 0.11 mg/kilogram body weight for 60 days immediately prepartum. If parturition had not occurred by the expected date, dieldrin was fed until the animal calved. The dieldrin was mixed in the grain, and contamination was accomplished as described for Trial I. Based on total feed consumption during contamination, HEOD intake was equivalent to about 5.4 ppm of the total diet. During contamination all heifers were fed hay at 1.5 kg/100 kg of body weight. Grain was fed in sufficient amounts to bring TDN intake up to 115% of the National Research Council requirement. The following dietary treatments were employed after parturition:

a) Medium energy (six animals). Alfalfa hay was fed at 2.0 kg/100 kg body weight and grain at 1.0 kg/3.5 kg milk produced.
b) High energy (six animals). Alfalfa hay was fed at 1.5 kg/100 kg body weight and grain at 1.0 kg/2.0 kg milk produced.
c) Depressed milk fat (six animals). Fed similarly to Group b, except that dehydrated alfalfa pellets replaced long hay.

It was assumed that no dieldrin was consumed by any of the animals before contamination periods in both trials. Lack of pretreatment exposure to the pesticide is substantiated by its absence in hay and grain fed during treatment.

Results

Trial I

Animal performance. Energy intakes for each treatment during contamination and decontamination were calculated as per cent of the 1966 National Research Council requirement for TDN and are shown in Table 1.

*Supplied by Agri-Tech, Inc., Kansas City, Missouri.

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TABLE 1. Total digestible nutrient intake of cows as per cent of the National Research Council's requirement.*

Treatment	Contamination	Week of decontamination				
	8 weeks	0-4	5-8	9-12	13-16	17-18
	(%)					
150% NRC	97.7	110.5	115.4	115.2	125.2	130.3
75% NRC	99.6	80.2	79.1	76.4	73.9	73.9
100% NRC	101.0	104.9	100.9	100.8	98.1	96.8
150% NRC + thyroprotein	101.4	98.7	106.4	127.1	138.4	138.0

* See Reference 10.

All cows were offered 100% of the Council's requirement during the eight-week contamination period. During decontamination it was intended to feed two groups 150%; but, because of appetite limitations during the first eight weeks, actual intakes for these groups were only slightly higher than the Council's requirement. This was especially true for the cows fed thyroprotein, because increased milk production resulted in a correspondingly higher requirement. During the last ten weeks of decontamination, lower production resulted in a decrease in energy needs; thus, intake was considerably higher than requirement for both high-energy groups, but it never reached the desired 150%.

Thyroprotein administration caused a rapid loss of body weight of cows (57 kg in four weeks) (Fig. 1). Thereafter, weights levelled and small gains were noted between 12 and 18 weeks. Body weight remained constant for the control cows until late in the treatment period, when slight increases were noted, whereas the 150% group exhibited early and sustained increases. Weights of the 75% group decreased slowly during the entire decontamination period.

A sharp initial increase in milk production was obtained for the thyroprotein treatment, with a smaller increase for the 150% group (Fig. 2). The decline in production of all groups during the third week of decontamination and subsequent recovery was due to several days of extremely hot weather. Greatest decreases in milk yields, which preceded the body weight losses, were noted for the 75% group. The precipitous decline in production for the 150% group during Weeks 9, 10, and 11 occurred because the highest-producing cow in the group suffered an udder injury and acute mastitis.

Excretion of HEOD in milk fat. The per cent of the HEOD intake excreted as the unchanged compound during the contamination period is shown in Table 2. A sharp increase in the per cent of the ingested dose of HEOD secreted in milk was noted between the first and eighth week of contamination, which may

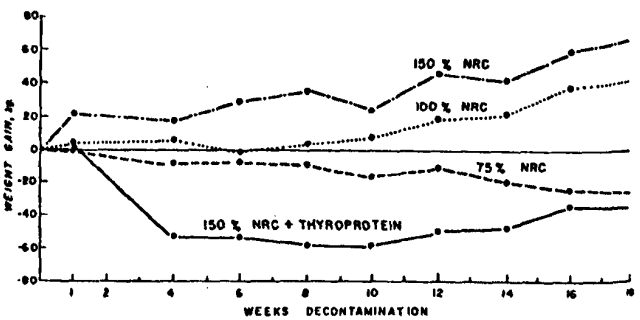


FIG. 1. Body weight changes during decontamination of cows fed thyroprotein and different levels of energy.



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During the 18 weeks
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TABLE 2. Weekly excreti

Per cent of intake:
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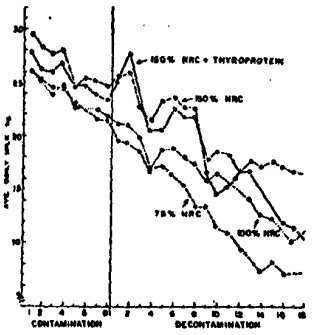


FIG. 2. Average daily milk production during contamination and decontamination of cows fed thyroprotein and different levels of energy.

reflect partial saturation by HEOD of certain tissues. By the end of contamination approximately 19% of the total HEOD fed had been excreted in the milk fat.

Residues of HEOD in milk fat of weekly samples fluctuated considerably, but dropped rapidly to about one-third of the initial levels after five weeks of decontamination (Fig. 3). Thereafter, rate of decline was slower, with apparent plateaus in concentrations occurring between Weeks 5 to 10 and 12 to 18 of decontamination. Eighteen weeks after cessation of dieldrin feeding, the milk from 12 of the 16 cows still contained measurable levels of HEOD (>0.01 ppm). Calculation of regression coefficients for the HEOD levels in milk fat showed that residues did not decline at an exponential rate.

During the 18 weeks of decontamination an average of about 19% of the total HEOD intake was excreted in the milk fat (Table 3). There was no significant treatment difference in the per cent of HEOD intake excreted. Excretion of HEOD was almost equally divided between eight weeks of contamination and 18 weeks of decontamination, with a total 37% of that ingested accounted for in the milk fat (Table 3).

Body fat HEOD and excreta. At the end of contamination, HEOD in external shoulder fat averaged 10 ppm, but declined exponentially to approximately 5 ppm at Week 8 and 1 ppm at Week 16 (Fig. 4). Although the cows fed thyroprotein declined at the fastest rate, numbers were insufficient to detect a significant difference. After 18 weeks of decontamination six cows were slaughtered for various reasons. By coincidence, three animals were from the thyroprotein group and one from each of the three other treatments. Data for cows which did not receive thyroprotein were pooled; mean values are presented in Table 4.

Residues in whole tissues from the kidney, liver, and udder showed little difference due to thyroprotein feeding. However, residues in fat separated from the shoulder, kidney, and omentum were three to five times higher for the thyroprotein-fed cows. The difference for concentrations in omental fat were highly significant ($P < 0.01$) and levels in the kidney fat approached significance ($P < 0.10$).

Urine and feces collected during the third week of decontamination showed trace amounts of HEOD (<0.001 ppm) in the urine of five cows and none in the other three. No HEOD was detected in the feces from any of the eight animals collected.

Trial II

Animal performance. Heifers receiving the highest level of energy reached a minimum in body weight at six weeks postpartum, but regained post-calving weight between 22 and 24 weeks (Fig. 5). Losses in weight for other groups were greater in magnitude and more persistent.

Although milk yields were highest for the high-grain, pelleted hay ration, they were not significantly different among the treatment groups (Table 5). Milk fat percentages for the normal group were higher ($P < 0.05$) than for the high-grain groups; and pelleting the forage (Group C) caused an even greater de-

TABLE 2. Weekly excretion of HEOD in milk fat during contamination.

	Week of contamination							
	1	2	3	4	5	6	7	8
Per cent of intake:								
Excreted weekly	11.7	10.6	15.2	15.4	16.6	21.5	23.9	24.4
Excreted to date	11.7	15.0	15.5	15.4	15.7	16.7	17.7	18.6

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TABLE 3. Total HEOD excretion in milk fat during contamination and decontamination.

Treatment group	HEOD intake	Intake excreted during: 8 weeks of contamination	18 weeks of decontamination	26 weeks total
	(mg)	(%)		
150% NRC	2,970	22.5	19.0	41.5
75% NRC	2,092	19.4	19.2	38.6
100% NRC	2,939	14.7	16.6	31.3
150% NRC + thyroprotein	3,939	16.9	21.0	37.9
SE of mean	160	3.5	2.3	5.4
Over-all mean	2,685 ± 80	18.6 ± 1.7	19.0 ± 1.4	37.4 ± 2.7

pression ($P < 0.05$) in fat content. Milk fat yields for the normal group were higher ($P < 0.05$) than for the group receiving pellets.

Excretion of HEOD in milk fat. Concentrations of HEOD in milk dropped rapidly for all heifers, with patterns similar to those noted for Trial 1 (Fig. 6). As with Trial 1, HEOD levels in milk fat did not decline at an exponential rate. Heifers fed pelleted forage exhibited the lowest fat content in milk but the highest ($P < 0.01$) concentration of HEOD in that fat. At 30 weeks postpartum, milk fat residues had declined to less than 1 ppm for all groups.

Ration effects on pesticide excretion are shown in Table 6. Animals fed pelleted hay had excreted a higher percentage ($P < 0.05$) of the ingested pesticide in milk fat by 18 and 24 weeks than those on normal or high-grain diets.

Excretion of HEOD in feces and urine. To investigate possible excretory pathways of HEOD, total collections of urine and feces were made for five days at 30 days postpartum in two heifers from all groups. As shown in Table 7, only small amounts of HEOD were eliminated in feces and traces in the urine;

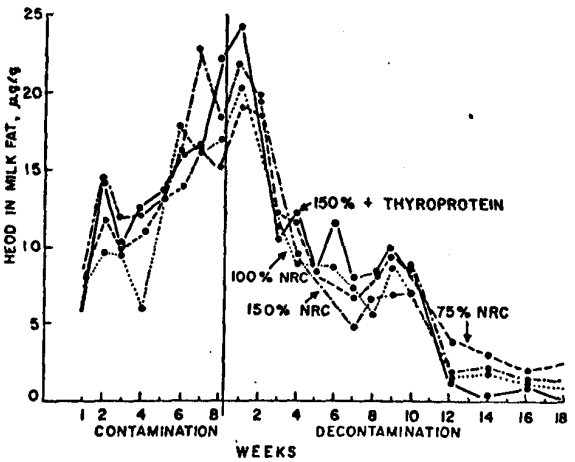


FIG. 5. Levels of HEOD in milk fat of cows contaminated during lactation and fed thyroprotein and different levels of energy.



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Discussion

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Thyroprotein
nonthyroprotein

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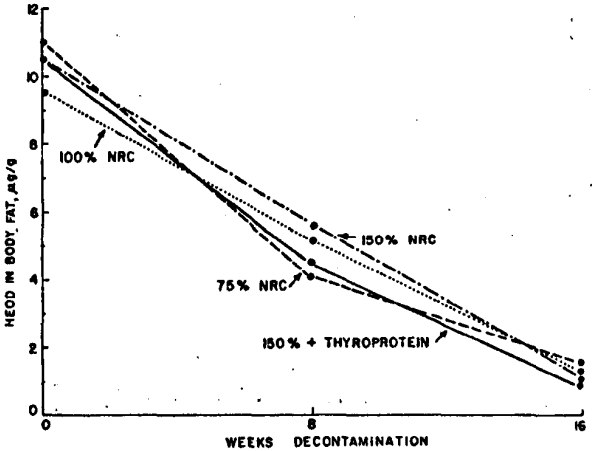


FIG. 4. Levels of HEOD in external body fat during decontamination of cows fed thyroprotein and different levels of energy.

whereas, milk was the major excretory pathway of the pesticide from lactating animals.

Discussion

Two distinct rates for dieldrin elimination are suggested by these data. Laben et al. (8) stated that DDT residues in milk fat declined exponentially after cessation of DDT intake; however, a semilogarithmic plot of their data shows levelling similar to that observed in our study. Also, the California workers (6) did not indicate statistical treatment of regression lines to test if the rate of residue decline observed in their studies could be described by other than linear function.

Other workers (4, 6, 9, 13) have found that after discontinuation of DDT intake, levels in the milk fat fell rapidly for the first three to five weeks, then levelled, and thereafter declined at a slower rate.

Witt et al. (13) reported that the depletion rate of DDT was uniform for low-level accumulations (<2 ppm in milk fat), but found two disappearance rates for higher levels of

TABLE 4. Residues of HEOD in tissues and body fat of cows fed thyroprotein or no thyroprotein after 16 weeks of decontamination.

	Whole tissue			Tissue fat		
	Kidney	Liver	Udder	Shoulder	Kidney	Omental
	(mg/kg)			(mg/kg)		
Mean for three nonthyroprotein cows	0.03	0.13	0.07	1.24	0.57[a]	0.72[a]
Mean for three thyroprotein cows	0.03	0.15	0.10	3.69	2.80[b]	2.42[b]
SE of mean	0.01	0.03	0.02	1.20	0.80	0.20
Ratio: Thyroprotein / nonthyroprotein	1.0	1.2	1.4	3.0	4.9	3.4

[a,b] Difference approaches significance ($P < .10$).
[a,a] Means are significantly different ($P < .01$).

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TABLE 7. Daily excretion of HEOD in feces, urine, and milk 30 days postpartum of heifers contaminated during the last 60 days of gestation.

Treatment group[a]	Feces			Urine		Milk			Total HEOD excretion
	DM production	HEOD		Production	HEOD conc	Production	HEOD		
		Conc	Excretion				Conc	Excretion	
	(kg)	(mg/kg)	(mg)	(kg)	(mg/kg)	(kg)	(mg/kg)	(mg)	(mg)
A	4.7	.08	.38	7.1	<.001	26.7	.13	3.47	3.86
B	4.0	.13	.52	7.2	<.001	27.1	.12	3.26	3.80
C	2.7	.17	.46	5.1	<.001	30.8	.06	1.72	2.18

[a] Two heifers per group.

on the low-energy diets. Miller's (9) cows were fed hay (9 kg/day) as the sole energy source from the seventh through 42nd day of lactation, and little decrease in milk production was noted compared to previous lactations. Energy for maintenance of milk yields in these cows very likely came from mobilization of body fat, thereby increasing pesticide release into milk. The cows in our study averaged six months postpartum at initiation of the low-energy diet and responded with decreased milk yields.

From the available data, it appears that low-energy diets may enhance elimination of chlorinated hydrocarbon pesticides from dairy cows during early lactation, when there is a greater stimulus to use body fat stores. However, any regimen which substantially decreases milk yields will prolong the persistence of pesticides.

Despite the marked depression in milk fat content for the group receiving pellets, it is noteworthy that the mean residue level in the whole milk was not different from the other groups. Heifers fed the pelleted hay produced the most milk (Table 5), which contributed to a greater removal of total pesticide.

Since it is generally accepted that HEOD is associated with the lipid portion of milk, the observation that a depression in per cent milk fat did not alter the residue level in whole milk indicates that HEOD excretion via the bovine mammary gland is related to factors other than the total amount of fat synthesized in the gland.

It is possible that HEOD concentration in milk can be altered by relative amounts of the different fat precursors taken up by the mammary gland. Laben et al. (8) suggested that

TABLE 8. Milk fat HEOD during decontamination for all dietary treatments.

Week	Trial I[a]				Trial II[b]		
	Per cent of TDN requirements				Diet		
	150	75	100	150 + thyroprotein	Normal	High grain	Pelleted hay
	(μg/g)						
1	24.9	18.2	21.0	24.0	18.8	17.4	23.9
2	19.9	19.1	10.2	19.9	13.4	9.9	11.4
3	13.4	11.8	11.8	10.7	7.3	8.2	12.5
4	9.7	11.7	8.8	12.2	8.4	10.3	11.9
5	8.0	0.9	9.1	8.6	7.0	9.0	10.9
6	6.4	7.5	8.8	12.2	5.2	6.3	8.8
7	4.6	6.4	7.4	8.0	.....	.....	.....
8	6.5	7.7	5.5	8.6	4.5	3.6	8.1
9	7.1	10.0	8.9	9.5	.....	.....	.....
10	7.2	7.7	8.6	8.8	4.0	3.8	7.3
12	1.6	4.2	1.6	1.0	4.0	3.4	7.8
14	2.2	2.8	1.8	0.4	.....	.....	.....
16	1.2	2.0	0.0	1.0	2.2	3.3	6.3
18	1.3	2.6	0.8	0.2	.....	.....	.....
20	.....	.....	.....	.....	1.3	1.6	2.8
24	.....	.....	.....	.....	1.0	1.2	1.7
30	.....	.....	.....	.....	0.8	0.2	0.3

[a] Four animals per treatment.
[b] Six animals per treatment.

various pools or fraction widely in their concent that a particular lipid portant precursor of m a disproportionate con than would be revealed analysis. Huber et al. lipids contributed to a total milk fat in cows roughage rations than ration.

As the pesticide wa body via secretion in th external shoulder fat d mals in each group of fat residue analysis in based on these data definite trends were not tions in samples taken weeks of decontaminati tial decline. Regression spective treatments of plus thyroprotein were

$$Y = 11.6,^{-0.08t}, Y$$
$$10.0,^{-0.07t}, \text{ and}$$

Thus, residue levels de to 2.24% per day (12. Although body fat leve protein-fed cows declin numbers were insufficier difference.

Experience gained fr every animal in Trial II body fat analysis. Body in Trial II decreased treatments after lactati gression equations for were

$$Y = 10.0,^{-0.09t}, Y =$$
$$13.2,^{-0.08t},$$

The three groups, ther of 1.16 to 1.47% per week). These eliminat parable to those report when initial body fat l 253, and 500 ppm for

The difference in the of HEOD from body fat (exponential declir riods) might be explain the eight-week interva might have masked any concentrations which o ing the intervening w et al. (8) took biopsy

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...um of heifers contaminated

...ith HEOD		Total HEOD excretion
...ose	Excretion	
...mg/kg)	(mg)	(mg)
...	3.47	3.86
...	3.28	3.80
...	1.72	2.18

depression in milk fat ... receiving pellets, it is ...ean residue level in the ...different from the other ...e pelleted hay produced ...5), which contributed to ...otal pesticide.

...y accepted that HEOD ... lipid portion of milk, ... dr... sion in per cent ...he residue level in whole ... HEOD excretion via the ...d is related to factors ...mount of fat synthesized

HEOD concentration in ... relative amounts of the ...s taken up by the mam... al. (8) suggested that

Trial II*	
Diet	
High grain	Pelleted hay
17.4	23.9
9.9	11.4
9.2	12.5
10.3	11.9
9.0	10.9
6.3	9.8
3.0	8.1
3.8	7.3
3.4	7.6
3 ...	6.3
1....	2.6
1.2	1.7
0.2	0.3

various pools or fractions of body fat may vary widely in their concentrations of residues and that a particular lipid fraction may be an important precursor of milk fat and also contain a disproportionate concentration of pesticide than would be revealed by a total carcass fat analysis. Huber et al. (7) reported that blood lipids contributed to a larger percentage of the total milk fat in cows fed high-grain, restricted roughage rations than in those on a normal ration.

As the pesticide was eliminated from the body via secretion in the milk, residue levels in external shoulder fat declined. Only two animals in each group of four were biopsied for fat residue analysis in Trial I; thus, estimates based on these data are not complete, but definite trends were noted. Residue concentrations in samples taken at zero, eight, and 16 weeks of decontamination showed an exponential decline. Regression equations for the respective treatments of 150, 75, 100, and 150% plus thyroprotein were

$$Y = 11.6_e{}^{-0.0317t}, \quad Y = 10.8_e{}^{-0.0317t}, \quad Y = 10.0_e{}^{-0.0317t}, \text{ and } Y = 10.0_e{}^{-0.0317t}.$$

Thus, residue levels declined at rates of 1.78 to 2.24% per day (12.5 to 15.7% per week). Although body fat levels of HEOD in thyroprotein-fed cows declined at the fastest rate, numbers were insufficient to detect a significant difference.

Experience gained from Trial I dictated that every animal in Trial II should be biopsied for body fat analysis. Body residue concentrations in Trial II decreased exponentially for all treatments after lactation was initiated. Regression equations for Groups A, B, and C were

$$Y = 10.0_e{}^{-0.0147t}, \quad Y = 10.0_e{}^{-0.0110t}, \text{ and } Y = 13.2_e{}^{-0.0135t}, \text{ respectively.}$$

The three groups, therefore, declined at rates of 1.10 to 1.47% per day (8.1 to 10.3% per week). These elimination patterns are comparable to those reported by Laben et al. (8), when initial body fat levels of DDT were 16, 253, and 590 ppm for three treatment groups.

The difference in the disappearance pattern of HEOD from body fat compared with milk fat (exponential decline versus plateau periods) might be explained in two ways. First, the eight-week interval between fat biopsies might have masked any plateau in tissue residue concentrations which could have occurred during the intervening weeks. However, Laben et al. (8) took biopsy samples at two-week intervals and did not find a levelling of DDT residues in body fat. Secondly, a decrease in residue concentrations of shoulder fat might might not accurately describe the decline of total pesticides in the body.

Limited evidence for differential storage and mobilization of HEOD was obtained with tissues removed from the six cows at slaughter (Table 4). Residues in shoulder fat were higher than those in kidney or omental fat. Moreover, thyroprotein-feeding appeared to mobilize fat without uniformly stimulating release of stored HEOD, as indicated by the observation that residues in shoulder, kidney, and omental fat were three to five times higher in HEOD for the thyroprotein-fed than control cows. The higher concentration of HEOD in fat at slaughter of the thyroprotein-fed cows might be explained on the basis that thyroprotein differentially stimulated mobilization in the two-compartment fat cell or at various fat depots. Thus, the residual HEOD was more concentrated in the lipid remaining in the fat cells of the thyroprotein-fed cows.

The appearance of HEOD in feces 30 days after contamination (Table 7) indicates a metabolic origin and recycling of the pesticide. Cook et al. (3) have demonstrated that dieldrin is recycled and appears in the bile, pancreatic juices, and saliva of goats. These were probable pathways through which dieldrin appeared in the feces of heifers during decontamination.

These data show that neither alteration in energy intake nor thyroprotein feeding offers any practical value for decontaminating dairy cows previously contaminated with dieldrin.

References

(1) Aronovsky, E., R. Levari, W. Kornbluth, and E. Werthelmer. 1963. Comparison of metabolic activities of orbital fat with those of other adipose tissue. Investigative Ophthalmol., 2: 259.

(2) Braund, D. G. 1968. Factors affecting the storage, excretion and placental transfer of dieldrin in dairy cattle. Ph.D. thesis, Michigan State University, East Lansing.

(3) Cook, R. M., J. W. Thomas, R. S. Emery, and J. T. Huber. 1967. Dieldrin recycling from the blood to the gut in ruminants. J. Anim. Sci., 26: 1480.

(4) Crosby, D. G., T. E. Archer, and R. C. Laben. 1967. DDT contamination in milk following a single feeding exposure. J. Dairy Sci., 50: 40.

(5) Price, G. F., W. P. Flatt, and L. A. Moore. 1967. Body fat loss and the secretion of

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DDT and its metabolites into milk. J. Dairy Sci., 50: 991.
(6) Gannon, N., and G. C. Decker. 1960. The excretion of dieldrin, DDT and heptachlor epoxide in milk of dairy cows fed on pastures treated with dieldrin, DDT and heptachlor. J. Econ. Entomol., 53: 411.
(7) Hubor, J. T., R. S. Emery, J. W. Thomas, and I. M. Yousef. 1969. Milk fat synthesis on restricted roughage rations containing whey, $NaHCO_3$, and MgO. J. Dairy Sci., 52: 54.
(8) Laben, R. C., T. E. Archer, D. G. Crosby, and S. A. Peoples. 1965. Lactational output of DDT fed prepartum to dairy cattle. J. Dairy Sci., 48: 702.
(9) Miller, D. D. 1967. Effect of thyroprotein and a low-energy ration on removal of DDT from lactating dairy cows. J. Dairy Sci., 50: 1444.
(10) National Academy of Sciences—National Research Council. 1966. Nutrient Requirements of Dairy Cattle. Publ. 1349.
(11) Stull, J. W., W. H. Brown, F. M. Whiting, L. M. Sullivan, Mary Milbrath, and J. M. Witt. 1968. Secretion of DDT by lactating cows fed thyroprotein. J. Dairy Sci., 51: 56.
(12) Wertheimer, H. E. 1965. Introduction—A perspective. In Handbook of Physiology. Sec. 5. Adipose Tissue. Amer. Physiol. Soc., Washington, D.C.
(13) Witt, J. M., F. M. Whiting, W. H. Brown, and J. W. Stull. 1966. Contamination of milk from different routes of animal exposure to DDT. J. Dairy Sci., 49: 376.

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11 P 1953
Distribution of organochlorine pesticides among some milk components.
Hugunin, A. G.; Bradley, R. L., Jr.
Journal of Dairy Science 54 (3) 355-359 (1971) [24 ref. En] [Dept. of Food Sci., Univ., Madison, Wisconsin 53706, USA]

Distribution it given of pesticides in fractions of the lipid phase of samples of (i) milk naturally contaminated with dicofol or aldrin in the cows' diet mixed with (ii) milk contaminated artificially with other pesticides. The higher concn. found in the high-density fat-globule membrane fraction obtained by ultracentrifugation of the mixed buttermilk and butter serum fractions of (i + ii) and results of electrophoresis of the membrane fraction of (ii) indicated preferential association of the pesticides with the membrane protein. The effect of removal of portions of the membrane during separation was studied. Concn. of dieldrin on a fat basis did not appear to be altered but there was an increase on a lipid P basis; values (g dieldrin/g lipid P) for raw cream, washed cream and skim-milk were 0.173, 0.268 and 0.459 respectively. No evidence was found to indicate that phospholipids bind with pesticide residues in the membrane but the high residues/g fat in skim-milk and their apparent emulsification by lecithin in studies on solubility indicated that phospholipid-pesticide micelles could exist in the serum phase. It was considered that preferential concn. in the membrane could explain the variations in pesticide/g fat found in dairy products. Most of the residues are associated with the triglycerides in the interior of the fat globules. BEPC

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3P440

3 P 440
Field study of a chlordane residue problem in milk.
Boyd, J. C.
Bulletin of Environmental Contamination and Toxicology 5 (4) 292-99 (1970) 9 ref. En] [Animal Sci. Dept., St. Univ., Bozeman, Montana, USA]

Following discovery of unacceptable levels of heptachlor epoxide in the milk supply of the Gallatin Valley, Montana, extensive investigations into the use of chlordane on lucerne, elimination of residue from milk, and production of reliable analytical results, were carried out. Results suggested that the 3 out of 5 sample procedure would be more realistic than taking a single sample. It was found that chlordane residues in hay of >0.065 ppm could be tolerated without the apparent heptachlor epoxide exceeding the legal action level of 0.3 ppm in milk, but that hay residues of 3.45 ppm would result in residues exceeding it. Chlordane did not build up to very high levels in the animals, and was dissipated relatively quickly once the contaminated feed was stopped. PEG

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J. D. Sci. 44 (1961) (9)

OUR INDUSTRY TODAY

AN INQUIRING LOOK AT ANTIBIOTIC RESIDUE CONTROL[1]

F. V. Kosikowski
Department of Dairy and Food Science, Cornell University, Ithaca, New York

Antibiotic residues in market milk were a real live subject a year ago, but the furor about antibiotic residues in milk has quieted down a little now and this may be good or bad. It means either that nothing is being done about antibiotic control or that certain objectives have been attained. The achievements of the dairy industry will be briefly reviewed, but actually the main theme is less concerned with achievements than with the new problems arising from our attempts to rid milk of antibiotic residues.

Practical means to control the antibiotic menace. The only practical way to institute residue control for antibiotics is to institute a solid test program. Once milk producers are aware of the existence of such a program, it serves as a psychological deterrent to their breaking the regulations. Testing for antibiotics is one of the most inexpensive programs of the various test programs conducted by the dairy industry, as such tests cost only a few cents each.

Once-a-month testing among producers is generally sufficient, but the testing must be regular and good records must be maintained. The State of Pennsylvania now has a law requiring the testing of all producer milks once a month. A positive antibiotic test automatically excludes the producer for two days. Another state, Wisconsin, is considering a similar law.

Education should follow up closely positive test results in the field, for at this point education, usually through personal remarks by the fieldman, becomes most effective. All positives should first be confirmed by penicillinase or by heating techniques, and regular offenders should be given the full penalty previously decided upon. Simple tests based on the disc assay principle or on test tube activity outlined in the 11th edition of the American Public Health Handbook of Standard Methods (4) are the most suitable at the grass-roots producer level. But for those public health officials checking bulk tanks and concerned with the strictest interpretation of present-day regulations, the best test, because of its greater sensitivity, is the *Sarcina lutea* disc assay test conducted at 25° C. for 18 hr. (4).

Current achievements. Since January, 1960, the efforts to bring antibiotic residues under control have gained much momentum. Now, almost a year later, some accounting of this nation-wide effort is possible from recent surveys made by Cornell University (Table 1).

Most of the significant results are summarized in Tables 1 and 1a. A nation-wide average incidence of 0.0% has dropped to 0.54% incidence. This is a remarkable reduction made possible only through the full cooperation of all parties concerned.

Some highlights garnered from this survey are of interest. Dairy industrial laboratories rather than state units carried out most of the testing, and this is as it should be. The most widely used test by the cooperating laboratories was the *Bacillus subtilis* disc assay test as described in the 10th edition of the Handbook of Standard Methods of the American Public Health Association.

The incidence reported by state health and agricultural laboratories was 0.44% and that by the industrial dairy laboratories was 0.56%. This is a good check, giving substance to the

TABLE 1

The national incidence of antibiotic residues in producer milks

(January 1 to October 15, 1960)

Organizations reporting	Number of producer milks analyzed	Number positive for antibiotics	Incidence (%)
17 dairies throughout the United States	655,703	3,040	0.56
28 State Health and State Agriculture Departments throughout the United States	112,705	493	0.44
Total			
45 Cooperating organizations	768,408	4,133	0.54

TABLE 1a

The New York State incidence of antibiotic residues in producer milks

(January 1 to October 15, 1960)

Number of producer milks tested	Number positive for antibiotics	Incidence (%)
129,214	568	0.44

[1] Portions of this manuscript were presented at the Ohio State University Dairy Conference, Columbus, Ohio, 1961, and at the New York State Sanitarians' Meeting, Syracuse, New York, 1960.

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DUE CONTROL[1]

, Ithaca, New York

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TABLE 1

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producer milks

1 to October 15, 1960)

Number of producer milk- ans	Number positive for anti- biotics	Inci- dence (%)
655,763	3,640	0.56
112,705	493	0.44
768,468	4,133	0.54

TABLE 1a

State incidence of antibiotic
ues in producer milks

1 to October 15, 1960)

Number positive for anti- biotics	Inci- dence (%)
56	0.44

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laboratories was 0.41%; and the
dairy laboratories was 0.56%.
check, giving substance to the

validity of these data. State laboratories perhaps exercised greater care in guarding against *false positives*, thus leading to a lower incidence.

Improvement, then, in our antibiotic residue problem is marked. Yet, from a public health point of view, does this lowered antibiotic incidence mean *our troubles are over and that*, in general, the problems that remain are minor? The answer is No—on both counts. A consideration of the more significant is presented.

False positives in analytical testing. Natural inhibitory substances of milk inevitably rear up to bedevil the unwary. Differing from blood, for which early tests were designed, milk shows natural inhibitory substances in greater profusion. These give zones on disc assay which have no relation to pharmaceutical antibiotics.

The problem of *false positives is not an* imaginary one and the closer one gets to the milk of the individual producer's cows, the more the likelihood exists of encountering false positives. Also, raw milks with certain strains of bacteria or with total high counts are more prone to show false positives on disc assay. A number of such instances are cited in the scientific literature (5-7).

False positives result from a variety of causes, but their appearance is unpredictable. *It is possible to run a* number of weeks without spotting any, but then suddenly a few may appear. Heating to 180° F. 2 to 5 min. invariably eliminates all of these false positives *without materially affecting the pharmaceutical* antibiotics that might reside in that milk.

The existence of even one false positive among 100,000 producer samples does a grave injustice to some individuals if no heating or other confirmatory check is applied. This is because that zone must be taken as bona fide evidence of the presence of either penicillin or some other pharmaceutical antibiotic. Without heating and the use of penicillinase there is no scientific means to fully characterize the positive zone other than *penicillin*. The Federal laws indict all pharmaceutical antibiotics, and not simply penicillin, as milk adulterants, so that penicillinase alone is not sufficient.

Penicillinase in milk. The Food and Drug Administration is cognizant of the remote possibility that milk producers may be using the enzyme, penicillinase, to destroy penicillin residues in milk. The addition of penicillinase is an adulteration and contrary to law.

It is an extremely easy task to check milk samples for the enzyme, penicillinase, by simply reversing the procedure for detecting penicillin. To the milk in question a small amount of pure penicillin (0.1 I.U./ml) is added and then the disc assay test is applied. The presence of penicillinase is indicated by the absence of a clear zone.

Transfer of penicillin and its significance. The word *transfer of penicillin* in cows has added much confusion. Transfer means that penicillin infused in one quarter of an animal may travel, by udder tissue or blood, into adjoining untreated quarters. If large amounts transfer, a milk producer may unknowingly ship milk to market containing detectable amounts of penicillin.

Dairy scientists have reported since 1951 *that penicillin transfer does not occur readily*, but a number of field workers are under the impression that massive transfer of penicillin is a common occurrence with many cows. Because of the availability of more sensitive analytical methods, a certain justification exists for re-examining this subject.

Dr. Blobel of the University of Wisconsin, in a recent excellent study, reported that 14 of 17 cows inserted with 100,000 I.U. penicillin showed transfer (2). His method of analysis, however, was the ultrasensitive *Sarcina lutea* test and not the standard disc assay test. Even by this method, the amounts transferred were exceedingly small, 0.005-0.01 I.U., and were *detectable for only about* 24 hr.

At Cornell University, in a recently completed cooperative study between the College of Agriculture and the College of Veterinary Medicine (3), an investigation on 50 cows revealed only two cows transferring penicillin, and these were at very low levels (0.01 I.U.) lasting only two milkings. In both of these large-scale experiments, if the standard disc assay test with 0.05 I.U. sensitivity were used, no detection of penicillin would have been possible.

Most scientific evidence to date indicates that transfer of penicillin in terms of concentration and persistence is not a problem of serious *proportions with our present system of testing.*

A double standard of comparison. A more serious aspect of antibiotic contamination in milk has been overlooked, however. This aspect is readily apparent by anyone familiar with the significant phases of antibiotic control. It is illustrated by the fact that on the identical 17 cows studied by Blobel and with the ultrasensitive *Sarcina lutea* method, the penicillin in milk from the treated quarters persisted up to 120 hr. Each quarter was treated with 100,000 I.U. penicillin G, crystalline, water-in-oil. It is the penicillin preparation most widely used and considered by many to be the most effective against mastitis.

Why didn't it clear up in 72 hr.? The simple reason is that in applying a more sensitive analytical method to show up transfer, it was possible now to observe the traces of penicillin persisting in milk from the treated quarter for long periods. According to FDA regulations, evidence of such long-time retention would rule out the use of this *penicillin preparation*, because 96 hr. of retention is the least allowed any preparation. Most present effective penicillin preparations, particularly ointments, fall in this category if an ultra sensitive method is used at the individual cow level. Perhaps

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such long-lasting drugs can be placed under prescription rules.

Factors observed in the recent Cornell study (4), which contributed antibiotic residues to fluid milk, in order of importance were: (1) persistence of commercial drugs in treated quarters well after 72 hr.; (2) careless contamination of milk from untreated cows standing next to treated cows; (3) intramuscular injections, and (4) transfer. The latter two factors were relatively minor in importance. It was calculated that about 40 times more antibiotic found its way into milk for consumption through persistence in treated quarters than from transfer.

Extension recommendations for antibiotic residues and their meaning. Recommendation differences between extension departments of state universities are readily apparent (Table 2). Some extension services simply recommend that milk be withheld only for 72 hr. after treatment; others require that milk should be retained from the cow for eight days, or 16 milkings. Twenty-two extension services recommend rejecting milk from the entire cow while 11 others recommend holding out milk from the treated quarters.

It is interesting to point out that between states which recommended rejection from the treated quarter, and those recommending rejection of milk from the entire cow, the rate of incidence after 1 yr. was similar.

There are some who feel that all milk from a treated cow should be withheld for 72 hr. even if only one quarter has been treated. This is despite the fact that the milk from the untreated quarters may be normal in every respect and that by this practice a heavy loss of such normal milk will ensue. It is based on the laudable principle that no milk from a diseased cow should be included in the milk supply.

Unfortunately, from the point of view of objectivity, even among highly qualified veterinarians and other public health officials there is no unanimity of agreement as to the definition of a diseased cow. Most early recommendations for antibiotics were to withhold milk from the treated quarter only. The later trend to withhold milk from the entire cow resulted more from fears of possible transfer of penicillin through quarters than from consequences of using milk from diseased cows. Actually, with the present system of withholding milk from the entire cow, there is no guarantee that milks from diseased cows are not reaching the consumer. Treatment with antibiotics and withholding all milk for 72 hr. may satisfy the legal rulings, but if the antibiotics are ineffective, this milk still may be coming from diseased cows unless good checking is conducted by the producer or other qualified persons.

Professional groups, such as the American Veterinary Medical Society, are formulating their own recommendations. Differences have arisen because many believe present Federal recommendations are incomplete and are not based on the best information leading to antibiotic-free milk. Poorly defined and unethical recommendations between states can undermine the confidence of the cooperating producer in any antibiotic-control program, seriously affect him economically by unnecessarily heavy loss of milk, and all this while influencing the welfare of the consumer.

Incompatibility of zero tolerance. The Food and Drug Administration insists on the principle of zero tolerance for antibiotics in milk. No one, least of all this writer, questions the desirability of such a ruling if it is feasible to protect the consumer. But in practice it is becoming apparent that a strict adherence to zero tolerance is incompatible with the

TABLE 2

Recommendations for antibiotic residue control by state extension services in the United States
(As of October 5, 1960)

A. How long should milk be withheld after treatment with antibiotic intramammary infusion?

No general recommendation	For 72 hr.	For 96 hr.	For three days or six milkings	For six to eight days water-in-oil or oil
6	34	1	3	2

B. Milk should be held from entire treated cow or treated quarters only.

Recommendation not clear	All milk from treated cows	Milk from treated quarters only
1	24	12

C. How long after intramuscular injection of antibiotics should milk from the entire cow be withheld?

No recommendation	For 72 hr.	Three to five days	Five days	Six days	Seven days
22	7	2	8	1	3

D. Should milk be withheld after feeding cow feed containing antibiotics?

Yes, for 72 hr.	No specific recommendation	Antibiotic feeds should not be allowed
1	37	1

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Food and Drug and most university recommendations on the use of antibiotics for cattle disease. Methods of analysis now available, but not widely used, have become so sensitive as to make the 72-hr. limitation on most antibiotic preparations obsolete. Other more sensitive methods are bound to follow, making detection of traces much easier and longer than now possible. This is the ultimate course of zero tolerance. It has no ending.

Strict adherence to a policy of zero tolerance for antibiotics in milk can only lead to the ultimate abandonment of antibiotics as a therapy measure for cattle disease, because most antibiotic preparations, even today, can not satisfy the legal requirements. On the other hand, if interested workers and health officials would accept the limiting sensitivity of 0.05 I.U. penicillin per milliliter as the practical minimum level for enforcement and for extension recommendations, most of the problems would be solved. Inasmuch as the Food and Drug Administration personnel use tests in the field with this sensitivity, there is every reason to believe that they consider it as the practical cut-off point for action.

Public health aspects. The public health menace of minute traces of antibiotics in milk, in this writer's opinion, has never been studied on a truly scientific basis. The skimpy research reports on this subject concern themselves with only a few cases and generally lack proper controls. If the health problem is so acute, why in past years have no large, well-controlled experiments been conducted in hospitals under our numerous public health research grants? Why have health departments generally been reluctant to assign personnel and proper facilities for extensive checking of violators, or why have so few violators been legally penalized? And what has happened to milk with known detectable amounts of penicillin? Into what channels was it directed?

These questions are raised because, if a public health problem does exist, all the means at our disposal must be used to prevent even slightly contaminated milk from reaching the consumer. Present unconfirmed medical evidence states that the smallest traces still found in milk are 50 to 100 times greater than the sensitive human can tolerate, but if it can be scientifically proved that no public health problem exists at our present new low levels, then recognition must be made of this fact, because otherwise the broad plans to eradicate diseases in cattle are threatened, a result which too may affect public health. The future of antibiotic therapy for cattle diseases is dependent upon a wise interpretation of the consequences of minute traces of antibiotics in milk and subsequent realistic control recommendations.

SUMMARY

The great differences in recommendations between extension services about retention of milk from treated cows; the lack of good data on the effect of minute concentrations of antibiotic residues on public health, and the inconsistency of federal laws which insist on zero tolerance but which have not been able to eliminate all commercial drugs leading to infractions of zero tolerance principles are all there for us to ponder.

A solution to these problems, perhaps, lies in the bringing together of the divergent groups, followed by the formulation of uniform and realistic control proposals that are acceptable to the dairy industry and to regulatory groups.

REFERENCES

(1) American Public Health Association. Standard Methods for the Examination of Dairy Products. 11th ed. New York, N. Y. 1960.

(2) Blobel, H. Concentrations of Penicillin in Milk Secretion and Blood Serum of Cows. J.A.V.M.A., 137: 110. 1960.

(3) Fischer, M. G., Guthrie, R. S., Johnson, S. D., and Kosikowski, F. V. Unpublished data. Cornell University, Ithaca, N. Y. 1961.

(4) Food and Drug Administration. Tentative Methods for the Determination of Antibiotics in Milk. Mimeographed publication. Food and Drug Administration, Washington, D. C. Rev. August, 1958.

(5) Pynes, J. J., Elsie, M., Hobson, M., and Thomas, S. B. The Incidence of Penicillin in Milk Supplies. J. Soc. Dairy Technol., 30: 81. 1957.

(6) Watts, P. S., and McLean, D. H. The Estimation of Penicillin in Blood Serum and Milk of Bovines After Intramuscular Injections. J. Comp. Pathol., 50: 70. 1940.

(7) Wolin, A. J., and Kosikowski, F. V. Formation of Bacterial Inhibitory Zones in Whey Agar by Raw Milk. J. Dairy Sci., 41: 34. 1958.

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Previously Unreported Odorous Compounds in Sterile Concentrated Skimmilk

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Abstract

Odorous compounds in acidic and nonacidic fractions of a diethyl ether extract of sterile concentrated skimmilk were investigated by gas-liquid chromatography and mass spectrometry. Twelve compounds not previously observed in sterile milks are reported. Reactions other than those usually associated with changes in sterile milks during production and storage may form off-flavors in these products.

Introduction

Identification of compounds in the stale flavor which develops in sterile milk during storage has been the subject of numerous investigations. Evidence implicates products of the Maillard reaction and compounds of nonoxidative lipid origin in the off-flavor of this product (8). In several studies, compounds have been identified whose origins cannot be explained readily on the basis of accepted chemical pathways (1, 3, 9). This study was undertaken to identify further odorous compounds in sterile milks with the ultimate goal of better understanding reactions in these products during manufacture and storage.

Experimental Procedure

Sterile concentrated skimmilk, purchased at local retail outlets and having flavors typical of this product, was dried with a Virtis Freeze Drying Unit (Virtis Research Equipment, Gardiner, New York[1]). One hundred grams of the dried sterile skimmilk were added to 500 ml of diethyl ether (distilled over sodium hydroxide pellets) in a 2-liter round bottom flask. The mixture was stirred magnetically while 10 ml of distilled water were added dropwise. The mixture was stirred for 10 min, transferred to a Soxhlet extractor, and extracted for 4 hr.

Separation into acidic and nonacidic fractions. The diethyl ether extracts of four 100-g batches of freeze-dried sterile skimmilk were extracted with 100 and 50 ml of a 10% aqueous solution of sodium carbonate to remove acidic compounds. The pooled diethyl ether layers, containing the nonacidic components, were dried overnight with sodium sulfate and reduced in volume to approximately 10 ml in a flash evaporator (Buchler Instruments, Inc., New York, N.Y.) at 25 C. The nonacidic compounds were separated from the residual skimmilk lipids in the reduced ether extract with a variation of the method of Wong and Parks (15). The reduced ether extract was added in .5 ml portions to 5 g of Celite 545 in a mortar, and the ether was allowed to evaporate at room temperature. The residual lipid and flavor extract were mixed thoroughly with the Celite, packed into a 1.2 × 20 cm chromatographic column, and the nonacidic compounds eluted with redistilled acetonitrile. The first 10 drops (ca .4 ml) of acetonitrile eluting from the column contained a sufficient concentration of compounds for gas chromatographic analyses.

The sodium carbonate extracts were acidified to approximately pH 2 with concentrated HCl and extracted three times with a total of 250 ml diethyl ether. These ether extracts containing the acidic fractions from the four 100-g batches of powder were combined, dried with sodium sulfate, and evaporated to dryness in a flash evaporator at 25 C. Immediately after evaporation of the last traces of ether, the acidic fraction was dissolved in 25 ml of methylene chloride (dried with sodium sulfate) and evaporated under a stream of nitrogen to a volume (ca .3 ml) suitable for gas chromatographic and mass spectral analyses. When feasible, weakly acidic compounds were separated from the stronger acids on a Celite column containing 2 g analytical grade Celite impregnated with 1.6 ml of a saturated aqueous solution of potassium bicarbonate. A methylene chloride solution (5 ml) of the acid fraction was percolated through the Celite-bicarbonate column. The column was washed with an additional 5 ml of methylene chloride, and the total effluent containing the weak

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[1] Trade names are mentioned for identification, implying no endorsement.

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acids was evaporated to approximately .3 ml under a stream of nitrogen.

Acidic and nonacidic fractions extracted from 400 g of freeze-dried raw skimmilk in the manner described served as control samples.

Gas liquid chromatography (GLC) *and mass spectrometry* (MS). Gas chromatographic separation of the extracts was performed on the Perkin-Elmer Model 900 GLC and the LKB 9000 GLC-MS with 1.52 m × .32 cm and 3.04 m × .32 cm stainless steel columns, respectively, and helium as the carrier gas. Components of the nonacidic extract were separated on column packings containing 7.5% ethylene glycol adipate with 2% phosphoric acid on Anakrom ABS (Analabs, Inc., Hamden, Conn.) and 10% Apiezon L on Anakrom ABS. Separations of the acidic fraction used the former chromatographic material.

The Perkin-Elmer 900 is equipped with a flame ionization detector with the helium stream split 15 parts to the exit port and one part to the detector. The splitter assembly allowed for odor evaluation and, when required, collection of compounds eluting from the chromatographic column. The flash heater and splitter assembly were maintained at 230 C and the column was programmed at 2.5 C per min over a range of 90 to 190 C.

The LKB 9000 uses a Total Ion Current Monitor to detect the compounds (ionized at 20 ev) eluting from the GLC Column. Mass spectra were obtained on the eluting compounds at an electron energy of 70 ev and a constant accelerating voltage of 3.5 kv. The flash heater and molecular separator were maintained at 220 C and the column was programmed from 90 to 190 C at 2 C per min.

Results and Discussion

Preliminary studies determined those odorous compounds common to various samples of sterile skimmilk. This was accomplished by smelling the effluent of the gas chromatograph during analyses of the acid and nonacid fractions of extracts of four different commercial brands of the product. Based on these initial studies 20 areas corresponding to retention times of odorous compounds, common to all four samples, were selected for further analyses and identification. Table 1 lists compounds in the selected group which have been identified positively or tentatively and have not been reported previously in sterile milks.

The presence of 1-octen-3-one and 6-trans-nonenal in sterile concentrated skimmilks suggests that low lipid oxidation occurs in spite of the reducing conditions in these products (8). Insufficient sample was available for positive mass spectral identification of these two compounds, and they were identified tentatively on retention data and their highly characteristic odors. Although 1-octen-3-one and 6-trans-nonenal were not observed in extracts of freeze-dried raw skimmilk, their formation during freeze-drying and extraction procedures cannot be ruled out completely.

Identification of methional further supports the role of Strecker degradation in the off-flavors arising in heated dairy products. Strecker degradation products previously reported in heated milk systems include methylpropanal, isobutyraldehyde, phenylacetaldehyde, and benzaldehyde (8, 10). The latter compound

TABLE 1. Compounds identified in ethyl ether extract of sterile concentrated skimmilk.

Nonacid fraction	Retention times[a] Apiezon L	EGA-H_3PO_4	Mass spectra[a]	Odor[a]
1-Octen-3-one	+	+	...[b]	+
6-Trans-nonenal	+	+	...[b]	+
Methional	+	+	+	+
2-Phenylethanol	+	+	+	+
Cinnamaldehyde	?	+	...[b]	+
Ethyl cinnamate	+	+	+	+
Skatole	+	+	+	+
Acid fraction				
Salicylaldehyde		+	+	+
Methylcyclopentane-1,2-dione		+	+	+
Ethylcyclopentane-1,2-dione		+	+	+
Phenylacetic acid[c]		+	+	+
O-Cresol		+	+	+

[a] Agreement with authentic compounds.
[b] Insufficient sample available for analysis.
[c] Present in raw skimmilk.

apparently also can arise as a product of the caramelization of sugars (5).

Skatol and O-cresol have been reported in various manufactured dairy products (4, 12). Although the origin of these compounds in the products investigated is not known, skatole is present in fresh milk of animals consuming various cruciferous plants (6, 7). O-cresol, considered by Ferretti and Flanagan (4) to be a significant part of the stale flavor of dry skimmilk, has not been observed in fresh milk and apparently appears during heat treatment and/or storage. Phenolic compounds have been observed in products of sugar caramelization, but other precursors and mechanisms for their formation in sterile milk cannot be ruled out (5).

3-Methylcyclopentane-1,2-dione and 3-ethylcyclopentane-1,2-dione occur in sterile milks as a result of sugar caramelization reactions (5). It is questionable if these two compounds are of major significance in the off-flavors of sterile milk since they apparently have relatively high flavor thresholds (10, 14) and occur at low levels in sterile milks.

Positive identification of 2-phenylethanol, phenylacetic acid, salicylaldehyde, ethyl cinnamate, and the tentative identification of cinnamaldehyde is the interesting aspect of this study. Following identification in those areas of the chromatogram selected, further studies revealed that cinnamic and benzoic acids also were present in the sterile skimmilks. However, these two acids, in addition to phenylacetic acid, were normal constituents of raw skimmilk. Presence of salicylic acid in sterile or fresh milks was not established. However, based on its presence as a glycine conjugate in fresh milk (2), it is reasonable to assume that the free acid also may be present.

Identification of aromatic acids, aldehydes, alcohol, and ester reported in this study, in addition to identification of benzaldehyde (1, 11, 13), benzyl alcohol (11), and phenylacetaldehyde (13) reported in previous studies, suggests that reactions other than those previously proposed (8) for formation of flavor compounds may be operative in heated milk systems.

References

(1) Arnold, R. G., L. M. Libbey, and E. A. Day. 1966. Identification of components in the stale flavor fraction of sterilized concentrated milk. J. Food Sci., 31:566.

(2) Booth, A. N., D. J. Robbins, and W. L. Dunkley. 1962. Occurrence of salicyluric acid in milk. Nature, 194:290.

(3) Cobb, W. Y., S. Patton, and H. Crill. 1963. Occurrence of vanillin in heated milks. J. Dairy Sci., 46:560.

(4) Ferretti, A., and W. P. Flanagan. 1972. Steam volatiles of stale nonfat dry milk. The role of the Maillard browning in staling. J. Agr. Food Chem., 20:095.

(5) Hodge, J. E. 1967. Pages 465-491 *in* Symposium on foods, chemistry and physiology of flavors. Edited by H. W. Schultz, E. A. Day, and L. M. Libbey. Avi Publishing Co., Westport, Conn.

(6) Park, R. J. 1969. Weed taints in dairy produce. I. Lepidium taint. J. Dairy Res., 36: 31.

(7) Park, R. J., and J. D. Armitt. 1968. Weed taints in dairy produce. II. Coronopus or land cress taint in milk. J. Dairy Res., 36: 37.

(8) Parks, O. W. 1967. Pages 290-314 *in* Symposium on foods, chemistry and physiology of flavors. Edited by H. W. Schultz, E. A. Day, and L. M. Libbey. Avi Publishing Co., Westport, Conn.

(9) Parks, O. W., D. P. Schwartz, and M. Keeney. 1964. Identification of O-aminoacetophenone as a flavor compound in stale dry milk. Nature, 202:185.

(10) Pittet, A. O., P. Rittershacher, and R. Muralidhara. 1970. Flavor properties of compounds related to maltol and isomaltol. J. Agr. Food Chem., 18:929.

(11) Ramshaw, E. H., and E. A. Dunstone. 1969. Volatile compounds associated with the off-flavor in stored casein. J. Dairy Res., 36: 215.

(12) Ramshaw, E. H., and J. Leary. 1971. Volatile components in casein after exposure to UV light. 18th Intern. Dairy Congr. 1E(sec. A.21):64. Sidney, Australia.

(13) Scanlan, R. A., R. C. Lindsay, L. M. Libbey, and E. A. Day. 1968. Heat-induced volatile compounds in milk. J. Dairy Sci., 51:1001.

(14) Shaw, P. E., J. H. Tatum, T. J. Kew, C. J. Wagner, Jr., and R. E. Berry. 1970. Taste evaluation of non-enzymic browning compounds from orange powder and use of inhibitors. J. Agr. Food Chem., 18:313.

(15) Wong, N. P., and O. W. Parks. 1968. Simple technique for extracting flavor compounds from fatty foods. J. Dairy Sci., 51:1768.

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Factors Influencing the Production of Staphylococcal Enterotoxin A in Milk[1,2,3]

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Abstract

The influences of the initial bacterial count and heat treatment of raw whole milk and the initial pH of sterile reconstituted nonfat dry milk on growth and enterotoxin A production by *Staphylococcus aureus* were evaluated. In milk relatively free from competing microorganisms, an *S. aureus* population of 2 to 3 million per milliliter was associated with detectable enterotoxin A. It was detected after 4 to 6 hours in low-count raw milk or sterile reconstituted nonfat dry milk inoculated initially with 10^2 to 10^5 *S. aureus* per milliliter. Though *S. aureus* reached 2 to 3 million per milliliter in commercial raw milks, no enterotoxin A was detected. Growth inhibition of *S. aureus* in raw milks may or may not always result in simultaneous inhibition of enterotoxin A production. Good growth and detectable enterotoxin A resulted in heat treated raw milk (pasteurized or heated at 65.6 C for 16 sec). Enterotoxin A was produced in sterile reconstituted nonfat dry milk at initial pH's of 4.5 to 6.5 (adjusted with HCl). At pH 4.5 lactic acid was bactericidal to *S. aureus*.

Introduction

Though cheese and dry milk were implicated in outbreaks of staphylococcal food poisoning (2, 3, 20), fluid milk is only very rarely implicated in such outbreaks (10, 18). Due to lack of a reliable and practical in vitro test for detection of staphylococcal enterotoxins, much of the early research was directed toward factors that influence growth of staphylococci, including enterotoxigenic *Staphylococcus aureus*. Recent development of serological procedures for detecting staphylococcal enterotoxins is contributing to knowledge on factors which influence enterotoxin production in food products.

Depending upon production and sanitation practices on farms as well as the storage temperature, the bacterial plate count (SPC) of raw milk may vary from few thousands up to 1×10^6 per milliliter or more for Grade A raw milk to 3 million per milliliter for manufacturing grade raw milk. *S. aureus* contamination of raw milks may vary; Grade A milk may contain few *S. aureus* cells, 10 to 3.5^{00} per milliliter (9), whereas, manufacturing grade raw milks may contain over 1×10^4 per milliliter. Poor growth of *S. aureus* in mixed populations (7, 14, 17), the lack of growth at common storage temperatures of raw or pasteurized milks, and the low incidence of enterotoxigenic *S. aureus* in the dairy environment (6, 11) may have contributed to the rare involvement of fluid milk in staphylococcal food poisoning. While there may be no growth of *S. aureus* in milk stored at below 4 C, during processing of milk products at higher temperatures, there is ample opportunity for growth of this organism. Heat treatment of milk is very common in processing dairy products. Heating may vary from 63.6 C for 15 seconds to 121 C for 15 minutes, depending upon the intent of heating. Also, pH may be important and may vary from about pH 6.6 in fluid milk to below pH 5.0 in cultured dairy products. There is very little information available on the effects of natural environmental factors on enterotoxin A production by *S. aureus* in milk.

In the only report of enterotoxin A production in milk, Donnelly et al. (12) observed poor growth

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2 Taken from data submitted to the Graduate School faculty at the University of Minnesota by the senior author in partial fulfillment of the requirements for the Ph.D. degree.

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...th of *S. aureus* in raw milks of greater ... 10⁶ SPC per milliliter as compared to ... per milliliter. Further, they observed good ...th of *S. aureus* and enterotoxin A produc... in lower SPC raw milks as well as in ...r-count raw milks after pasteurization. ...al *S. aureus* populations of about 50 ... per milliliter and a minimal incubation ... hours at 35 C were required to result ...otoxin A in milk.

...e purpose of this investigation was to ... additional information relative to effects ...itial bacterial count and heat treatment of ... milk and the initial pH of sterile recon...ted nonfat dry milk on growth and entero... A production by two strains of *S. aureus*.

...perimental Procedures

...wo enterotoxin A producing strains of *S.* ... designated 196E and F265 (phage pat... 6/47/53/54/77/83A/84+ and 53/54/75/ ...84+) were the test organisms which dif...d in their sensitivities to heat and penicillin. ...ne F265 was more sensitive to heat than ...E, being inactivated in eight minutes as ...ared to 38 minutes for 196E in whole milk ...C. Culture F265 was also more sensitive ...penicillin than 196E, being inhibited by 0.5 ... as compared to over 50 units for 196E. ...e cultures were routinely propagated and ...ained in sterile reconstituted nonfat dry ... (10% solids w/v) with transfers at three-...h intervals using 1% inoculum into 100 ml of sterile *reconstituted* nonfat dry milk in ...w cap dilution bottles for transfer. After ...o 18 hours incubation at 32 or 37 C, these ...tures were stored at 4 C. At least two con...utive transfers were made prior to inoculating ...cultures into test milks. The amount of ...culum to obtain the *desired initial S. aureus* ...nt in the test milks varied from 0.1% to ...% (v/v).

...urce and handling of test milk. With the ...ception of commercial raw milk, raw whole ... was obtained from individual cows at the ...versity dairy herd. Low-count raw milks ...re obtained from individual cows by either ...nd or machine milking after carefully san...ing the udder and discarding the first few ...ams of milk. Raw milks of high initial SPC ...re obtained by incubating the low-count raw ... at 32 or 37 C for three to eight hours. ...e another portion of the low-count raw milk ...s refrigerated. At the end of incubation the ...-count raw milk was stored along with the ...-count raw milk at 4 C until used.

The low temperature long-time method of ...derization of milk (LTLT, 62.8 C for 30 min) was done in a water bath while the high-temperature short-time (HTST) method was done with a Cherry-Burrell pasteurization unit. Steaming of milk was performed in a steam chest with free flowing steam.

In experiments involving the effect of the initial pH of sterile nonfat dry milk, the pH was adjusted after sterilization (just before use) with sterile N HCl, 10% lactic acid, or N NaOH. The pH of milk was measured with a Corning, Model 12, or Beckman, Model H-2, *pH meter*.

From 400 to 750 ml of the test milks were placed in sterile, 1-liter, cotton-plugged Erlenmeyer flasks containing about 150 glass beads (4 mm diameter) to help break up bacterial clumps during the enumerating procedures and were tempered to 32 or 37 C before inoculating with the *S. aureus* culture.

Plating procedures. Counts of *S. aureus* were obtained by surface plating, in duplicate, 0.1 ml of the appropriate dilutions of sample onto prepoured and dried plates of Staphylococcus Medium 110 (S110). After spreading the inoculum, the plates were incubated at 37 C for 48 hours and an additional 24 hours at room temperature to promote pigmentation of *S. aureus* colonies. The two test strains of *S. aureus* (196E and F265) produced deep orange yellow colonies on the S110 medium. The standard plate counts were done according to Standard Methods (1) using pour plates and plate count agar (Difco). Samples of milk taken at these plating intervals were cooled immediately in an ice water bath and then stored at −20 C until tested for enterotoxin A.

Procedures for detecting enterotoxin A. The extraction procedure of Casman and Bennett described by Zehren and Zehren (20) was used to separate enterotoxin A from 100-ml volumes of milk. The microslide immunodiffusion technique of Casman and Bennett (5) was used for assaying enterotoxin A. The quantitative recovery by this extraction procedure for separating enterotoxin A and the assay by the microslide technique was estimated to be about 50%. The sensitivity of extraction and assay for the smallest amount of enterotoxin in 100 ml milk which gave a positive enterotoxin test was 0.25 μg.

Results

To determine the minimal *S. aureus* population and minimal time required to result in detectable enterotoxin A, sterile reconstituted nonfat dry milk was inoculated with a 15- to 18-hour culture of *S. aureus* F265 at different initial populations of 10^1, 10^2, 10^3 per milliliter

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and incubated at 32 C for 24 hours. The results are in Figure 1. A plus sign (+) indicates detectable enterotoxin and a negative sign (−) indicates none. The absence of a sign at any plotted point indicates no enterotoxin test was performed. Enterotoxin A was detected after 4 hours with the high initial inoculum of 10^5 per milliliter. With lower initial inocula of 10^4 or 10^3 per milliliter, enterotoxin A was detected after eight hours. Enterotoxin A was detected with at least about 3 million *S. aureus* per milliliter regradless of time (4 or 8 hours) to reach that population or of the initial inoculum of 10^2 to 10^5 per milliliter. The earlier appearance of enterotoxin with a greater initial inoculum as compared to lesser inocula may have been due to the highest numbers of *S. aureus* in the shortest time or the carry-over of more enterotoxin from the source inoculum or of both. Results similar to *S. aureus* F265 for minimal population and incubation required to result in detectable enterotoxin A were also observed with *S. aureus* 196E. With initial inocula of 10^3 to 10^8 per milliliter, at 37 C enterotoxin A was detected after six hours of incubation at a minimal *S. aureus* 196E population of about 3 million per milliliter.

Minimal *S. aureus* F265 populations associated with detectable enterotoxin A in reconstituted nonfat dry milk per milliliter was about 3 million on S110 medium, about 4.5 million on plate count agar, and about 6.5 million cells by the direct microscopic procedure.

To determine minimal incubation time and minimal population of *S. aureus* associated with detectable enterotoxin A in raw whole milk, both strains were inoculated separately at two

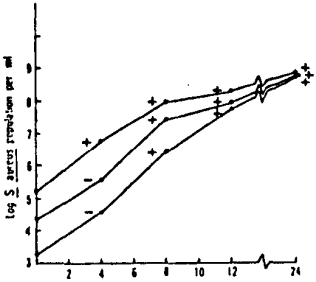


FIG. 1. Growth and enterotoxin production by *S. aureus* (F265) in sterile reconstituted nonfat *dry milk at 32 C.*

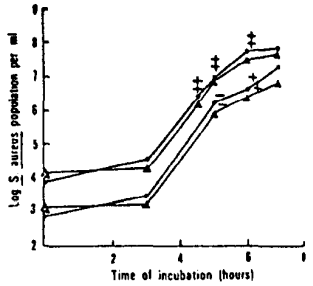


FIG. 2. Growth and enterotoxin production by *S. aureus* in aseptically drawn raw whole milk (80 per ml. SPC) at 37 C. ●—● 196E; ▲—▲ F265.

initial populations (10^2 and 10^4 per milliliter into raw whole milk of 80 SPC per milliliter from two individual cows. Growth curves and times at which enterotoxin was detected are in Figure 2. Beginning with high initial counts of both *S. aureus* strains, enterotoxin A was detected after 4.5 hours and after six hours with low initial inocula. These results were similar to those for sterile reconstituted nonfat dry milk in which minimal populations associated with enterotoxin A were about 2 million with strain F265 and 3 million per milliliter with strain 196E as enumerated on S110 medium. Thus there was no measurable difference in enterotoxin A production in sterile reconstituted nonfat dry milk or in low-count raw whole milk.

Heat treatment of raw milk is widely used in processing dairy products. Pasteurization of raw milk at 62.8 C for 30 minutes or 71.7 C for 15 seconds is mandatory for public health reasons; whereas, steaming or sterilization is used to further extend the keeping quality or to provide other characteristics in the product. Also, high heat treatment may be used to improve the physical and flavor characteristics of certain dairy products. Depending upon the extent of heating, there can be varying degrees of heat-induced changes such as reduction in viable bacteria, inactivation of enzymes, denaturation of proteins, destruction of some essential amino acids, etc. The degree of heat induced changes increased in the following order: heating at 65.6 C for 0 to 16 seconds, pasteurization at 62.8 C for 30 minutes or 71.7 C for 15 seconds, steaming, and sterilization at 121 C for 15 minutes. It is not known

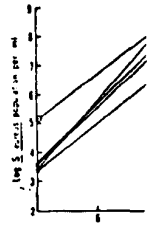


FIG. 3. Effect of h
milk on growth and
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(2,500/ml SPC); ○
SPC); △—△ Milk
minutes; ●—● Milk
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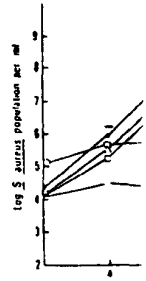


FIG. 4. Growth o
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steamed for 30 min

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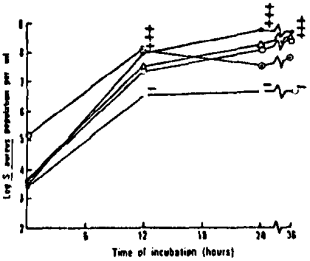


FIG. 3. Effect of heat treatment of raw whole milk on growth and enterotoxin production by *S. aureus* (F265) at 32 C. ⊙—⊙ Raw milk (2,500/ml SPC); ○—○ Raw milk (2,000/ml SPC); △—△ Milk heated at 62.8 C for 30 minutes; ●—● Milk steamed for 60 minutes; □—□ Milk autoclaved (121 C for 15 minutes).

how certain of these heat treatments influence enterotoxin A production in milk.

The effect of heating milk on growth and enterotoxin A production was determined in low-count raw whole milk from two individual cows. *S. aureus* F265 was inoculated into raw and its heated milks (all from the same batch of raw milk of 2,000 SPC per milliliter), and these were incubated at 32 C. The results are in Figure 3. *S. aureus* grew much better in the heated milks, reaching a maximum of over 10^8 per milliliter but only 7×10^6 in the raw milk. There were no measurable differences of practical significance in growth of *S. aureus* among the heated milks. Enterotoxin A was detected in all heated milks after 12 hours. No enterotoxin could be detected even after 36 hours in raw milk even from an *S. aureus* population of 7 million per milliliter earlier associated with enterotoxin A (Fig. 2). It is possible that the enterotoxin may have been destroyed or more likely its synthesis was inhibited by competing microorganisms in the raw milk. Enterotoxin A was detected in another batch of raw milk of 2,500 SPC per milliliter in which *S. aureus* reached a much higher population of 1×10^8 per milliliter than that cited above.

The most common heat treatment of raw whole milk for cheese making is pasteurization at 62.8 C for 30 minutes or 72 C for 15 seconds, the latter being most commonly employed. Reiter et al. (17) reported a heat labile inhibitor in raw milk that was not inactivated by pasteurization at 71.7 C for 17 seconds but was inactivated by flowing steam. Consequently, it would be desirable to assess the influence of pasteurization of raw milk at 62.8 C for 30 minutes (LTLT) or 72 C for 16 seconds (HTST), or of steaming for 30 minutes on growth and enterotoxin A production by *S. aureus*. Commercially produced raw whole milk was employed. Two different initial inocula of 10^4 and 10^5 *S. aureus* per milliliter were used in the raw milk and only one initial level of 10^4 per milliliter for pasteurized and steamed milks. The results are in Figure 4. *S. aureus* grew well in pasteurized or steamed milks, but there was no growth in raw milk. It reached a maximum of over 10^8 per milliliter in the pasteurized milks regardless of method, LTLT or HTST. *S. aureus* grew better early in the steamed milk as compared to HTST pasteurized milk. This may have been due to difference in initial SPC of these milks prior to inoculating *S. aureus*: <30 per milliliter in the steamed milk versus 1,000 in the pasteurized milk. Enterotoxin A was detected in pasteurized and steamed milks after eight hours, but none was detected in raw milk even after 24 hours.

A 2-fold increase in *S. aureus* in raw and a 55-fold increase in steamed milk after four hours were similar to results of Reiter et al. (17) who reported a 2-fold increase of this organism in raw milk and a 70-fold increase in steamed milk after five hours. Contrary to their results, we obtained a 12-fold increase of *S. aureus* in HTST pasteurized milk as compared to the 1.5-fold increase observed by them.

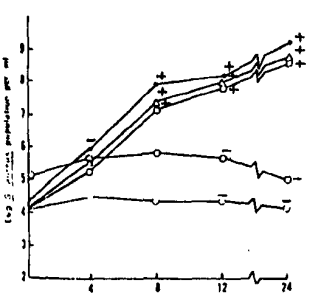


FIG. 4. Growth and enterotoxin production by *S. aureus* (F265) in raw and heated commercial [illegible] milk at 32 C. ○ ○ Raw milk (6.5 million/ml SPC); △—△ Milk heated at 62.8 C for 30 minutes (1,300/ml SPC); □ □ Milk heated 72 C for 16 seconds (1,000/ml SPC); ●—● Milk steamed for 30 minutes (<30/ml SPC).

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Though *S. aureus* increased somewhat faster in steamed milk in the first four hours, the eventual extent of its growth was comparable in HTST pasteurized and steamed milks. Lack of growth reported by Reiter et al. (17) in HTST pasteurized milk may have been due to a short incubation of five hours and to possible presence of numerous thermoduries in the raw milk as well as the strain of *S. aureus*.

Heat treatment much lower than pasteurization is commonly employed for Cheddar and Colby cheese manufacture because 65.6 C for 0 to 16 seconds substantially reduces or completely eliminates *S. aureus* in the raw milk and does not prolong ripening of cheese such as with pasteurized milk. Thus, it would be of interest to determine what effect this type of heat treatment may have on growth and enterotoxin production by *S. aureus* in commercially produced milk. *S. aureus* 196E was inoculated at 10^4 and 10^5 per milliliter in raw milk and at 10^4 in the heated milks and incubated at 37 C. Results of growth and enterotoxin production are in Figure 5. It grew better in heated milks than in raw milk even with the higher initial inoculum of 10^5 per milliliter. Enterotoxin A was detected in both heated milks after six hours. Though *S. aureus* reached about 8.5 million per milliliter, no enterotoxin A was detected in the raw milk even after 24 hours. Because enterotoxin A was detected in raw milk of low SPC (Fig. 2) and not in raw milk of higher SPC at about the same *S. aureus* population, this suggests that competing microorganisms in raw milk in some way inhibited enterotoxin production.

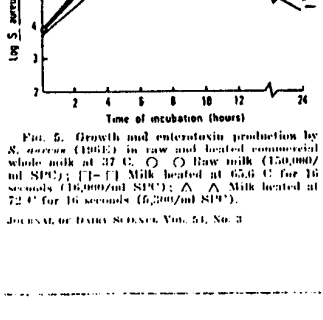


FIG. 5. Growth and enterotoxin production by *S. aureus* (196E) in raw and heated commercial whole milk at 37 C. ○ ○ Raw milk (150,000/ml SPC); □—□ Milk heated at 65.6 C for 16 seconds (18,000/ml SPC); △ △ Milk heated at 72.4 C for 16 seconds (6,300/ml SPC).

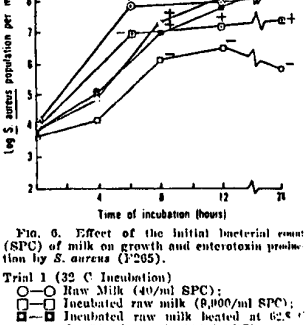


FIG. 6. Effect of the initial bacterial count (SPC) of milk on growth and enterotoxin production by *S. aureus* (F265).

Trial 1 (32 C Incubation)
○—○ Raw Milk (40/ml SPC);
□—□ Incubated raw milk (9,000/ml SPC);
■—■ Incubated raw milk heated at 62.8 C for 30 minutes (<30/ml SPC).

Trial 2 (37 C Incubation)
⊙—⊙ Raw Milk (950/ml SPC);
⊡—⊡ Incubated raw milk (9 million/ml SPC).

The effect of the initial SPC of milk on growth and enterotoxin A production was determined by inoculating *S. aureus* F265 into the following milks which were obtained from the same batch of raw milk: (a) low count raw, (b) high-count raw obtained by incubating (a), and (c) heated milk of low count obtained by heating (b). Figure 6 shows the results of two separate experiments, one in which the milks were incubated at 32 C and the other at 37 C.

S. aureus grew much better in raw milk with 40 SPC per milliliter than in raw milk of 9,000, reaching over 10^8 and 3.5×10^8 *S. aureus* per milliliter, respectively. It also grew better and reached over 10^8 per milliliter in heated milk of <30 SPC per milliliter. Enterotoxin A was detected in the low-count raw and heated milks after eight hours; whereas none could be detected in the higher count raw milk even after 24 hours.

Though *S. aureus* showed growth response in low and high-count raw milks similar to Trial 1, the magnitude of difference in maximum population attained in these milks was greater in Trial 1. In low-count raw milk of both trials, *S. aureus* reached about the same maximum population. Despite the higher initial SPC of high-count raw milk of Trial 2, *S. aureus* grew better in this milk than in high-count raw milk of Trial 1. This may

have been due t
tion temperature
of competing

TABLE 1. Summa
milk and heate

Type of milk	
Raw	
Raw	
Raw	
Raw	
Raw	
Raw	
Raw	
Raw[b]	
Raw[c]	
Raw	
Sterile nonfat d	
Sterile nonfat d	
Raw[b]	
Heated at 65.6 C for 16 sec[b]	
HTST pasteuri (heated at 72 for 16 sec)	
LTLT pasteuri (heated at 62 for 30 min)	
Steamed milk (100 C for 1	
(100 C for 3	
Sterilized (121 C for 1	

[a] Maximum toxin test.
[b] and [c] were (—) Entero (+) Entero

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have been due to the difference in the incubation temperature employed or possibly the type of competing microorganism(s) involved or of both. Enterotoxin A was detected after 12 hours in the higher count raw milk of 9 million SPC per milliliter in which the *S. aureus*

TABLE 1. Summary of results of enterotoxin A production by *S. aureus* in raw or heated whole milk and heated reconstituted nonfat dry milk.

Type of milk	Initial SPC	Initial *S. aureus* inoculum	*S. aureus*	Maximum[a] or minimum *S. aureus* count	Enterotoxin A
	(per ml)	(per ml)		(per ml) (millions)	
Raw	40	10^4	(F265)	22	+
Raw	80	10^3		2	+
Raw	80	10^3	(196E)	3	+
Raw	950	10^4	(F265)	62	+
Raw	2,000	10^4		7	−
Raw	2,500	10^5		110	+
Raw	9,000	10^4		3.5	−
Raw[b]	150,000	10^5		3.3	−
Raw[c]	6,500,000	10^5		0.6	−
Raw	9,000,000	10^4		13	+
Sterile nonfat dry milk	0	10^3		2.8	+
Sterile nonfat dry milk	0	10^3	(196E)	3	+
Raw[b]	150,000	10^5		3.6	−
Heated at 65.6 C for 16 sec[b]	16,000	10^4	(F265)	16	+
	16,000	10^4	(196E)	7.5	−
	16,000	10^4		12	+
HTST pasteurized[b] (heated at 72 C for 16 sec)	5,300	10^4		38	+
[b]	6,300	10^4	(F265)	75	+
[c]	1,000	10^5		1.9	−
[c]	1,000	10^5		71	+
[c]	1,000	10^4		17	+
LTLT pasteurized (heated at 62.8 C for 30 min)	<30	10^4	(F265)	3.3	+
	<30	10^4		12	+
	<30	10^4		90	+
[c]	1,300	10^5		6	−
[c]	1,300	10^5		92	+
Steamed milk (100 C for 60 min)	<30	10^3		100	+
	<30	10^5		400	+
(100 C for 30 min)[c]	<30	10^4		1	−
[c]	<30	10^4		100	+
Sterilized (121 C for 15 min)	0	10^3		39	+
	0	10^5		620	+

[a] Maximum count with a negative enterotoxin test and minimum count with a positive enterotoxin test.

[b] and [c] were two different batches of commercially produced raw milk.

(−) Enterotoxin A not detected.

(+) Enterotoxin A detected.

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reached 13 million per milliliter. The uninoculated raw milk of 9 million SPC (control) which showed a maximum indigenous *S. aureus* count of about 6 million did not show enterotoxin after 24 hours.

To see if any trend was evident, the results of enterotoxin A production in raw and heated milks as well as in heated reconstituted nonfat dry milk were summarized in Table 1. Enterotoxin A was detected in all the heated milks (pasteurized, steamed, or autoclaved) in which *S. aureus* grew well. Among the heated milks, a minimal population of about 3 million per milliliter was associated with enterotoxin A. Enterotoxin A was also detected at about 2 to 3 million *S. aureus* per milliliter in low-count raw milk of 80 SPC per milliliter where *S. aureus* grew free from the influence of competing organisms such as in some heated milks. But enterotoxin was not detected at 3 million *S. aureus* in some raw milks of 2 to 10 or 150 thousand SPC per milliliter. Enterotoxin A could be detected even in a very high count raw milk of 9 million SPC per milliliter but only at a higher *S. aureus* population of about 13 million. These results suggest that the competing microorganisms in some way inhibit enterotoxin A production.

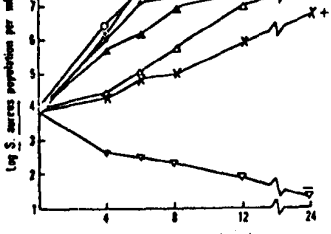


FIG. 7. Effect of the initial pH of sterile reconstituted nonfat dry milk on growth and enterotoxin production by *S. aureus* (196E) at 37 C.

Initial	Final	
○—○	6.4	5.5
◎—◎	6.0	5.5
●—●	5.5	5.5
△—△	5.0	5.2
▲—▲	5.0	5.1 (HCl)
▽—▽	4.5	4.6
×—×	4.5	4.7 (HCl)

The pH is another factor that influences the growth of microorganisms; staphylococci grow within the pH range of 4 to 10. An initial pH of 6 or 6.5 was optimum for enterotoxin A production (15). Since the pH of cultured dairy products may vary from 4.5 to 6.5 and is in the growth range, the influence of the initial pH on growth and enterotoxin A production in sterile reconstituted nonfat dry milk was determined.

Since principally lactic acid is produced by the starter bacteria in cultured dairy products, it was used to adjust the pH of sterile reconstituted nonfat dry milk. In certain products manufactured by direct acidification, HCl may be used. Consequently, HCl was also used to adjust the pH at 4.5 and 5.0. As shown in Figure 7, *S. aureus* 196E grew well in milks of pH 5.0 or higher exceeding 10^7 per milliliter after 24 hours. Even at pH 4.5 adjusted with HCl, there was delayed but distinct growth of *S. aureus* to about 4.5 million per milliliter after 24 hours. In contrast, at pH 4.5 obtained with lactic acid, *S. aureus* did not grow; in fact, there was destruction. *S. aureus* decreased from about 10^4 per milliliter to about 10 after 24 hours. Even at pH 5.0, the rate of growth of *S. aureus* was slower in milk adjusted with lactic acid than with HCl during the early growth period. There were tenfold differences in *S. aureus* populations after 4, 6, and 8 hours between the two acids used, higher populations with HCl. With the exception of milk of pH 4.5 adjusted with lactic acid, enterotoxin A was detected in all milks of pH 4.5 to 6.5 after 24 hours. The reason for no enterotoxin in milk of pH 4.5 (lactic acid) is obviously the lack of growth of *S. aureus*. Similar results also were observed with *S. aureus* F265.

Discussion

Staphylococci, including enterotoxigenic *S. aureus*, grow poorly in mixed populations in raw milks of higher bacterial count. This has been variously attributed (12,14) to the high numbers of competing organisms present and by others (17) to some natural inhibitors present in raw milk.

Our data provide somewhat more direct evidence for the growth inhibition of *S. aureus* by the more competing organisms present in the higher count raw milks. In Figure 6 growth inhibition of *S. aureus* was observed in raw milk of higher bacterial count as compared to the same batch of raw milk but of lower bacterial count. Also, when high-count raw milk was heated prior to inoculation, growth of *S. aureus* occurred to the same extent as

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in the lower count raw milk. Since these three milks (high and low-count raw and the heated) were from the same lot, they would be expected to contain the same inhibitor, if any; and therefore, growth of *S. aureus* would be expected to occur similarly in all three milks according to the report of Reiter et al. (17). Reduction in bacterial count and simultaneous removal of growth inhibition of *S. aureus* in higher count raw milk by pasteurization plus similar growth patterns of this organism in low-count raw and pasteurized milk from the same lot, indicate that its growth inhibition in higher count raw milk, in all probability, was due to the higher numbers of competing organisms. The maximum population of *S. aureus* attained in raw milk was dependent on the level of initial contamination (Fig. 3, 4, 5); higher numbers with higher initial inocula.

Commercially produced raw herd milks provided more growth inhibition of *S. aureus*, as shown in Figures 4 and 5, than the raw milks obtained from individual cows. Also, there was practically no growth in one commercial raw milk of 0.5 million SPC (Fig. 4); whereas in another raw milk of 9 million SPC per milliliter (Fig. 6), there was growth to the extent of 40 million per milliliter. This may be due to possible differences in the microflora of these raw milks. Milks obtained from individual cows under the good sanitary milking conditions employed here would contain only species of few genera such as *Micrococcus, Streptococcus*, and few diphtheroids (13) and these in small numbers. On the other hand, commercial raw milk, in addition, should contain species of genera such as *Bacillus, Escherichia, Achromobacter, Pseudomonas, etc.* (13). Consequently, commercial milk would be expected to show a greater degree of inhibition of *S. aureus* than milk obtained from individual cows under sanitary conditions. McCoy and Faber (10) observed variable effects of food microorganisms on growth and enterotoxin A production by *S. aureus* in meat.

The results of growth of *S. aureus* in HTST pasteurized commercial herd milks (Fig. 4 and 5) were contradictory to those of Reiter et al. (17) who reported an inhibitor in raw milk which was not inactivated by pasteurization. Our results as well as those of others (12) not only showed that pasteurization of raw milk resulted in removal of its inhibitory property, but our data further showed that a less severe heat treatment than pasteurization resulted in greater growth of *S. aureus*, indicating the removal of the inhibitory property of raw milk by the low heat treatment. Reiter et al. (17) did not consider the competing organisms as a potential inhibitory factor because no mention was made of the bacterial counts of their milks. It is quite possible that the raw milk employed by them contained a high population of thermoduric microflora which could have accounted for the similar growth patterns of *S. aureus* in raw and pasteurized milks.

As for enterotoxin A production in milk, the data (Table 1) showed that in milk relatively free of competing organisms, such as in sterile reconstituted nonfat dry milk or low-count raw milk, growth of *S. aureus* to only 2 to 3 million per milliliter resulted in detectable enterotoxin A. However, that population, when attained in the presence of high numbers of competing organisms, was not accompanied by enterotoxin A. It was detected in high-count raw milk only at a population of 13 million *S. aureus* per milliliter. Apparently, the competing organisms in some way alter the rate and extent of enterotoxin A production by *S. aureus*. No attempt was made to elucidate the mechanism of inhibition of enterotoxin A production by the competing organisms. Therefore, it can only be speculated as to why enterotoxin A was detected in some raw milks and not others in all of which the *S. aureus* reached at least 3 million per milliliter.

Thatcher et al. (19) reported enterotoxin production by two strains of *S. aureus* in sliced Canadian back bacon (at 37 C) in atmospheric air, 5% CO_2 to O_2 mixture, or nitrogen at atmospheric pressure, but in only small amounts under anaerobic conditions. Similarly, Chesbro and Auborn (8) observed enterotoxin A production to be substantially reduced under anaerobic conditions. Kato et al. (15) also observed better enterotoxin A production through an increased rate of shaking of the growth medium. Thus, it seems that a reduction in the oxidation-reduction (O-R) potential of the growth medium might result in reduced enterotoxin A production. The competing microorganisms present in milk change the O-R potential by their growth. Since microorganisms differ in their ability to alter this potential (some reduce the potential more than others), the number as well as the type of organisms present can conceivably influence the extent of this change.

Our data as well as those of Donnelly et al. (12) indicate that the minimal *S. aureus* population required to result in the presence of enterotoxin A in raw milk may be influenced by high numbers of competing microorganisms. The lower minimal *S. aureus* populations and the shorter incubation times required for the

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presence of enterotoxin A observed in this study as compared to those reported by Donnelly et al. (12) could be attributed to the better recovery and sensitivity of the enterotoxin A detection method used in our study (0.1 versus 0.0025 μg for our method) and possibly to the difference in the strains of *S. aureus* employed.

Ease of enterotoxin production in heated milks emphasize the danger of post-heat treatment contamination and subsequent exposure to growth temperatures adequate for *S. aureus*.

Though *S. aureus* growth was reduced as the pH of the reconstituted sterile nonfat dry milk was decreased below 5.0, enterotoxin A could still be produced at pH 4.5 despite the relatively poor growth of *S. aureus* to a maximum of only about 5 million per milliliter. Also at pH 4.5 lactic acid was bactericidal to *S. aureus*. Bactericidal and bacteriostatic effects of weakly dissociating organic acids and some volatile fatty acids are well known.

References

(1) American Public Health Association. 1966. *Standard* Methods for the Examination of Dairy Products, 12th ed. 1790 Broadway, New York City.

(2) Anderson, F. H. R., and D. M. Stone. 1955. Staphylococcal food poisoning associated with spray-dried milk. J. Hygiene, 53: 387.

(3) Armijo, R., D. A. Henderson, R. Timothee, and H. B. Robinson. 1957. Food poisoning outbreaks associated with spray-dried milk—an epidemiologic study. Amer. J. Public Health, 47: 1003.

(4) Barber, M. A. 1914. Milk poisoning due to a type of *Staphylococcus albus* occurring in the udder of a healthy cow. Philippine J. Sci., 9: 515.

(5) Casman, E. P., and R. W. Bennett. 1965. Detection of staphylococcal enterotoxin in food. Appl. Microbiol., 13: 181.

(6) Casman, E. P., R. W. Bennett, A. E. Dorsey, and J. A. Issa. 1967. Identification of a fourth staphylococcal enterotoxin, enterotoxin D. J. Bacteriol., 94: 1875.

(7) Casman, E. P., D. W. McCoy, and P. J. Brandly. 1963. Staphylococcal growth and enterotoxin production in meat. Appl. Microbiol., 11: 498.

(8) Chesbro, W. R., and K. Auborn. 1967. Enzymatic detection of the growth of *Staphylococcus aureus* in foods. Appl. Microbiol., 15: 1150.

(9) Clark, W. S., and F. E. Nelson. 1961. Multiplication of coagulase positive staphylococci in grade A raw milk samples. J. Dairy Sci., 44: 232.

(10) Dauer, C. C. 1961. 1960 summary of disease outbreaks and a 10 year resume. Public Health Rep., 76: 915.

(11) *Donnelly*, C. B., J. E. Leslie, L. A. Black, and K. H. Lewis. 1967. Serological identification of enterotoxigenic staphylococci from cheese. Appl. Microbiol., 15: 1382.

(12) Donnelly, C. B., J. E. Leslie, and L. A. Black. 1968. Production of enterotoxin A in milk. Appl. Microbiol., 16: 917.

(13) Foster, E. M., F. E. *Nelson*, M. L. Speck, R. N. Doetsch, and J. C. Olson, Jr. 1957. Dairy Microbiology, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

(14) Jones, A. C., G. J. G. King, H. Fennell, and D. Stone. 1957. Growth of *Staphylococcus aureus* in milk with special reference to *food poisoning*. Mon. Bull. Min. Health, Public Health Serv., 16: 109.

(15) Kato, E., M. Khan, L. Kujovich, and M. S. Bergdoll. 1966. Production of enterotoxin A. Appl. Microbiol., 14: 906.

(16) McCoy, D. W., and J. E. Faber. 1966. Influence of food microorganisms on staphylococcal growth and enterotoxin production in meat. Appl. Microbiol., 14: 372.

(17) Reiter, B., B. G. Fewins, T. F. Fryer, and E. M. Sharpe. 1964. Factors affecting the multiplication and survival of coagulase positive staphylococci in Cheddar cheese. J. Dairy Res., 31: 201.

(18) Steele, F. D. F., M. O. H. Buxton, and J. L. G. Iredale. 1962. Staphylococcal infections of raw milk as a cause of food poisoning. Mon. Bull. Min. Health, Public Health Lab. Ser. 21: 122.

(19) Thatcher, F. S., J. Robinson, and I. Erdman. 1962. The "vacuum pack" method of packaging foods in relation to the formation of the botulinum and staphylococcal toxins. J. Appl. Bacteriol., 25: 120.

(20) Zehren, V. L., and V. F. Zehren. 1961. Examination of large quantities of cheese for staphylococcal enterotoxin A. J. Dairy Sci., 51: 635.

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viable bacteria count after UHT pasteurization was only 80 per ml. Similar formulas prepared with low thermoduric count milk solids and subjected to UHT treatment for three seconds at 135, 137.8, and 140.6 C had a shelf-life at 4.4 C of two, three, and five months, respectively, before visible spoilage occurred. Spores of unidentified *Bacillus* species isolated from spoiled formulas and inoculated into raw frozen dessert mixes in numbers of from 48×10^4 to 16×10^3 spores per milliliter were decreased to less than 20 per milliliter by UHT heating at 140 C for three seconds, and the shelf-life of the pasteurized product was more than eight weeks at 4.4 C. Results indicate that improvement in shelf-life depends on quality of the raw products as well as the temperature of pasteurization. Types of bacteria are more important than total numbers.

Development and consumer evaluation of a soft-serve frozen dessert. William J. Doll* and Morrison Loewenstein, University of Georgia, Athens.

The purpose of this research was to develop and evaluate several soft-serve frozen dessert products containing various kinds of fat. The ... composition desired in the product was: ... fat, 10% solids-not-fat, 17% sweetener, and 0.5% stabilizer-emulsifier.

Selection of one vegetable fat from the 20 ... used, with acceptable textual and flavor properties was of paramount importance. A number of butter-flavor compounds were evaluated. ...ural sweeteners were investigated; a 60:40 ... of sucrose-dextrose syrup proved most ...table.

The final samples submitted for consumer ...luation consisted of: a) all milk fat, b) a ...d of one part milk fat to three parts vege... fat, and c) all vegetable fat. The con... panel consisted of nearly 500 randomly ...ted patrons of a soft-serve store. Results ...e consumer acceptance study indicated ... three products received equal accept...

...ator of homogenized milk packaged in paper ... plastic containers. J. J. Janzen, Clemson ...versity, Clemson, South Carolina.

...e use of moulded plastic milk bottles is ...ly recent, but has made considerable ... in various markets since 1963. Most of ...ilk marketed in moulded plastic bottles ...ken in gallon and half-gallon containers. ...per and plastic containers of homogenized ...were obtained in the market place. Organ... examinations were made within hours ...e. All milks were kept iced in transit ...ntil flavors were determined. Flavor ...s were made on all milks initially ...one- and two-week intervals. The initial ...of the milks was rather striking. Ap...ely 60% of all the milk in plastic con... was criticized as being oxidized. None of the milk in paper cartons was criticized for this defect. The shelf-life of milk in plastic containers was usually less than milk in paper containers.

Electrophoretic analysis of skimmilk lipase. L. C. True* [1] and J. B. Mickle, Oklahoma State University, Stillwater.

A modification of the procedure of Fox and Tarassuk (J. Dairy Sci., 51:820, 1968) was used to obtain purified skimmilk lipase. These modifications included: a) filtering the sample through Sephadex G-25 rather than removing the $(NH_4)_2SO_4$ by dialysis and b) concentrating the sample with Lyphogel. Some of the fractions from a DEAE-cellulose column were further studied by concentrating them with Lyphogel and rechromatographing them on Sephadex G-200. The proteins were eluted from the DEAE-cellulose column by a stepwise NaCl gradient, in 0.1 M increments from 0.1 to 0.5 M. Polyacrylamide gel electrophoresis was performed by the method of Blattler (Anal. Biochem., 27:73, 1000) using a 7.0% gel and 6.5×10^{-2} M sodium phosphate buffer.

Sephadex G-200 gel filtration of the lipase-active protein peak from the DEAE-cellulose column indicated a mole wt ≅ 200,000. The polyacrylamide gel showed two major protein bands in this peak, each with a mole wt ≅ 50,000. Thus, the lipase-active protein appeared to be dissociated into at least two different subunits. Four of these subunits would have a molecular weight close to the 200,000 estimated for the lipase-active protein before electrophoresis.

Growth of psychrotolerant bacteria in raw milk under variable conditions of refrigerated storage. J. H. Martin,* E. G. Bailie, and K. S. Su, University of Georgia, Athens.

Sixty raw milk samples from bulk tank milk supplies were analyzed for total bacteria and split into two portions; one was stored at 4.4 C, the other at 10 C, and total bacteria count after seven days was again determined on each of the milk samples. Thirty samples were laboratory pasteurized at 63 C for 30 minutes and the number of surviving bacteria determined. Immediately after pick-up from the farms, all of the milk samples except three complied with the 100,000 per milliliter limit for total bacteria. However, after storage for seven days at 10 C, total bacteria counts were in the millions in all samples, and only 22 of those stored at 4.4 C complied with the legal maximum of 300,000 per milliliter at the pasteurizer. Pasteurization decreased bacteria to below the legal limit of 15,000 per milliliter in 93% of the samples, and to 500 per milliliter or below in 60% of the samples. The results indicate that many of the bacteria in bulk tank milk are

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psychrotolerant, and prolonged cold storage of raw milk could result in tremendous increases of these bacteria. However, in most instances the organisms are not thermoduric, and pasteurization effectively decreased numbers to below the legal maximum.

Hydrolytic changes in milk lipids under refrigerated conditions. G. W. McKirahan* and C. W. Dill, Department of Animal Science, Texas A&M University, College Station.

Hydrolytic rancidity was induced in raw whole milk by homogenization, freeze-thawing, and momentary heating at 90 F. Rates of hydrolysis were different for the treatments, as would be expected from the differences in the disruption of the fat globule. Some differences in lipid classes were also noted as a result of the different treatments.

Influence of mastitis on total and free concentrations of major minerals in milk. P. T. Tallamy* and H. E. Randolph, Texas A&M University, College Station.

Individual-quarter Wisconsin Mastitis Test negative (WMT < 10 mm) and positive (WMT > 20 mm) milk samples were obtained from cows in the University herd. The total and unbound concentrations of eight minerals in skimmilk and ultrasupernatant (144,880 × *g* 3-hr) obtained from the milk samples were determined by atomic absorption spectrophotometry and autoanalyzer techniques. Minerals present in the ultrasupernatant were considered to be in the free form.

Total potassium, phosphorus, and calcium concentrations were lower in the WMT-positive samples than in the negative samples. The WMT-positive samples contained higher total concentrations of iron, copper, zinc, magnesium, and sodium. Total calcium-phosphorus ration were higher in the WMT-positive samples. Similar trends were observed in the mineral concentrations of the ultrasupernatants. Unbound calcium and phosphorus were significantly lower in the WMT-positive samples. Results indicate that mastitis causes changes in the concentration and distribution of some of the major minerals in milk.

Influence of mastitis on buffer capacity of milk. H. L. Lane,* R. L. Richter, and H. E. Randolph, Texas A&M University, College Station.

Individual-quarter Wisconsin Mastitis Test negative (WMT < 10 mm) and positive (WMT > 20 mm) milk samples were obtained from cows in the University herd. The samples were stored at 4.5 C until used. Various quantities (0 to 11 ml) of 0.2 N NaOH or HCl were added to 25 ml portions of the samples at 20 C. The samples were mixed thoroughly, allowed to stand 15 minutes, and the pH determined. Titration curves were plotted and buffer capacity calculated in the acid range.

The pH of the WMT-positive and negative samples was relatively constant throu... titration curves. An identical maxim... value (0.032) was obtained for the p... negative samples. The maximum ha... ity of the WMT-positive samples w... in a slightly higher pH range. The ... peared to be related to a higher ... The results indicate that mastitis do... nificantly alter the buffer capacity o...

Freezing point of milk as affected by ... abnormality. J. J. Janzen, Clemso... sity, Clemson, South Carolina.

Somatic cells in the raw milk ... currently being used as one criter... mality. The Wisconsin Mastitis T... is a widely used screening proced... indirect estimation of somatic cell... milk supply. Freezing point deter... also used routinely to detect abnor... tions such as watering of milk.

Twenty individual quarter sam... cows were analyzed for freezing ... WMT at 0-, 24-, 48-, 72-, and 9... vals using two methods for hand... The milk was stored at 4.4 C. In M... same unit of milk was analyzed, ... re-analyzed at the designated inter... out the 96-hour period. In Method ... sample was divided into five sub... separate unit was then used for ... observations. All quarter-milk ... also analyzed for chloride and lac...

There was a significant differe... the freezing point between cows. T... freezing point between quarters ... cow were not significant, even thou... values varied considerably. There ... icant (P .01) decrease in somatic ... with time of storage. Chloride v... icantly between cows (P .01) and ... .01). Lactose did not vary sig... tween cows or quarters. The corre... cients of chlorides and lactose to fr... were +0.42 and −0.42, respectively.

Effect of somatic cell concentration ... life of finished product. Calvin P... and J. J. Janzen, Clemson Univer... son, South Carolina.

Casual observation of milk quali... possible correlation of problems asso... mastitis have occurred as the result of ... milk surveys. Five plants with d... grees of occurrence of abnormal mi... cated by somatic cell counts obtain... Wisconsin Mastitis Test (WMT) we... Field service, size, and interest in ... mastitis on the farms varied. W... tris Tests were run by central st... as well as two of the plants, duri... mary period of over two years at ... vals. Milk samples during the test ... from the raw producer milk bef... clarification, and the pasteurized ...

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J. D. S. 44 (1961)

MULTIPLICATION OF COAGULASE-POSITIVE STAPHYLOCOCCI IN GRADE A RAW MILK SAMPLES[1, 2]

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Department of Dairy and Food Industry, Iowa Agricultural and Home Economics Experiment Station, Ames

SUMMARY

Coagulase-positive staphylococci could be recovered from all samples of raw milk examined. The initial counts ranged from 25 to 3,300 per milliliter.

Coagulase-positive staphylococci did not multiply in naturally infected milk held at 4°C. for seven days. In milk held at 10°C. for seven days, these organisms did multiply. The extent of multiplication varied from sample to sample and was 1,000-fold in the sample where the greatest percentage increase occurred. The greatest staphylococcus count obtained was 360,000 per milliliter.

At the 4 and 10°C. holding temperatures, the standard plate count increased much more than the count of coagulase-positive staphylococci. Particularly at 10°C., the milk usually became unpalatable because of microbial activity before the staphylococcus population became high enough to be of positive concern as a cause of food poisoning.

Numerous accounts of staphylococcus food-poisoning outbreaks may be found in the literature. Some outbreaks occurred as a result of consuming milk or other dairy products. The first staphylococcus food-poisoning outbreak as a result of drinking milk was reported by Barber (3) in 1914. This outbreak occurred in the Philippine Islands from the consumption of raw milk from an apparently healthy family cow. The exact incidence of staphylococcus food poisoning as a result of consuming dairy products is unknown. However, a number of workers have reported that staphylococci are commonly found in normal raw milk (4, 5, 8).

The presence of staphylococci in raw milk is not justification for incriminating the milk as a potential cause of food poisoning, for not all staphylococci are capable of producing the enterotoxin responsible for staphylococcus food poisoning. Evans and Niven (6) reported that most enterotoxigenic staphylococci were members of the coagulase-positive group. On the basis of this and similar reports, only coagulase-positive staphylococci were considered potentially enterotoxigenic and were examined in this study.

Those strains of staphylococci capable of producing enterotoxin must grow extensively to produce enough enterotoxin to be responsible for food poisoning. This study has been made to determine the extent to which these organisms can grow in milk held under refrigeration.

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[2] This investigation was supported in part by research grant RG-5502, National Advisory Health Council, Public Health Service.

[3] Dairy Industrial Research Fellow, supported by Dairy Industries Supply Assoc., Inc.

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EXPERIMENTAL PROCEDURE

A modified Tellurite-glycine agar medium (9) was employed for enumerating coagulase-positive staphylococci. This medium consisted of 5 g. Trypticase, 5 g. Proteose Peptone, 5 g. yeast extract, 8 g. glycine, 15 g. mannitol, 5 g. K_2HPO_4, 5 g. LiCl, and 15 g. agar. A 1% solution of potassium tellurite was prepared and sterilized; 20 ml. of the solution was aseptically added to 1,000 ml. of the medium after it had been autoclaved at 121° C. for 20 min. and cooled to 50° C. The agar was poured into pressed-glass petri dishes in approximately 15-ml. amounts, allowed to harden, and then dried by overnight incubation at 37° C. before use.

A surface plating technique was used wherein 0.1 ml. of milk or a suitable dilution was smeared over the dry surface of the Tellurite-glycine agar. Plates were incubated at 37° C. for 48 hr., after which time typical coagulase-positive staphylococcus colonies appeared smooth, convex, glistening, and jet-black in color.

Dilutions were prepared and standard plate count determinations made in accordance with Standard Methods for the Examination of Dairy Products (2), except that shaking was continued 50 times to more thoroughly break up staphylococcus clumps.

Twenty raw milk samples were collected from producers using bulk tanks in the Iowa State University milkshed during the period June-August, 1959. Samples were plated initially and after two, four, and seven days of storage. Storage temperatures of 10 and 4° C. were chosen because they most closely approximated holding temperatures under can and bulk-tank holding conditions, respectively.

RESULTS

The number of coagulase-positive staphylococci initially found in Grade A raw milk samples ranged from 25 to 3,300 per ml. (Table 1). The milk samples held at 4° C. for periods of two, four, and seven days showed no definite growth of staphylococci, with highest coagulase-positive staphylococcus counts occurring initially in six cases, after two days in one sample, after four days in ten samples, and after seven days in three samples.

When these same milk samples were held at 10° C., definite multiplication of staphylococci occurred (Table 2). In every sample, the count of coagulase-positive staphylococci increased at least twofold. In one sample, the increase was 1,000-fold. The highest count of staphylococci obtained was 360,000 per milliliter. This was a 360-fold increase over the initial staphylococcus count obtained on this sample. The lowest level of coagulase-positive staphylococci per milliliter was obtained initially with 18 of 20 samples. The lowest level in the two other samples was obtained after seven days of storage. In both of these latter samples, the standard plate count (SPC) was greater than 30×10^6 per milliliter after storage for two days. Also, one of these samples was heavily contaminated with micrococci which grew abundantly on the Tellurite-glycine agar. The maximum count of coagulase-positive staphylococci per milliliter was obtained after four

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TABLE 1

Multiplication of coagulase-positive staphylococci in raw milk held at storage temperatures of 4° C. for seven days

Sample No.	Initial count/ml		Count/ml at two days		Count/ml at four days		Count/ml at seven days	
	Staphylococci	SPC[a]	Staphylococci	SPC	Staphylococci	SPC	Staphylococci	SPC
1	70	27×10^3	600	15×10^4	750	$>30 \times 10^6$	450	....[b]
2	1,000	14×10^3	250	12×10^5	450	11×10^6	700	....
3	3,100	21×10^3	3,000	18×10^4	3,500	31×10^6	2,100	....
4	460	11×10^3	500	19×10^4	620	$>30 \times 10^6$	510	....
5	1,200	87×10^3	1,100	51×10^4	2,000	$>30 \times 10^6$	2,200	....
6	700	16×10^3	1,900	$<30 \times 10^4$	1,300	$<30 \times 10^4$	1,200	....
7	3,300	68×10^3	1,100	35×10^4	2,000	16×10^6	200	....
8[c]	1,100	11×10^4	1,100	65×10^4	600	$>30 \times 10^6$	50	....
9[d]	600	85×10^3	400	$<30 \times 10^4$	1,000	10×10^6	200	12×10^6
10[d]	750	11×10^4	100	$<30 \times 10^4$	850	21×10^6	500	$>30 \times 10^6$
11	1,100	14×10^3	1,100	$<30 \times 10^4$	1,000	30×10^6	1,100	24×10^6
12	150	38×10^3	200	$<30 \times 10^4$	370	11×10^6	250	$>30 \times 10^6$
13[d]	220	12×10^4	25	14×10^4	25	88×10^6	140	45×10^6
14[d]	220	10×10^4	120	13×10^5	160	88×10^6	200	38×10^6
15	120	88×10^3	250	$<30 \times 10^4$	320	12×10^6	50	$>30 \times 10^6$
16	330	33×10^3	500	20×10^5	550	$>30 \times 10^6$	95	....
17	750	39×10^3	1,000	45×10^5	1,700	10×10^6	1,500	19×10^6
18	440	$<30 \times 10^3$	400	60×10^5	1,200	92×10^6	1,200	$>30 \times 10^6$
19[d]	200	74×10^3	40	13×10^5	210	75×10^6	360	23×10^6
20[d]	25	$<30 \times 10^3$	60	30×10^5	60	33×10^6	140	$>30 \times 10^6$

[a] Standard plate count at 32° C.
[b] Determination not made.
[c] Heavy growth of micrococci on all Tellurite-glycine plates.
[d] Initial plating at 0 hr.

TABLE 2

Multiplication of coagulase-positive staphylococci in raw milk held at storage temperatures of 10° C. for seven days

Sample No.	Initial count/ml		Count/ml at two days		Count/ml at four days		Count/ml at seven days	
	Staphylococci	SPC[a]	Staphylococci	SPC	Staphylococci	SPC	Staphylococci	SPC
1	70	27×10^3	3,400	$>30 \times 10^6$	7,000	....[b]	5,000	....
2	1,000	14×10^3	3,100	14×10^6	15,000	$>30 \times 10^6$	35,000	....
3	3,100	21×10^3	3,300	31×10^6	5,100	$>30 \times 10^6$	9,000	....
4	460	11×10^3	920	23×10^6	8,000	$>30 \times 10^6$	12,000	....
5	1,200	87×10^3	13,000	30×10^6	18,000	$>30 \times 10^6$	2,000	....
6	700	16×10^3	16,000	$<30 \times 10^4$	20,000	$>30 \times 10^6$	27,000	....
7	3,300	68×10^3	5,400	$>30 \times 10^6$	14,000	....	1,000	....
8[c]	1,100	11×10^4	3,000	$>30 \times 10^6$	3,400	....	<100	....
9[d]	600	85×10^3	6,300	60×10^5	20,000	21×10^6	83,000	....
10[d]	750	11×10^4	2,000	29×10^5	15,000	$>30 \times 10^6$	12,000	....
11	1,100	14×10^3	14,000	49×10^5	120,000	$>30 \times 10^6$	360,000	....
12	150	38×10^3	3,600	$>30 \times 10^6$	7,000	....	7,000	....
13[d]	220	12×10^4	1,000	47×10^4	550	$>30 \times 10^6$	54,000	....
14[d]	220	10×10^4	2,200	23×10^4	29,000	$>30 \times 10^6$	23,000	....
15	120	88×10^3	3,000	34×10^5	23,000	$>30 \times 10^6$	13,000	....
16	330	33×10^3	2,500	24×10^5	3,300	....	2,200	....
17	750	39×10^3	1,000	16×10^5	31,000	$>30 \times 10^6$	340,000	....
18	440	$<30 \times 10^3$	4,400	48×10^5	7,300	16×10^6	21,000	$>30 \times 10^6$
19[d]	200	74×10^3	450	50×10^5	18,000	$>30 \times 10^6$	200,000	$>30 \times 10^6$
20[d]	25	$<30 \times 10^3$	100	11×10^5	11,000	$>30 \times 10^6$	9,500	$>30 \times 10^6$

[a] Standard plate count at 32° C.
[b] Determination not made.
[c] Heavy growth of micrococci on all Tellurite-glycine plates.
[d] Initial plating at 0 hr.

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days of storage with nine samples and after seven days of storage with 11 samples.

At both storage temperatures, the SPC increased considerably. At 10° C. the SPC on every sample plated after seven days of storage was greater than 30×10^6 per milliliter. By comparison, the SPC on eight of the 11 samples held at 4° C. and plated after seven days was less than 30×10^6 per milliliter. The proportion of coagulase-positive staphylococci to the initial SPC ranged from 14% in two samples to less than 1% in others. After storage at 4° C. for seven days, this proportion was less than 1% in every sample. After storage at 10° C. for the same period, the proportion of coagulase-positive staphylococci to the SPC was greater than 1% in only two samples (1.2 and 1.1%), while this proportion in the remaining samples was far below 1%.

DISCUSSION

Coagulase-positive staphylococci did not show definite growth when held at 4° C. for periods up to seven days. As shown in Table 1, the counts varied slightly, some showing an increase and some a decrease during the storage period. The factors responsible for this variation in the viable count are difficult to determine. The tendency of this organism to clump in raw milk undoubtedly is one factor. Smith (10) has demonstrated the presence of a heat-labile clumping factor for *Staphylococcus aureus* in raw milk.

During storage at 4° C., the standard plate count increased so that the per cent of the total count which these staphylococci comprised after seven days was less than 1% in all samples.

Multiplication of coagulase-positive staphylococci did occur in samples held at 10° C. for periods up to seven days. The greatest increase which occurred was 1,000-fold. In spite of the definite multiplication of staphylococci at this temperature, the percentage of the standard plate count which they comprised decreased. This was due to the very marked increase in the standard plate count. This is in agreement with those workers (7, 10, 11) who stated that the presence of other bacteria appeared to restrain the growth of staphylococci. However, staphylococci undoubtedly would increase rather slowly at 10° C. even if they were in pure culture and in heat-treated milk.

No correlation was observed between the initial and final populations of staphylococci. The sample which gave the highest final level of coagulase-positive staphylococci, 360,000 per milliliter, had an initial count of 1,100 per milliliter. Another sample which initially contained 1,100 coagulase-positive staphylococci per milliliter showed less than 100 per milliliter after storage at 10° C. for seven days.

The mere presence of coagulase-positive staphylococci in raw milk is noteworthy, because some organisms of this group are known to be enterotoxigenic. Since these organisms can multiply in milk held at 10° C., mismanagement on the part of either the producer or the processor to permit temperatures to rise before pasteurization, or contamination after pasteurization followed by mistreatment of the product by the processor or the consumer, could result in a

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final milk product capable of producing food poisoning. Barber's report (3) of a staphylococcus food-poisoning outbreak from drinking raw milk has clearly demonstrated that milk is a good substratum for enterotoxin formation. Other studies in more recent years have confirmed this observation.

The increase of coagulase-positive staphylococci in milk held at 10° C. is important, but should not be considered as a probable direct cause of food poisoning, for several reasons. Not all coagulase-positive staphylococci are enterotoxigenic, and although Allison (1) suggests 500,000 per gram as the minimum number of viable coagulase-positive staphylococci as supporting evidence for staphylococcus food poisoning, no enterotoxin will be formed, even by large numbers, of nonenterotoxigenic coagulase-positive staphylococci. The three highest staphylococcus counts obtained at a storage temperature of 10° C. were after a holding period of seven days. This is not a common holding period, and these milk samples had become rancid by this time. This would usually preclude using the milk for human consumption.

REFERENCES

(1) Allison, V. D. Discussion on Food Poisoning. Proc. Roy. Soc. Med., 42: 216. 1949.

(2) American Public Health Association. Standard Methods for the Examination of Dairy Products. 10th ed. Am. Public Health Assoc., Inc., New York. 1953.

(3) Barber, M. A. Milk Poisoning Due to a Type of *Staphylococcus albus* Occurring in the Udder of a Healthy Cow. Philippine J. Sci., 9B (Trop. Med.): 515. 1914.

(4) Dolman, C. E. Ingestion of Staphylococcus Exotoxin by Human Volunteers with Special Reference to Staphylococcic Food Poisoning. J. Infectious Diseases, 55: 172. 1934.

(5) Evans, A. C. The Bacteria of Milk Freshly Drawn from Normal Udders. J. Infectious Diseases, 18: 437. 1910.

(6) Evans, J. B., and Niven, C. F., Jr. A Comparative Study of Known Food Poisoning Staphylococci and Related Varieties. J. Bacteriol., 59: 545. 1950.

(7) Jones, A. C., King, G. J. G., Fennell, H., and Stone, D. The Growth of *Staph. aureus* in Milk with Special Reference to Food Poisoning. Monthly Bull., Ministry Health and Public Health Lab. Serv., 16: 109. 1957.

(8) Minett, F. C. Studies on Bovine Mastitis. XII. Mastitis Due to Staphylococci. J. Comp. Pathol. Therap., 50: 101. 1937.

(9) Moore, T. D. Department of Dairy and Food Industry, Iowa State University of Science and Technology, Ames. Personal communication. 1959.

(10) Smyth, H. W. The Multiplication of *Staphylococcus aureus* in Cows' Milk. Monthly Bull., Ministry Health and Public Health Lab. Serv., 16: 30. 1957.

(11) Takahashi, I., and Johns, C. K. *Staphylococcus aureus* in Cheddar Cheese. J. Dairy Sci., 42: 1032. 1959.

MONS 038679

MONS 038680

10 C 229
Dairy farm methods committee - Detailed report, 1967-1968. Antibiotics, pesticides, and other adulterants.
Summers, D. K.; Rintelmann, R.; Nickel, V.; Saffian, B.; Kihlstrum, E.; Spencer, S. B.; Atherton, H.; Arledge, W. L.
Journal of Milk and Food Technology 32 (7) 278-85 (1969) [En]

The report of this committee of the International Association of Milk, Food and Environmental Sanitarians, Inc. includes sections on (i) the widespread use of antibiotics and pesticides and consequent contamination of milk and milk products (recommendations to eliminate this problem are listed), (ii) the adulteration of milk by water, detergents, sanitizers and other chemicals, (iii) an investigation of in-place cleaning and sanitizing of dairy farm equipment (while strongly approving this method, recommendations arising from their findings are listed), (iv) a survey of the application of plastics on the farm (the type of plastics used for equipment, its performance and suggestions for improvement are tabulated), (v) the improvement of milk quality with special emphasis on the sediment test, (vi) the compatibility of detergent with farm water supplies (the water problems encountered and corrective treatments are tabulated), (vii) the effect of farm water supplies on milk quality, (viii) a survey carried out by the Dairy Farm Management sub-committee to determine the national practices followed from the time a cow enters a barn for milking until she leaves. MPH

Dairy
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10 P 903
Residues in milk from cows fed 4-amino-3,5,6-trichloropicolinic acid.
Kutschinski, A. H.
Journal of Agricultural and Food Chemistry 17 (2) 288-90 (1969) [7 ref. En] [Residue Res., Dow Chemical Co., Midland, Michigan 48640, USA]

4 Holstein-Friesian dairy cows were used in an expt. on residues in milk after feeding with the K salt of the herbicide 4-amino-3,5,6-trichloropicolinic acid. After a 2 wk conditioning period, 2 cows remained on the basal control ration and 2 were fed the compound at a 10 ppm level for 6 days, followed by a 30 ppm level for 8 days. Subsequently 3 cows (1 control remaining) were fed at levels of 100, 150, 300 and 1000 ppm for 2 wk consecutive periods. Using 2 related analytical procedures giving 97% and 99% recoveries respectively, the compound was detectable in milk at a feeding level of 100 ppm and significant residues (0.05 ppm) found at the 150 ppm level. On average, at the higher feeding levels 0.02% of the concn. in the diet appeared in the milk. After withdrawal of the herbicide, residues were not detected in the milk of any cow after 58 h. JMa

MUNS 038681

10 D 586
Malathion: tolerances for residues.
Anon.
Federal Register 34 (134, July 15), 11589-90 (1969) [En]

The following additional tolerances are established under the US Federal Food, Drug and Cosmetic Act for the title insecticide (O,O-dimethyl dithiophosphate of diethyl mercaptosuccinate) (from preharvest application unless otherwise specified): 135 ppm in or on cowpea forage and hay, lespedeza hay and straw, lupin hay and straw, peanut forage and hay, soya bean forage and hay, and vetch hay and straw; 50 in or on almond hulls; 8 in or on lentils, okra, soya beans (dry and succulent) and sugar beet tops, and peanuts (from pre- and postharvest); 1 in or on almonds, chestnuts, filberts, macadamia nuts, papayas, sugar beet roots, and sweet potatoes; 0.2 in or on safflower seed; 0.5 in milk fat reflecting negligible residue in milk from application to dairy cows; 0.1 in eggs from application to poultry; and 0.6 in refined safflower oil from application to the growing plant. CAS

10 D 587
O,O-Dimethyl 2,2,2-trichloro-1-hydroxyethyl phosphonate; tolerances for residues.
Anon.

Federal Register 34 (134, July 15) 11590-91 (1969) [En]

The following tolerances are established for residues of the title insecticide under the US Federal Food, Drug and Cosmetic Act: 45 ppm in or on lucerne and clover hay; 12 in or on fresh lucerne, barley (green fodder and straw), fresh clover, flax straw, oats (green fodder and straw), sugar beet tops, and wheat (green fodder and straw); 2 in or on bananas (of which ≤0.2 is present in the pulp); 1 in or on bean and cowpea vines; 0.1(negligible residue) in or on artichokes, barley grain, dried beans, garden beets, brussels sprouts, cabbage, carrots, cauliflower, collards, maize (fodder, forage, and kernels plus cob without husk), cottonseed, cowpeas, flaxseed, lettuce, lima beans, meat, fat and meat byproducts of cattle, oats (grain), peppers, pumpkins, safflower seed, snap beans, sugar beets, tomatoes, and wheat (grain); and 0.01 (negligible residue) in milk. CAS

7 D 426
Food additives. Tylosin.
Anon.
Federal Register 34 (61, March 29) 5929-30 (1969) [En]

Tylosin, 0.8-1.0 kg/ton, may be used in broiler chicken feed under the US Federal Food, Drug and Cosmetic Act to aid in the control of chronic respiratory disease caused by Mycoplasma gallisepticum. The tolerances in edible products of treated animals are changed from zero to the following (negligible residues): fat, muscle, liver, and kidney of chickens, turkeys, cattle, and swine, 0.2 ppm; eggs, 0.2 ppm; milk 0.05 ppm. CAS

7 D 428
Dicamba; tolerances for residues.
Anon.
Federal Register 34 (66, April. 8) 6239 (1969) [En]

The following additional tolerances are established under the US Federal Food, Drug and Cosmetic Act for residues of the herbicide dicamba (3,6-dichloro-o-anisic acid) and its metabolite 3,6-dichloro-5-hydroxy-o-anisic acid: 40 ppm in or on grasses (pasture and rangeland) and grass hay; 0.05 (negligible residue) in milk. CAS

MONS 038682

4 D 210
Coumaphos tolerances for residues.
Anon.
Federal Register 34 (12, Jan. 17) 726-27 (1969) [En]

The previous tolerance under the US Federal Food, Drug and Cosmetic Act for the title insecticide (O,O-diethyl O-3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl phosphorothioate) and its O analogue (O,O-diethyl O-3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl phosphate) is revised from zero to 0.5 ppm in milk fat reflecting negligible residues in milk, and 0.1 ppm in eggs. CAS

4 D 211
Parathion or its methyl homologue; tolerances for residues.
Anon.
Federal Register 34 (15, Jan. 23) 1014 (1969) [En]

A tolerance of 0.2 ppm is established under the US Federal Food, Drug and Cosmetic Act for residues of the insecticide parathion (O,O-diethyl O-p-nitrophenyl thiophosphate) or its methyl homologue in or on sunflower seed. CAS

11 D 905
Food additives. Thiabendazole.
Anon.
Federal Register 35 (131, July 8) 10952-53 (1970) [En]

The previous zero tolerances for the title feed additive under the US Federal Food, Drug and Cosmetic Act is revised to the following negligible residue tolerances: 0.1 ppm in edible tissues of cattle, goats, sheep, and swine, and 0.05 in milk. Revised indications for use were also made. CAS

MONS 038683

9 P 1180
Metabolism and excretion of Bromacil in milk of dairy cows.
Gutenmann, W. H.; Lisk, D. J.
Journal of Agricultural and Food Chemistry 18 (1) 128-29 (1970) [1 ref. En] [Pesticide Residue Lab., Cornell Univ., Ithaca, New York 14850, USA]
The herbicide, Bromacil (5-bromo-3-sec-butyl-6-methyl uracil) was fed for 4 days to (i) a 1550 lb Holstein-Friesian cow at the 5 ppm level (based on a 50 lb daily ration) in the evening grain and to (ii) a 1450 lb Holstein-Friesian cow at the 30 ppm level. Subsamples (a.m. and p.m.) of the total daily milk were taken from (i) and (ii) as well as samples of total daily urine and faeces from (i) only. Bromacil was not detected in urine or faeces (lower limits of detection 0.04 and 0.01 ppm, respectively); small quantities were found in milk samples, rising to 0.13 and 1.30 mg/day for (i) and (ii) respectively, the herbicide being predominantly secreted in the p.m. milk. Bromacil was not decomposed in vitro in 7 h in the presence of rumen fluid or when incubated for 1 h with a 10 000 × g homogenized liver fraction supernatant. BEPC

4 P 387
Status of iodine in milk preserved with sodium metabisulphite and formaldehyde.
Murthy, G. K.
Journal of Dairy Science 52 (1) 124-25 (1969) [7 ref. En] [Nat. Center for Urban and Industrial Health, U.S. Public Health Service, Cincinnati, Ohio, USA]
The addition of $Na_2S_2O_5$ to fresh raw whole milk labelled in vitro with ^{131}I maintained the I in the reduced state during storage at 23-26°C, but did not prevent spoilage. Reconstituted dried milk, also labelled in vitro with ^{131}I, was successfully preserved by addition of formaldehyde without affecting the recovery of ^{131}I. [See also J. Dairy Sci. (1966) 49 (10) 1190-96.] RWS

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2 P 164
Direct addition of tocopherol to milk for control of oxidized flavour.
King, R. L.
Journal of Dairy Science 51 (10) 1705-07 (1968) [6 ref. En] [Dept. Dairy Sci., Univ., College Park, Maryland, USA]

0.1 and 0.5 ppm Cu were added to samples of mixed milk from 8 cows followed by tocopherol (from D-α-tocopherol in hexane, ethanol and various liquid emulsifiers) at concn. of 12.5-400 μg/g milk fat. After 2 days refrigerated storage, samples were evaluated for oxidized flavour by thiobarbituric acid and organoleptic methods. Non-emulsified forms of tocopherol did not prevent development of oxidized flavour. Addition of 25-100 μg emulsified tocopherol/g milk fat prevented oxidized flavour development. The amount of tocopherol required, increased with level of Cu contamination and was within the same range as naturally incorporated vitamin E, but due to poor transfer of vitamin E from feed rations to milk, amount of tocopherol added to milk was ~1% of that required in rations. Addition of tocopherol to milk at the farm is recommended. **CDA**

2 P 151
Radioactive lactose in skim milk following administration of carbonyl-^{14}C-carbaryl to a lactating cow.
Baron, R. L.
Journal of the Association of Official Analytical Chemists 51 (5) 1046-49 (1968) [10 ref. En] [Division Food Chemistry & Technology, Food & Drug Administration, Washington, D.C. 20204, USA]

Administration of 2 g carbonyl-^{14}C-carbaryl to a lactating cow resulted in radioactive residues in milk of ~1% of the administered dose. Analysis of the distribution of radioactivity in skim milk showed 13 and 87% of the radioactivity present as organic-soluble and water-soluble components, respectively. Crystallization of lactose from the water-soluble components resulted in removal of 90-95% of the ^{14}C radioactivity. The data obtained indicate that following hydrolysis of the carbonyl-^{14}C-carbaryl, a small quantity of $^{14}CO_2$ was incorporated into lactose. **AS**

MONS 038685

1 P 9
Compounds in milk accompanying feeding of ethoxyquin.
Dunkley, W. L.; Franke, A. A.; Low, E.
Journal of Dairy Science 51 (8) 1215-18 (1968) [3 ref. En] [Dept. Food Sci. & Technol., Univ., Davis, California, USA]
A feeding trial was conducted on 3 Holstein-Friesian cows to determine if ethoxyquin, or its residues, is transferred to milk when fed at 0.015% of dry matter intake. Feeding ethoxyquin did not increase milk tocopherol, but was accompanied, 1 day after feeding, by appearance in milk of an unidentified compound that interfered with determination of ethoxyquin by a fluorometric method and of tocopherol by a spectrophotometric method [see Analyt. Chem. 36: 1055]. Max. concn. of ethoxyquin detected in milk, after separation from interfering compounds by hexane and acid extractions, was < 7 μg/l. [See also J. Dairy Sci. (1967) 50 (4) 492-99.] CDA

1 P 10
Insecticide residues in the milk of dairy cows treated for control of ectoparasites.
Kawar, N. S.; Bostanian, N. J.; Badawi, S. M.
Journal of Dairy Science 51 (7) 1023-25 (1968) [7 ref. En] [American Univ. of Beirut, Lebanon]
BHC (1,2,3,4,5,6-hexachlorocyclohexane), chlordane (2,3,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene), and ronnel [O,O-dimethyl-O-(2,4,5-trichlorophenyl) phosphorothioate] residues were determined quantitatively in milk samples obtained from 21 Holstein-Friesian cows at regular intervals for 22 days following treatment. 3 wk after application, 0.006 and 0.016 ppm BHC were found in whole milk of cows sprayed with 0.03 and 0.06% BHC, respectively. Similarly, the utilization of 0.25 and 0.5% chlordane resulted in residues of 0.232 and 0.319 ppm, respectively. Application of 0.38 and 0.75% ronnel resulted in undetectable levels 4 days after application. All reported concn. of insecticides were on whole milk basis. AS

1 D 38
O,O-Diethyl O-3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl phosphorothioate; tolerances for residues.
Anon.
Federal Register 33 (169, Aug. 29) 12187-88 (1968) [En]
A tolerance of 0.5 ppm of the insecticide is established under the US Federal Food, Drug and Cosmetic Act in milk fat, reflecting negligible residues in milk from use on dairy cows. CAS

MONS 038686

2 C 50
Environmental surveillance around a nuclear fuel reprocessing installation, 1965-1967.
Kelleher, W. J.
Radiological Health Data and Reports 10 (8) 329-39 (1969) [9 ref. En] [Bureau of Radiological Health, Dept. of Health, Albany, New York, USA]

The report summarizes data obtained during 1965, 1966 and 1967 on levels of radioactivity in air and milk samples, liquid wastes, local watersheds, silt, deer and fish in the area surrounding a nuclear fuel reprocessing plant, which began operating in April 1966. No changes in the levels of ^{131}I, ^{137}Cs or ^{90}Sr in milk were detected during the test period. Levels of ^{137}Cs in the soft tissues of deer increased significantly in 1967, probably as a result of drinking contaminated water. Similar, high levels of ^{90}Sr were found in fish. These levels are considered sufficiently high to cause possible health hazards. MEG

6 P 806
Fate of organochlorine pesticides during processing of milk into dairy products.
Li, C. F.; Bradley, R. L., Jr.; Schultz, L. H.
Journal of the Association of Official Analytical Chemists 53 (1) 127-39 (1970) [31 ref. En] [Dept. of Food Sci., Univ., Madison, Wisconsin 53706, USA]

Groups of 2 lactating cows were fed (i) dieldrin, (ii) toxaphene, (iii) chlordan, (iv) endosulfan, (v) dicofol, or (vi) a mixture of heptachlor, DDT and lindane. Milk from each group was manufactured into pasteurized whole milk, 30% cream, butter, spray-dried or condensed whole milk and Cheddar cheese. The pesticides remaining in these dairy products, and in skim-milk, buttermilk and Cheddar cheese whey, were determined by gas-liquid chromatography in freshly prepared and stored samples. In general, the pesticides present in the milk were unchanged by the manufacturing processes. (i), (iii) and lindane, however, showed a 27, 11 and 34% decrease, respectively, in spray-dried products and concn. of (i) and (ii) increased slightly on storage. Most of the pesticides, particularly (i), (iii) and heptachlor had some bacteriostatic or bactericidal effect on the cheese starter organisms. The pesticide content/g fat was generally higher in skim-milk, buttermilk and whey, possibly because of the affinity of the residues for the lipoproteins present in these products. (See also FSTA (196) 1 1P106.) MEG

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6 P 748
Offsite radiological surveillance for Project Gasbuggy, June 1967-July 1968
McBride, J. R.; Hill, D.
Radiological Health Data and Reports 10 (12) 535-46 (1969) (2 ref. En) [Southwestern Radiological Health Lab., Las Vegas, Nevada, USA]

75 samples of milk were taken from 22 dairy locations up to a radius of 150 miles from ground zero during 4 periods of 'Project Gasbuggy', an expt. in which an underground nuclear explosion on Dec. 10, 1967 was used to stimulate production of natural gas. ^{131}I was below the detectable limit (10 pCi/l.) in all samples before and after the explosion; the number of samples giving results above the detectable limits of ^{137}Cs and ^{89}Sr (10 & 5 pCi/l., respectively) was insufficient for the average of all samples to exceed those limits. Average values for ^{90}Sr were 6 and 4 pCi/l. before and after the explosion, respectively (detectable limit 2 pCi/l.). Samples were not taken when the gas well was re-drilled (Jun. 13-Jul. 22, 1968) since by this time all radio-iodines had decayed below significant levels. BEPC

6 P 747
Mixed sample tests for extraneous matter in milk.
Maloney, P.; Armstrong, J. G.
Journal of Milk and Food Technology 32 (11) 455-57 (1969) (7 ref. En) [Dairymen's Association Res. Unit, Dept. of Food Sci., Univ., Edmonton, Alberta, Canada]

In 149 individual cans of milk extraneous matter was measured by 2 methods, (i) the 'off-the-bottom' method in which 16 fl oz of milk are drawn from the bottom of the can and forced through a filter pad and the amount of sediment is assessed on a scale of 1 to 4, and (ii) the 'mixed milk' method in which the milk is mixed before the sample is taken. For each of the scores 1 to 4 assessed by (ii) the scores by (i) varied widely; e.g. for the 30 samples scored 1 by (ii), representing an average of 0.05 mg sediment/16 fl oz milk, the amount of sediment by (i) ranged from 0.3 to 2.5 mg. Similar results were obtained with milk from the cans of each of 74 producers tested by (i) in the cans and by (ii) after pouring into the dump-tank. The causes of variation by (ii) are discussed: (i) is superior in several respects and is recommended for adoption as the standard method for both bulk milk and milk in cans. SJR

MONS 038688

2 P 148

Radioiodine in the milk of cows and goats after oral administration of radioiodate and radioiodide.

Lengemann, F. W.

Health Physics 17 (4) 565-69 (1969) [8 ref. En] [Dept. of Physical Biology, St. Vet. Coll., Cornell Univ., Ithaca, New York 14850, USA]

2 lactating cows and 2 lactating goats were each given a single oral dose of $Na^{131}I$ and $Na^{125}IO_3$. During a 7-day collection period, amounts of ^{131}I recovered from cows and goats, respectively, were 3.8 and 43.7% in milk, 49.2 and 18.7% in urine, 27.1 and 14.5% in faeces, and 7.4 and 14.3% in thyroid tissue; values for the recovery of ^{125}I were similar. In a 2nd expt. 3 lactating cows and 2 lactating goats were given daily doses of $Na^{131}I$ and $Na^{125}IO_3$ for 14 days. Average level of excretion of ^{131}I and ^{125}I into milk on days 10-14 was 0.42 and 0.44% in cows and 48.7 and 40.9% in goats. Small differences in the excretion of ^{131}I and ^{125}I indicated that $NaIO_3$ is not absorbed from the digestive tract as efficiently as NaI. SPT

P-1259

9 P 1222

Road dust as a source of sediment in milk and cream.

Armstrong, J. G.

Journal of Milk and Food Technology 33 (3) 109-10 (1970) [4 ref. En] [Dept. of Food Sci., Univ., Edmonton, Alberta, Canada]

Average sediment (mg/16 fl oz) found in tests using tap water transported under various conditions in 12 (¾ full) milk cans of various ages with 'mushroom' tops and 12 (¾ full) milk cans of various ages with inset tops were, respectively: cans in open truck, 0.02 and 0.02; cans in truck covered by tarpaulin, 0.02 and 0.02; individual plastics cover on each can with truck top open, 0.01 and 0.02; and waxed paper placed under lids of cans with truck top open, 0.04 and 0.03. Differences between average amounts of dust found in individual cans as an average of 4 tests were (mg/16 fl oz): 10 cans, 0.01; 5 cans, 0.02; 6 cans, 0.03; 2 cans, 0.04; and 1 can, 0.05. It was concluded that road dust was not the most important source of contamination of milk delivered in cans to manufacturing plants. Individual covers for cans are effective where dust protection seems desirable. BEPC

MONS 038689

6 C 149

Carbon-14, tritium, and plutonium-239 in milk and total diet July 1965 to December 1968.

United States of America, Public Health Service, Bureau of Radiological Health

Radiological Health Data and Reports 10 (11) 500-05 (1969) [3 ref. En] [Washington, DC 20201, USA]

Results obtained from the examination of milk samples taken at 11 locations from Jan. 1966 to June 1967, when sampling was discontinued, indicated that ^{239}Pu was not present in detectable amounts; total diet samples taken in the same period contained low but detectable amounts with a max. of 7.9 fCi/kg. Mean ^{14}C concn. in milk and total diet samples taken at 9 selected geographical locations during the period July-Dec. 1965 were 570 and 1120 pCi/kg, respectively. For semi-annual samples from Jan. 1966 to Dec. 1968 the mean for all locations for total diet samples (pCi/kg) increased to 1300 in Apr. 1967 but decreased to 1030 in Oct. 1968; values for milk were about the same as in 1965. Ranges of detectable values (nCi/kg) of ^{3}H in food and milk samples respectively for the following years were: 1966, 0.4-9.9 and 0.8-5.9; 1967, 0.4-2.7 and 0.3-3.6; 1968, 0.4-2.2 and 0.5-1.7. Corresponding average values (nCi/kg) for electrolytically enriched samples were: 1966, 1.2 and 1.4; 1967, 0.7 and 0.6; 1968, 0.6 and 0.5. The number of samples with concn. below the lower limit of detection increased markedly between 1966 and 1968. BEPC

10 P 1403

Milk surveillance, December 1969.

Anon.

Radiological Health Data and Reports 11 (4) 187-97 (1970) [12 ref. En]

Monthly and annual average conc. of ^{90}Sr, ^{131}I and ^{137}Cs in milk are tabulated for 176 sampling locations in the Western Hemisphere for 1969. Concn. of ^{131}I were below the practical reporting level in all samples except 4 taken in the state of Pennsylvania in Dec. (max. value 18 pCi/l.). Annual averages for ^{90}Sr and ^{137}Cs for the 63 sampling stations of the pasteurized milk network in the USA were 7 and 9 pCi/l. respectively. [See FSTA (1970) 2 8P1049 for comparison of raw and pasteurized milk sampling networks.] Highest 12-month average for ^{90}Sr was 19 pCi/l. at Del Norte, California, equivalent to 9.5% of the Federal Radiation Council's radiation protection guide. Highest 12-month average for ^{137}Cs was 90 pCi/l. in south-east Florida, representing 2.5% of the guide for this nuclide. ^{137}Cs levels in 1969 were consistently higher in Florida and Jamaica compared with the other locations. [See FSTA (1969) 1 10P905 for 1968 values.] BEPC

3 P 281

Comparative excretion and retention of DDT analogues by dairy cows.

Fries, G. F.; Marrow, G. S.; Gordon, C. H.

Journal of Dairy Science 52 (11) 1800-05 (1969) [12 ref. En] [Animal Husbandry Res. Division, USDA, Beltsville, Maryland 20705, USA]

3 groups of 3 cows each were fed 25 mg of p,p'-DDT, p,p'-DDD, or p,p'-DDE/day for 60 days. Concn. of the compounds in milk fat approached, but did not reach, equilibrium during the feeding period. From days 40 to 60, 25.8% of the p,p'-DDE, 7.6% of the p,p'-DDD, and 5.1% of the p,p'-DDT as p,p'-DDT (2.1%) and p,p'-DDD (3.0%), were excreted in the milk. When the feeding of the compounds ended at 60 days, the decline in milk fat concn. of all compounds could be described as the sum of 2 first-order terms. The initial partial concn. of the first term were 0.41, 0.91, and 0.41 with rates of decline of 67, 41, and 31%/day for p,p'-DDT, p,p'-DDD, and p,p'-DDE, respectively. The initial partial concn. of the second term were 0.59, 0.09, and 0.59, with rates of decline of 1.3, 2.6, and 1.3%/day, respectively. [See also FSTA (1969) 1 8C392.] AS

MONS 038690

6 A 195
Vitamin B_6 components in some meats, fish, dairy products, and commercial infant formulas.
Polansky, M. M.; Toepfer, E. W.
Journal of Agricultural and Food Chemistry 17 (6) 1394-97 (1969) [15 ref. En] [Human Nutrition Res. Division, Agric. Res. Service, Beltsville, Maryland 20705, USA]

Pyridoxine, pyridoxal, pyridoxamine and total vitamin B_6 values for meat, fish, dairy products and infant formulae were determined microbiologically using Saccharomyces carlsbergensis. The hydrolysed food extracts were separated by chromatography on Dowex 50 resin column prior to microbiological assay. Total vitamin B_6 concn. ($\mu g/g$) were as follows: in meat, from 2.87 in chicken leg to 8.21 in ox liver; in fish, from 0.5 in oysters to 3.78 in tuna; in dairy products, from 0.01 in buttermilk and homogenized milk to 0.12 in blue cheese; in dried egg, 4.00; and in infant formulae, from 0.37 in Similac to 3.95 in Bremil. Pyridoxal and pyridoxamine were the predominant forms of vitamin B_6; only small amounts (generally <10%) of pyridoxine were present. Vitamin B_6 in fully cooked or canned food consisted of >70% pyridoxamine. SPT

5 P 380
Metabolites of 2,3,5-triiodobenzoic acid in cows' milk.
McGee, C. E.; Born, G. S.; Christian, J. E.; Liska, B. J.
Journal of Dairy Science 52 (11) 1864-66 (1969) [8 ref. En] [Purdue Univ., Lafayette, Indiana 47907, USA]

In this investigation, which was performed concurrently with that of Ice et al. [J. Pharm. Sci. (1968) 57 (3) 399-404], 100-g samples of milk from a 3-yr-old 477-kg Holstein-Friesian cow which had been orally dosed with 1.197 g of 2[^{131}I],3,5-triiodobenzoic acid (TIBA), were subjected to gas-chromatographic analysis. TIBA and 7 metabolites were detected in the milk; 4 of the metabolites were identified, but only TIBA and the major metabolite, 2-hydroxy-3,5-diiodobenzoic acid could be quantitatively determined. Levels, in milk, of TIBA and its major metabolite respectively, at various times up to 54 h after dosing were (mg/kg): 6 h, 0.42 and 0.08; 18 h, 0.48 and 0.19; 30 h, 0.79 and 0.23; 42 h, 0.75 and 0.27; 54 h, 0.43 and 0.21. CDA

MONS 038691

§ D 323
Food additives. Sulphadimethoxine.
Anon.
Federal Register 35 (35, Feb. 19) 3161-62 (1970) [En]

The previous regulation under the US Federal Food, Drug and Cosmetic Act is revised to extend the use of the title drug in the drinking water of chickens and turkeys at a level of 0.938 g/gal (0.025%) and to revise the existing zero tolerances to the following negligible residue tolerances: 0.1 ppm in chickens, turkeys and cattle; 0.01 ppm in milk. CAS

§ C 118
Environmental levels of radioactivity at atomic energy commission installations. I. Hanford atomic products operation calendar year 1967.
Anon.
Radiological Health Data and Reports 10 (9) 408-16 (1969) [9 ref. En] [Battelle Memorial Inst., Richland, Washington, USA]

Data on radionuclides from monitoring reports are summarized for the Hanford plant area (1300 km^2), its environs, the Columbia River flowing through it, and 3 towns directly downstream. Milk from local farms irrigated with water downstream contained ^{32}P, ^{65}Zn and ^{131}I as well as fission products from fall-out. Average levels of ^{32}P and ^{65}Zn were 320 and 200 pCi/l. respectively against none detectable in the commercial milk available. ^{131}I level was the same as in commercial milk, averaging 4 pCi/l. Levels of ^{131}I in fresh vegetables from local farms and markets were $\leq$0.05 pCi/g, the prescribed limit. From the species distribution and analysis of fish caught in the Columbia River it is calculated that intake by the max. consumer of the fish (200 meals/yr) would be 1.6 μCi ^{32}P and 0.4 μCi ^{65}Zn, 10% of max. permitted intake. Average levels of ^{65}Zn and ^{32}P in oysters were 30 and 3.3 pCi/g respectively. Data are given also for drinking water of river origin. SJR

MONS 038692

1495

Milk surveillance, December 1971.
Anon.
Radiation Data and Reports 13 (4) 195-203 (1972) [8 ref. En]

An outline is given of the continuing monitoring of radionuclides in milk in USA, Canada and parts of Central and S. America. For 1971, the average data for the pasteurized milk network in USA were 7 pCi ^{90}Sr and 9 pCi ^{137}Cs/l. milk; the ranges for Canada and Central + S. America respectively were 5-17 and 0-5 pCi ^{90}Sr and 11-33 and 0-80 pCi ^{137}Cs/l. milk. [See FSTA (1971) 3 12P2088 for 1970 results.] JMD

Assay for residues in milk and cream from cows fed 6-chloropicolinic acid.
Jensen, D. J.
Journal of Agricultural and Food Chemistry 19 (5) 897-899 (1971) [6 ref. En] [Residue Res., Agric. Dept., Dow Chemical Co., Midland, Michigan 48640, USA]

6 dairy cows were fed rations containing 6-chloropicolinic acid, the principal metabolite of the nitrification inhibitor 2-chloro-6-(trichloromethyl)pyridine (Dowco 163). Samples of milk and cream were assayed for 6-chloropicolinic acid by a procedure in which the sample was hydrolysed with sulphuric acid to liberate the compound from possible conjugates. The free 6-chloropicolinic acid was extracted with ether, followed by cleanup on a Woelm neutral alumina 200 column esterified with diazomethane and quantitatively determined by GLC employing a LAC-446-H$_3$PO column and electron capture detection. Recoveries were 89% from milk and 83% from cream. Assay results reveal that no measurable residues (<0.025 ppm) appeared in milk or cream from cows ingesting 6-chloropicolinic acid at levels up to 100 ppm in the diet. AS

194

2 P 194
Enrichment of pasteurized whole milk with iron.
Edmondson, L. F.; Douglas, F. W., Jr.; Avants, J. K.
Journal of Dairy Science 54 (10) 1422-1426 (1971) [5 ref. En] [Dairy Products Lab., E. Marketing and Nutrition Res. Div., USDA, Washington, DC 20250, USA]

Organoleptic evaluation of whole milks showed that addition of Fe^{3+} salts to raw whole milk increased the heat resistance of lipase, resulting in rancid flavours in milks heat-treated for 16 sec at below 79°C; this defect was overcome by increasing the treatment temp. to 81°C to inactivate the lipase. Addition of Fe^{2+} salts caused development of an oxidized flavour when added before heat treatment. This could be overcome by de-aerating the milk before adding the Fe^{2+} salt. The degree of rancidity increased during storage at 4.4°C for up to 14 days whereat that of oxidized flavour decreased. Of the 2 compounds extensively studied for use in iron-fortification of milk, ferric ammonium citrate added prior to heat treatment for 16 sec at 81°C was considered more suitable than ferrous sulphate added between de-aeration and heat treatment. CDA

193

2 P 193
Fate of polychlorinated biphenyls in dairy products processed from the milk of exposed cows.
Platonow, N. S.; Funnell, H. S.; Bullock, D. H.; Arnott, D. R.; Saschenbrecker, P. W.; Grieve, D. G.
Journal of Dairy Science 54 (9) 1305-1308 (1971) [18 ref. En] [Dept. of Biomed. Sci., Univ., Guelph, Ontario, Canada]

2 lactating Jersey cows received a single oral dose of 10 or 100 mg polychlorinated biphenyls (PCB)/kg body wt. Concn. of PCB (mg/kg) recovered in milk and products processed from the milk of the cow receiving 10 and 100 mg PCB respectively were as follows: whole milk, 3.893 and 36.099; cream, 23.321 and 262.872; skim-milk, 0.456 and 1.522; heated skim-milk, 0.165 and 0.427; dried skim-milk, 1.677 and 4.838; Cottage cheese, 1.486 and 5.930; and whey, 0.284 and 1.621. PCB tended to be lipophilic and the concn. were proportional to the fat content in whole milk and cream and nearly proportional in Cottage cheese and dried skim-milk, but the whey contained more PCB/fat unit than did any other sample. GLC of PCB from the different products showed that the metabolic form was not significantly altered by processing except in cream, which contained significantly less of the 1st of the 14 chromatographic fractions, when compared with a standard chromatogram. CDA

MONS 038694

10 P 1590

Transfer to milk of ingested radiolead.
Stanley, R. E.; Mullen, A. A.; Breithauer, E. W.
Health Physics 21 (2) 211-215 (1971) [6 ref. En] [SW Radiological Health Lab., Las Vegas, Nevada 89114, USA]

4 lactating cows were each given orally 1.5 mCi ^{203}Pb as nitrate; ^{203}Pb was estimated in milk, urine and faeces for the next 5 days. Peak activity appeared in the milk 30 h after dosing and the activity declined with a half-life of 70 h. Less than 0.02% of the ingested dose was secreted in the milk, suggesting that radiolead that may result from nuclear explosions is of little direct significance to man. JMD

P1084

7 P 1084

Determination of aflatoxins B and M_1 in milk.
Jacobson, W. C.; Harmeyer, W. C.; Wiseman, H. G.
Journal of Dairy Science 54 (1) 21-24 (1971) [7 ref. En] [Div. of Vet. Res., Dept. of Health, Education and Welfare, Beltsville, Maryland 20204, USA]

Cows fed contaminated rations containing the mould metabolite aflatoxin B_1 secrete low levels of aflatoxin B and its metabolite aflatoxin M_1 in milk. To establish the relationship between ingested and milk-secreted aflatoxin, a sensitive method is needed to determine aflatoxins B and M_1 in milk. A method is presented by which good recoveries, within the limits of visual comparison, were obtained from samples containing 0.5 parts aflatoxin per thousand million. Deproteinized milk (80% methanolic filtrates) was adjusted to 50% by addition of 4% salt solution and defatted by extraction with hexane. Aflatoxins were extracted from the alcoholic phase with chloroform which was removed in vacuo. The residue was dissolved in benzene/hexane (1:1) and chromatographed on a partition column of Celite coated with an aqueous solution of $CaCl_2$ to separate aflatoxins B and M_1. The eluted B was passed through another partition column of Celite coated with methanol/water (1:1) for additional cleanup. Aflatoxin eluates were dissolved in chloroform and spotted on TLC plates for fluorescence comparisons. AS

MONS 038695

P 1383

9 P 1383
Responses from cows fed diets containing fenthion or fenitrothion.
Johnson, J. C., Jr.; Bowman, M. C.
Journal of Dairy Science 55 (6) 777-782 (1972) [12 ref. En] {Animal Sci. Dept., Coastal Plain Sta., Tifton, Georgia, 31794, USA}

Diets containing 0, 25, 50 or 100 ppm of either fenthion (O,O-dimethyl O-[4-(methylthio)-m-tolyl]phosphorothioate) or fenitrothion (O,O-dimethyl O-4-nitro-m-tolyl phosphorothioate) were fed to pairs of lactating Jersey cows for 28 days. Although fenthion depressed dietary intake ($P<0.05$) when fed at 50 or 100 ppm, neither insecticide affected milk yield. Levels of fenthion and its metabolites in milk of cows receiving 25, 50 and 100 ppm respectively were 0.010, 0.043 and 0.078 ppm after 7 days and 0.018, 0.049 and 0.099 ppm after 28 days feeding. With fenitrothion, only the amino analogue was detected in the milk, corresponding levels being 0.002, 0.004 and 0.020 ppm after 7 days and 0.002, 0.006 and 0.017 ppm after 28 days. No residues of either insecticide were detected in milk 7 days after the feeding of them was terminated. CDP

C2

9 C 226
The excretion of hexachlorophene in the dairy cow.
St. John, L. E., Jr.; Lisk, D. J.
Journal of Agricultural and Food Chemistry 20 (2) 389-391 (1972) [7 ref. En] {Pesticide Residue Lab., Dept. of Entomology, Cornell Univ., Ithaca, New York 14850, USA}

On feeding hexachlorophene [2,2'-methylene-bis-(3,4,6-trichlorophenol)] over a period of 4 days at a level of 5 ppm in the daily ration (22.7 kg) to a lactating Holstein-Friesian cow (body wt. 572 kg and average daily milk yield 16 kg), no detectable residues of the bactericide were found in milk samples taken daily throughout the feeding period and for 6 days thereafter. SAC

226

9 C 227
Metabolism of xenobiotics in ruminants. IV. Storage and excretion of HEOD in Holstein cows.
Wilson, K. A.; Cook, R. M.
Journal of Agricultural and Food Chemistry 20 (2) 391-394 (1972) [11 ref. En] {Dairy Sci. Dept., Michigan St. Univ., East Lansing, 48823, USA}

HEOD (1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo,exo-5,8-dimethanonaphthalene) was administered orally in gelatin capsules to groups of 2 lactatmg Holstein-Friesian cows at a level of 0.1 mg/kg body wt./day for 3 or 6 wk. The main route of HEOD elimination was not through milk but through faeces. Peak concn. of <0.14 and <0.10ppm, respectively, were found in milk. 4 other cows, similarly fed, also received phenobarbital at the rate of 10 mg/kg body wt./day throughout the 6-wk period, this resulted in slightly lower HEOD levels, in milk during the 4th-6th wk, regardless of HEOD treatment. SAC

MONS 038696

6U387

6 U 387
Ethion; tolerance for residues.
Anon.
Federal Register 37 (38, Feb. 25) 3988 (1972) [En]
The following additional tolerances are established under the Federal Food, Drug and Cosmetic Act for the title insecticide (O,O,O',O'-tetraethyl S,S'-methyl bisphosphorodithioate) *including its O-analogue* (-[[(diethoxyphosphinothioyl)thio]methyl]O,O-diethyl phosphorothioate): cottonseed and milk fat (reflecting negligible residues in milk), 0.5 ppm; eggs, meat, fat, and meat by-products of goats, pigs, horses, poultry and sheep, 0.2 ppm. CAS

6U390

6 U 390
Copper; exemption from the requirement of a tolerance.
Anon.
Federal Register 37 (31, Feb. 15) 3352-3353 (1972) [En]
Cu is exempted from the requirement of a tolerance under the Federal Food, Drug and Cosmetic Act in eggs, fish, meat, milk, irrigated crops, and shellfish when it results from the use of $CuSO_4.5H_2O$ as an algicide or herbicide in irrigation conveyance systems and bodies of waters in which fish or shellfish are cultivated; and basic $CuCO_3$ (malachite) as an algicide or herbicide in impounded and stagnant bodies of water. CAS

1 P 98
A residue study of phenoxy herbicides in milk and cream.
Bjerke, E. L.; Herman, J. L.; Miller, P. W.; Wetters, J. H.

Abstracts of Papers. American Chemical Society 162: PEST 57 (1971) [En] [Residue Res., Agric. Dept., Dow Chemical Co., Midland, Michigan 48640, USA]
Cows were fed a complete ration containing 2,4-dichlorophenoxyacetic acid (2,4-D), 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), 2-(2,4,5-trichlorophenoxy)propionic acid (silvex), or 2-methyl-4-chlorophenoxyacetic acid (MCPA) at graduated levels from 10 to 1000 ppm for 2-3 wk at each level. Milk and cream samples were collected at predetermined intervals during feeding of the respective herbicides and for 7 days following withdrawal of the highest herbicide level fed. Free phenols and acids, as methyl esters, were determined by electron capture or microcoulometric gas chromatography after the acids and their respective phenol moieties were separated by liquid chromatography on acidic alumina. Details of the analytical procedures and results of these studies are presented with respect to the analytical correlations that can be drawn from these data. AS

MONS 038697

5 U 277
Food additive. 3',4'-Dichloropropionanilide; tolerances for residues.
Anon.
Federal Register 37 (2, Jan. 5) 74 & 78 (1972) [En] [Environment Protection Agency, Washington DC, USA]

Tolerances are established under the Federal Food, Drug and Cosmetic Act for residues of the title herbicide (i) and its metabolites (calculated as (i)) as follows: rice straw, 75 ppm; rice bran, hulls, polishings, and other milling fractions resulting from the application of (i) to the growing crop, 10; rice, 2; meat, fat, and meat by-products of cattle, goats, hogs, horses, poultry, and sheep, 0.1 (negligible residue); and eggs and milk, 0.05 (negligible residue). CAS

4 U 179
Dalapon *sodium* salt; tolerances for residues.
Anon.
Federal Register 36 (244 Dec. 18) 24065-24066 (1971) [En]

The following additional tolerances are established under the Federal Food, Drug and Cosmetic Act for the title herbicide (calculated as dalapon, 2,2-dichloropropionic acid): kidney of poultry, 9ppm; sorghum forage, 5; meat of poultry, 3; beans, bean straw, macadamia nuts, sorghum, soybeans and soybean straw, 1; eggs, 0.3; meat and meat by-products of cattle, goats, hogs, and sheep, 0.2; and milk, 0.1 (negligible residue). CAS

5 U 356
Piperonyl butoxide; tolerances for residues.
Anon.
Federal Register 37 (11, Jan. 18) 737-738 (1972) [En] [Environment Protection Agency, Washington, DC, USA]

Tolerances of 0.25 ppm are established under the Federal Food, Drug and Cosmetic Act for residues of the title *insecticide (butyl carbityl* 6-propyl piperonyl) in milk (negligible residue) and 0.1 ppm (negligible residue) in the meat, fat, and meat by-products of cattle, goats, hogs, horses, and

5 U 302
Diphenamid; tolerances for residues.
Anon.
Federal Register 37 (11, Jan. 18) 738 (1972) [En] [Environment Protection Agency, Washington DC, USA]

Tolerances are established under the Federal Food Drug and Cosmetic Act for the title herbicide (N,N-dimethyl-2,2-diphenylacetamide) including its desmethyl metabolite (N-methyl-2,2-diphenylacetamide) as follows: 2 ppm, peanut hay and forage; 0.5, peanut hulls and soybean hay and forage; 0.2, cotton forage; 0.1 (negligible residue), apples, cottonseed, okra, peaches, peanuts, soybeans, and sweet potatoes; 0.05 (negligible residue), in meat, fat, and meat by-products of cattle, goats, hogs, horses, and sheep; and 0.01 (negligible residue) in milk. CAS

MONS 038698

4 P 538

Excretion of o,p'-DDT in milk of cows.

Fries, G. F.; Marrow, G. S., Jr.; Gordon, C. H.

Journal of Dairy Science 54 (12) 1870-1872 (1971) [9 ref. En] [Animal Sci. Res. Div., USDA, Beltsville, Maryland 20705, USA]

2 groups of 4 mid-lactation Holstein-Friesian cows were fed 100 mg/day of (i) o,p'-DDT or (ii) p,p'-DDT for 20 days. Average concn. of residues in the milk fat for days 10-20, when levels of all analogues were fairly constant, were: after feeding (i), 1.82 ± 0.30 mg o,p'-DDD and 0.41 ± 0.08 mg o,p'-DDT/kg; after feeding (ii), 7.68 ± 0.69 mg p,p'-DDD and 2.47 ± 0.41 mg p,p'-DDT/kg. Total residue excreted during this period, based on an average fat yield of 0.77 kg/day, was (i) 1.7% and (ii) 7.8% of intake. 15 days after DDT feeding ceased, residues of (i) were no longer detected, but cows fed (ii) were still excreting 0.72 ± 0.23 mg p,p'-DDD and 0.73 ± 0.05 mg p,p'-DDT/kg milk fat. It is concluded that o,p'-analogues are not a significant contributor to total DDT residues in milk. [See also FSTA (1970) 2 3P281] CDA

4 P 537

Persistance of Phosvel in corn silage and effects of feeding dairy cows the treated silage.

Johnson, J. C., Jr.; Bowman, M. C.; Leuck, D. B.; Knox, F. E.

Journal of Dairy Science 54 (12) 1840-1847 (1971) [10 ref. En] [Dept. of Animal Sci., Coastal Plain Sta., Tifton, Georgia 31794, USA]

Maize treated in the field with Phosvel [O-(4-bromo-2-5-dichlorophenyl) O-methyl phenylphosphonothioate] at rates of 0, 0.56, 1.12 and 2.24 kg/ha was ensiled 1 day later and subsequently fed to 16 lactating cows (4/treatment). Silages produced from treated maize and fed for 8 wk commencing 62 days from ensiling contained 56-66% of the ensiled Phosvel. Ingesting Phosvel and its phenol at averages of 0.41 to 1.71 mg/kg body wt. did not affect (P>0.05) silage DM intakes even though blood cholinesterase was measurably, but not critically, lowered (P<0.05). Cows fed silage from the high treatment had greater body wt. gains (P<0.05) but produced less milk (P<0.05) than cows fed control silage; thus, Phosvel residues seemed to effect a preferential formation or utilization of nutritive metabolic products or both for synthesizing body tissues rather than milk. Residues of Phosvel were present in milk, faeces, and urine of all cows fed treated silage, but the highest mean residues in milk at any sampling were 0.244 ± 0.12 ppm Phosvel and 0.030 ± 0.003 ppm its phenol. Except for an average of only 0.012 ppm Phosvel in milk from cows fed the high residue treatment, the milk, urine and faeces were free of residues within 1 wk after feeding of the treated silage was terminated. AS

1 C 20

Pesticide residues in foods. V. Residues of BHC isomers and other organochlorine pesticides in fatty foods of Japan.

Uyeta, M.; Taue, S.; Nishimoto, T.

Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi] 11 (4) 256-263 (1970) [18 ref. En] [Kochi Prefectural Public Health Lab., Kochi-shi, Japan]

Residue measurements were performed for persistent organochlorine pesticides in 56 samples of milk and milk products and in 40 samples of meat and eggs produced in Japan. The levels and whole milk basis in market milk ranged 0.059-0.356 ppm for total BHC, 0.006-0.037 ppm for total DDT, and 0.002-0.010 ppm for dieldrin. Levels on fat basis in milk products and meats respectively were: 0.25-2.43 ppm and 0.50-13.68 ppm for total BHC; 0.48-1.46 ppm and 0.29-0.56 ppm for total DDT, and 0.01-0.09 ppm and 0.01-0.25 ppm for dieldrin. B-BHC predominated to the extent of ~70% of total BHC residues. This is of concern because B-BHC is reported to have a lower acute toxicity but a higher chronic toxicity than the other isomers. TM

MONS 038699

3 P 311
Effects on flavour of fortifying milk with iron and absorption of the iron from intestinal tract of rats.
Demott, B. J.
Journal of Dairy Science 54 (11) 1609-1614 (1971) [25 ref. En] [Dairy Dept., Univ., Knoxville, Tennessee 37901, USA]

Ferric pyrophosphate, ferric phosphate, ferrous sulphate, ferric ammonium citrate, ferrous gluconate and ferrous lactate at 5.2-12.6 ppm elemental Fe were evaluated for their influence upon the flavour of whole milk and skim-milk. Ferric pyrophosphate and ferric phosphate caused only minor off-flavours. Whole milk fortified with either of these 2 compounds was fed as the sole ration to weanling rats for 9 wk. Milk plus Fe from either source was equally effective in maintaining tooth colour, haematocrit, and body wt., but was not as effective as a standard dry ration plus water. Milks containing 5.2 or 10.4 ppm Fe added as ferric pyrophosphate were equally effective in maintaining body wt. for both male and female rats. Male rats aged 5-9 wk consuming milk with 10.4 ppm added Fe had higher ($P<0.05$) haematocrit values than rats on milk containing 5.2 ppm added Fe. After 9 wk of age the haematocrit values were not significantly different ($P>0.05$). The ratio of wt. and haematocrit values of males to females indicated that females withstood stress of insufficient Fe intake better than did males. AS

MONS 038700

3 P 311

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MONS 038701

J. D. Sci. 46 (1963)

EFFECTS OF FEEDING ARSENIC AND LEAD UPON THEIR SECRETION IN MILK[1]

Information has not been observed on the influence of continuous feeding to cows of relatively low levels of arsenic and lead upon the secretion of these elements in milk. Bovine milk has been reported to contain 0.032 to 0.060 mg/liter of arsenic, with the concentration being somewhat higher in colostrum (5). Milk from one cow late in lactation was found to contain 0.02 mg/kg of lead (1), whereas Kehoe et al. (6) reported the lead content of three milk samples ranging from 0.02 to 0.04 mg/kg.

Both the arsenic and lead contents of cow's milk have been increased by the oral intake of large quantities of these elements. On an area where land and water were contaminated with arsenic, and illness and death of cattle were attributed to arsenic toxicity, milk samples from cows contained from 0.8 to 1.5 mg/liter of arsenic (4). Drenching a lactating heifer daily with 0.3428 g of As_2O_3 as sodium arsenite for three days did not cause an increase in milk arsenic over the predrenching level of 0.23 to 0.27 mg/liter, but did increase the concentration in urine (3). Beginning 11 days later, the animal was drenched with 1.307 g of As_2O_3 daily for three consecutive days, and the arsenic content of milk samples ranged from 0.34 to 0.47 mg/liter during the ensuing four days prior to her death.

A dairy herd consumed two feedings of concentrate contaminated with lead oxide. Milk taken 12 days later from two surviving cows contained 2.26 and 0.15 mg/kg of lead, respectively (8). Milk samples from these two cows taken 122 days after lead feeding contained 0.028 and 0.030 mg/kg of lead, respectively.

This present study was undertaken to determine whether any change in milk levels of arsenic or lead could be detected following continuous feeding of low levels of these elements to lactating cows.

EXPERIMENTAL PROCEDURE

Eight lactating Jersey cows were assigned to four groups of two animals each. They either grazed on millet pasture or were fed chopped millet forage and were offered a concentrate mixture twice daily at the rate of 1 lb per 3 lb of milk produced. Composition of the concentrate mixture expressed as pounds was: soybean meal, 100; ground corn, 300; ground oats, 100; wheat bran, 100; salt, 6; steamed bonemeal, 6. Arsenic and lead were administered by incorporating one-half the daily allowances, as lead arsenate, into 1 lb of concentrate and permitting each cow to consume this before the remainder of the concentrate allowance was offered. Arsenic and lead fed daily to the cows in milligrams per 100 lb body weight were: Group 1, 0.00 and 0.00; Group 2, 1.17 and 3.23; Group 3, 2.34 and 6.5; Group 4, 4.68 and 12.95, respectively. The levels were fed for 126 days. Body weights of cows fed arsenic and lead ranged from 820 to 1,040 lb.

Before initation of lead and arsenic feeding, two dingonally positioned quarters were hand-milked and the other two machine-milked. Since no differences were detected in lead or arsenic content of the milk extracted by each method the animals were milked by machine during the experiment.

With reference to the initation of arsenic and lead feeding, milk samples for analysis were taken at −5, 0, +1, +3, and +14 days and subsequently at 14-day intervals, respectively, through the remainder of the 126-day feeding period. Samples were placed in 250-ml polyethylene bottles, cooled in ice water, and kept under refrigeration until analyzed.

Arsenic was determined spectrophotometrically by a minor modification of the Gibson and Funnell method (7). This method utilizes a wet digestion of the sample with HCl, followed by reduction of the arsenic in the mixture and distillation as arsine. Ten-milliliter samples of milk were digested with 15 ml of HCl at 50 C for 1 hr. Under these conditions excellent recovery of added arsenic was obtained.

Lead was determined by a mono-color dithizone method developed by Cholak and Burkey (2). Ten-milliliter samples of milk were evaporated and charred under an infrared evaporator and finally ashed at 550 C in a muffle furnace.

RESULTS AND DISCUSSION

In all milk samples analyzed, including samples from control cows, concentrations of arsenic and lead were less than 0.05 mg/liter. This was the lower limit for estimation based on a 10-ml sample.

These results obtained on arsenic feeding are in accord with those of Fitch et al. (3), who observed that drenching a heifer with 0.3428 g of As_2O_3 daily for three consecutive days did not cause an increase in arsenic level of the milk. Baxter (1) reported that when less than 3 mg of lead was ingested daily by sheep there was no retention, and within the daily intake range of 2 to 110 mg, absorption apparently was only 1.3 ± .8%. Low absorption and the urinary excretion of lead might account for the observation that no increase was detected in milk lead content at the feeding levels employed.

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REFERENCES

(1) BAXTER, K. L. Lead as a Nutritional Hazard to Farm Livestock. II. The Absorption and Excretion of Lead by Sheep and Rabbits. J. Comp. Pathol., 60: 140. 1950.
(2) CHOLAK, J., AND BURKEY, R. Private communication. Dept. Prevent. Med. Indust. Health. University of Cincinnati. 1952.
(3) FITCH, L. W. N., GRIMMETT, R. E. R., AND WALL, E. M. Occurrence of Arsenic in Soils and Waters of the Waiotapu Valley and Its Relation to Stock Health. II. Feeding Experiments at Wallaceville. New Zealand J. Sci. Technol., 21: 146a. 1939.
(4) GRIMMETT, R. E. R. Arsenical Soils of the Waiotapu Valley. New Zealand J. Agr., 58: 383. 1939.
(5) HOVE, E., ELVEHJEM, C. A., AND HART, E. B. Arsenic in the Nutrition of the Rat. Am. J. Physiol., 124: 205. 1938.
(6) KEHOE, R. A., CHOLAK, J., AND STORY, R. V. A Spectrographical Study of the Normal Ranges of Concentration of Certain Trace Metals in Biological Materials. J. Nutrition, 19: 579. 1940.
(7) OLIVER, W. T., AND FUNNELL, H. S. Determination of Arsenic in Biological Materials. Anal. Chem., 31: 250. 1959.
(8) WHITE, W. B., CLIFFORD, P. A., AND CALVERY, H. O. The Lethal Dose of Lead for the Cow: The Elimination of Ingested Lead Through the Milk. J. Am. Vet. Med. Assoc., 102: 292. 1943.

ZINC CONTENT OF CERTAIN FEEDS, ASSOCIATED MATERIALS, AND WATER[1]

It has been shown that cattle require *zinc* (2, 3); However, the practical importance of zinc in ruminant nutrition has not been established and its metabolism is limited.

One of the handicaps in planning nutrition studies is the lack of reliable data on the zinc content of most feeds. Thus, one of the purposes of this paper is to publish data on the zinc content of several feeds and other materials which might be used in future studies. Also, this information will aid in determining the practical importance of zinc in ruminant rations.

Zinc analyses were made by the dithizone procedure developed by Vreeker et al. (9). These results are summarized in Table 1. Each of the samples was a composite from one or more different lots of material and thus represents an independent estimate of the zinc content of the ingredient or material. Every sample was analyzed two or more times. The materials chosen for analyses were those which were under consideration for use in zinc nutrition studies or those with which the animals might come in contact.

The 14 milk samples were collected either from the milking machine pail or the bulk tank of herd milk. None of the milk had been in contact with galvanized equipment. The results agree quite closely with values of 3.5 ppm given by Underwood (8) as normal for cow's milk.

Of the feeds for which zinc analyses are presented in this paper, data were given only for beet pulp, citrus pulp, and corn in a comprehensive compilation published in 1950 for the United States and Canada (1). The average value of 8.0 ppm for beet pulp is more than ten times the 0.3 mg/lb presented in that compilation (1). The 8.0 and 24 ppm for the citrus pulp and yellow corn are somewhat lower and somewhat higher, respectively, than amounts given for these feeds (1). However, the value for the corn grain is in good agreement with analyses reported previously (5-7, 10). Likewise, the average values for soybean oil meal (6, 7, 10), isolated soybean protein (6, 10), washed isolated soybean protein (10), dried egg albumin (egg white) (6), and nonfat dried milk (7) are in good agreement with those reported previously. The dicalcium phosphate used in this study was manufactured by a *Dorr* process and is expected to have a lower zinc content than that made by the wet ash process as used by Ziegler et al. (10).

TABLE 1

Zinc content of certain feed ingredients, associated materials, and water (as-fed basis)

Material	No. samples	Zinc (ppm.) Range	Avg
Milk, whole*	14	3.8–4.8	4.0
Beet pulp, dried	7	7.4–11.0	8.9
Citrus pulp, dried	4	6.5–11.0	8.9
Coastal Bermuda grass, dried (Piedmont)*	34	23–54	32
Coastal Bermuda grass, dried (Coastal plain)*	10	12–22	16
Corn grain, yellow	2	21–26	24
Soybean oil meal (41% protein, solvent extracted)	2		62

[1] Journal Paper no. 289 of the College Experiment Station, University of Georgia.

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J. D. Sci 46 (1963

EFFECT OF INTRAUTERINE INFUSION OF PENICILLIN-STREPTOMYCIN AND FURACIN[1] AND VAGINAL DEPOSITION OF FURACIN ON CHEMICAL RESIDUE LEVELS IN MILK[2]

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SUMMARY

The milk from 25 dairy cows was examined for chemical residues, using the disc assay technique, following intrauterine infusion of penicillin-streptomycin and Furacin and vaginal deposition of Furacin. Milk samples were collected during the 12- to 96-hr period after the single treatment with antibiotics. They were collected over a 3-wk period during the extended Furacin treatment with suppositories. No chemical residues were found in any of the milk samples from animals subjected to the three types of treatment. There was no evidence of Furacin build-up during the 3-wk treatments.

Several studies (1, 6) have indicated that intrauterine infusions of penicillin-streptomycin will improve the reproductive picture in repeat breeder cows. Other studies (4, 7, 9) have failed to support such observations. It has also been reported that Furacin vaginal inserts (10) or Furacin-antibiotic intrauterine infusions (6) will improve conception rates. Veterinarians are using intrauterine infusions of Furacin alone, when indicated, for a similar purpose.

The above treatments are frequently used in treating hard breeding cows during lactation. Although Kendrick and Pier (5) have shown that antibiotics infused into the uterus do not give rise to residues in milk, there are no data available concerning chemical residues in milk following intrauterine infusion or vaginal insertion of Furacin in dairy cows. Henningson (3) and Hawkins et al. (2) have shown that little or no Furacin appears in the milk drawn from the udder approximately 12 hr after intramammary infusion. This report deals with the examination of milk for chemical residues after treating hard breeding cows with various Furacin preparations and with antibiotics.

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[1] Trade name for 5-nitro, 2-furaldehyde semicarbazone, and a product of Eaton Laboratories, Norwich, N. Y.

[2] Technical contribution No. 414, South Carolina Agricultural Experiment Station, Clemson Agricultural College, Clemson, South Carolina, and published with the approval of the Director.

EXPERIMENTAL PROCEDURE

Twenty-five animals of assorted breeds and in various stages of lactation were treated in three different ways. In Trial One, ten animals termed hard breeders (all had been inseminated at least three times prior to treatment) were given intrauterine infusions consisting of 600,000 IU of procaine G penicillin and 1 g of dihydrostreptomycin in 5 ml of aqueous suspension. This single treatment was administered during estrus. Milk samples were collected, using a Milk-O-Meter,[3] at 12, 24, 48, 72, and 96 hr after treatment.

In Trial Two, ten animals, 30 to 60 days post-partum, were given intrauterine infusions consisting of 60 to 90 ml of a 0.2% Furacin solution in a water-miscible vehicle. One 0.4% Furacin suppository in a water-soluble base was vaginally inserted at the time of infusion. Subsequent treatments consisted of depositing one furacin suppository in the vagina at three evenly spaced intervals per week for 3 wk. The total treatment consisted of one infusion and ten suppositories. Milk samples were collected, using a Milk-O-Meter, 12 and 24 hr and 1, 2, and 3 wk after treatment was initiated.

In Trial Three, five animals, 30 to 60 days post-partum, were given three 0.4% Furacin suppositories at a time, utilizing three evenly spaced periods per week for 3 wk. The total

[3] A mechanical device for weighing and sampling milk, taking a proportional sample, and manufactured by Technical Industries, Ft. Lauderdale, Florida.

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treatment consisted of 27 vaginally inserted suppositories in a water-soluble base. Milk samples were collected as in Trial Two.

Milk samples were assayed for Furacin content by the disc assay method using *Bacillus subtilis* (8) on Pennassay Agar. This method is known to detect as little as 0.03 μg/ml of Furacin in milk (3). All milk samples were assayed in duplicate after heating to 180 F for 5 min, to prevent the possibility of false zones. The sensitivity of the disc assay procedure was checked using Difco discs of known penicillin concentration. Discs containing 0.05 IU of penicillin yielded, with a 7.0-mm disc, zones averaging 13 mm in diameter and ranging from 11 to 14 mm in diameter.

RESULTS AND DISCUSSION

No chemical residues were detected in the milk samples obtained from the treated animals in any of the three trials. These Holstein, Guernsey, Jersey, and cross-bred cows were in various stages of lactation. The days animals were in milk ranged from 35 to 180 at the initiation of the treatments. Milk production per cow per day ranged from 20 to 80 lb of milk during the treatment period.

Results obtained in Trial One using penicillin and dihydrostreptomycin, support the findings of Kendrick and Pier (5) in respect to intrauterine infusions of antibiotics. Results obtained in Trial Three show that triple the recommended suppository dosage, employed in Trial Two, did not give rise to Furacin residues in the milk at any time during the course of such treatments. The absence of residues in the milk from treated animals during the entire treatment period indicates that Furacin levels do not build up when treatments are extended over this time period. Both types of Furacin treatments were easy to administer and no side effects due to such treatments were noted in the course of the investigation.

REFERENCES

(1) Easley, G. T. Bacteriological, Pathological, and Clinical Studies on the Reproductive Tract of the Hereford Cow and a Bacteriological Study of Hereford Bull Semen. No. Am. Vet., 32: 258. 1951.

(2) Hawkins, G. E., Parr, G. E., and Cannon, R. Y. Concentrations and Percentage Recovery of Furacin in Milk Following Intramammary Infusions. J. Dairy Sci., 44: 2212. 1961.

(3) Henningson, R. W. Furacin Residues in Milk. J. Dairy Sci., 44: 1705. 1961.

(4) Hjerpe, C. A. An Evaluation of Uterine Infusion as a Treatment for Repeat Breeding in Dairy Cattle. J. Am. Vet. Med. Assoc., 138: 500. 1961.

(5) Kendrick, J. W., and Pier, A. C. Antibiotic Levels in Milk Following Intrauterine Infusion. Calif. Vet., 13: 27. 1959.

(6) Lindley, D. C. Intra-Uterine Antibiotic Therapy Postservice in Infertile Dairy Cattle. J. Am. Vet. Med. Assoc., 124: 187. 1954.

(7) Roberts, S. J. An Evaluation of Uterine Infusions for the Treatment of Infertility in Dairy Cattle. Cornell Vet., 46: 21. 1956.

(8) Silverman, G. J., and Kositkowski, F. V. Systematic Testing of Inhibitory Substances in Milk. J. Milk Food Technol., 15: 120. 1952.

(9) Ulberg, S. C., Block, W. G., Ridder, H. E., McDonald, L. E., Carida, L. E., and McNutt, S. H. The Use of Antibiotics in the Treatment of Low Fertility Cows. J. Am. Vet. Med. Assoc., 121: 436. 1952.

(10) Vigne, R. F., Fitzgerald, W. H., and Castrucci, R. F. Management of Bovine Genital Infections. I. Intravaginal Therapy. J. Am. Vet. Med. Assoc., 134: 300. 1959.

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J. Dairy Sci 46, (1963)

EXCRETION OF 3-Cl-ANILINE AND ISOPROPYL-N-(3-CHLOROPHENYL) CARBAMATE (CIPC) IN THE MILK AND URINE OF DAIRY COWS FED CIPC[1]

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SUMMARY

No isopropyl-N-(3-chlorophenyl) carbamate (CIPC) or 3-Cl-aniline residues were found in the milk when dairy cows were fed CIPC twice daily at the rates of 1, 5, and 25 ppm during a 4-wk period. Also, no residues of CIPC or 3-Cl-aniline were found in milk during the 48-hr period following ingestion of 100 ppm CIPC in a single feeding. However, 3-Cl-aniline was found in the urine 3 hr after feeding 100 ppm CIPC and during the subsequent 12 hr. The minimum detectable levels of the analytical method were 0.05 ppm CIPC and 0.03 ppm 3-Cl-aniline. The feeding of CIPC in this investigation produced no measurable effect on the physiology of the cows or their milk production.

Experimentally CIPC, isopropyl-N-(3-chlorophenyl) carbamate, has been found to be useful in eliminating weeds from forage crops, but detectable residues of the herbicide were present on the forage at harvest time. CIPC and several other organic compounds, useful as insecticides and herbicides, are esters of carbamic acid and are classified as carbamates. Gyrisco et al. (3) fed the insecticide Sevin,[2] a carbamate, to dairy cows at levels up to 450 ppm in their daily ration to determine if Sevin or its metabolite, 1-naphthol, appeared in the milk. That investigation and similar studies (1, 4, 6) indicated that no residues of Sevin, or 1-naphthol, occurred in the milk when cows were fed Sevin at levels ranging from 2.5 to 450 ppm in their daily ration.

The purpose of this investigation was to determine if residues of CIPC or its probable metabolite, 3-Cl-aniline, appeared in the milk or urine of dairy cows when this herbicide was continuously fed at levels of 1 to 25 ppm or in a single dosage of 100 ppm.

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[1] State Special Project No. 111, supported in part by a grant from the Pittsburgh Plate Glass Company, Chemical Division, Barberton, Ohio. Contribution to Regional Project NC-33, Pesticide Residues on or in Food, Feed, and Forage Crops (Their Magnitude, Character, and Persistence).

[2] Copyrighted name for 1-naphthyl-N-methylcarbamate, manufactured by Union Carbide Chemicals Co., Division of Union Carbide Corp., 180 South Broadway, White Plains, New York.

EXPERIMENTAL PROCEDURES

The single feeding of CIPC at the 100 ppm level was made to two cows on two occasions. The CIPC feeding at 0, 1, 5, and 25 ppm levels was made twice daily for 28 consecutive days with two cows in each group. One cow in each group was producing approximately 40 lb milk daily and the second cow in each group was producing 20 lb or less.

The pretest or single feeding of 100 ppm CIPC was accomplished by adding the technical grade CIPC directly to the grain or by placing it in a 20-ml bolus capsule with a small amount of grain and administering with a bolus gun. In this manner the quantity ingested at one feeding contained 100 ppm CIPC based on the *individual cow's daily dry matter intake*. The continuous feeding of 1, 5, and 25 ppm was achieved by fortifying a 15 days' supply of grain with an ethanolic solution of CIPC and stirring at high speed for 15 min in a large rotary feed-mixing device. One pound of fortified grain contained CIPC at a level of 1, 5, or 25 ppm CIPC based on the average daily dry matter intake of the individual cows. One half pound of the treated ration was included in the concentrates fed each morning and evening. Whenever the *grain ration was not completely* consumed, which occurred rarely, the remaining

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concentrates were added to and consumed with the concentrates at the subsequent feeding.

In the pretest study, 1-pt milk samples were collected as control samples just before ingestion of the treated ration and at 1-, 2-, 4-, 8-, 12-, 24-, and 48-hr intervals following CIPC ingestion. Only 1 pt of milk was removed from each cow's udder at the 1-, 2-, 4-, 8-, and 12-hr intervals, because the cows available for this part of the investigation were producing milk at a very low level. At the 24- and 48-hr intervals the sample was taken following a thorough mixing of the milk obtained at a complete milking of each cow. The samples were contained in 1-pt capped bottles and held at 40 F until analyzed. The majority of the samples were analyzed within 48 hr and the others within 72 hr after collection. The following procedure was used to test the stability of 3-Cl-aniline and CIPC in raw, whole milk: Two 100-ml samples of raw, whole milk were fortified with 15 μg of 3-Cl-aniline and 25 μg of CIPC, respectively. These samples were analyzed on the day of fortification and following 12 days' storage at 40 F. No measurable loss could be detected with either material following storage at 40 F for 12 days. In the continuous-feeding study, milk samples were collected at the regularly scheduled milking time on each Monday and Thursday. These samples were taken after the milk obtained at a complete milking of each cow had been thoroughly mixed, and the samples were held as described above until analyzed.

Data concerning the physiological condition of the cows were collected on the day before initiation of CIPC feeding and again on the 14th and 28th days of the experiment. These observations included body weight, respiration rate, pulse rate, body temperature, and the appearance of feces and urine. Daily milk weights were recorded and the routine monthly determinations for milk fat, SNF, and protein were made on the milk of each cow on the 21st day of the trial period.

The method used in the microdetermination of CIPC and 3-Cl-aniline in milk has been described by Gard and Ferguson (2). This method utilized the alkaline hydrolysis of CIPC to 3-Cl-aniline, which is separated from the mixture by steam distillation, and is based on the colorimetric measurement of the complex formed between 3-Cl-aniline and N-1-naphthylethylenediamine dihydrochloride after diazotization of the 3-Cl-aniline with nitrous acid. The color complex was read at 540 mμ, using a 5-cm cuvette in a Beckman B spectrophotometer. Standard curves were established by fortifying water with CIPC and milk with both CIPC and 3-Cl-aniline at the beginning and termination of the study. Recovery studies of CIPC and 3-Cl-aniline from raw whole milk were conducted. The average per cent recoveries from 100-ml raw milk samples fortified with 5, 10, 15, 25, and 50 μg CIPC were 81, 64, 70, 61, and 52%, respectively. Milk was fortified with 3-Cl-aniline only at the 15-μg level and averaged 66% recovery.

Following the second feeding of 100 ppm CIPC, urine samples were collected at each urination during the first 12-hr period. These samples were analyzed by the Chemical Division, Pittsburgh Plate Glass Company, Barberton, Ohio, following the methods described by Gard and Ferguson (2). Urine analyses were also conducted on samples collected from the cows which received 25 ppm CIPC.

RESULTS

The optical densities of the milk analyses indicated the amount of CIPC or 3-Cl-aniline present. Results of the pretest trials, feeding 100 ppm CIPC in a single dosage, are given in Table 1. In the first trial, April 29, the analysis of milk withdrawn prior to CIPC feeding was used as the control. In the second

TABLE 1

Effect of feeding 100 ppm CIPC in a single dosage

Date	Treatment	No. of observations	Optical density: Mean	Optical density: Standard error
April 29	Prefeeding	10	.1358	.011
	CIPC feeding	28	.1186	.005
May 16	Prefeeding	12	.1336	.009
	Control	7	.1471	.007
	CIPC feeding	24	.1085	.005

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TABLE 2
Results of feeding CIPC continuously for 28 days

Level of CIPC feeding	No. of observations	Optical density		
		Mean	Standard error	Range
Control	10	.1291	.012	.1062–.1020
1 ppm	23	.1042	.004	.1124–.0960
5 ppm	29	.1180	.000	.1373–.1005
25 ppm	33	.1103	.004	.1184–.1032

trial, May 10, milk from a cow which had not received CIPC served as an additional control during the 48-hr milk sampling period. Application of the standard errors to compute confidence limits of the means indicated that none of the means of optical densities were statistically different. Therefore, it was concluded that these data show no evidence of CIPC or 3-Cl-aniline in the milk. Table 2 shows similar negative results from the analyses of milk samples from all cows fed CIPC continuously for 28 days. Results of the analyses of urine from cows fed 100 ppm CIPC appear in Table 3. These analyses positively indicate detectable levels of CIPC or 3-Cl-aniline in the urine 3.00 hr after ingestion. One urine sample from these cows was analyzed to determine whether the chemical response was due to CIPC or 3-Cl-aniline. This was accomplished by omitting the alkaline hydrolysis. Results indicated that the urine constituent was 3-Cl-aniline and not CIPC. Results of the analyses of urine from the cows which had received 25 ppm CIPC were inconclusive, because the absorption values were too similar to the average control values to be distinguishable.

No effect of feeding 100 ppm CIPC could be detected in respect to milk yield, appearance of feces and urine, or body temperature, pulse, and respiration rate. These physiological functions were likewise unaffected in the continuous-feeding trial and the data indicated that this treatment had no measurable effect on milk composition or body weight of the cows.

DISCUSSION

The general class of carbamate esters is normally hydrolyzed in the GIT of mammals to the acid and alcohol fractions. One such material, the insecticide Sevin, is hydrolyzed to 1-naphthol by both plants and animals (6). A study involving the feeding of high levels of Sevin to dairy cows showed that neither Sevin, 1-naphthol, nor conjugates of 1-naphthol pass into the milk. Results of their work indicate that part of the Sevin dosage is hydrolyzed to 1-naphthol, which in turn is detoxified and eliminated in the urine as water-soluble 1-naphthyl sulfate; a small amount of free 1-naphthol or Sevin also appears in the urine and some Sevin appears in the feces unchanged (1). Westlake and San Antonio (6) stated

TABLE 3
Results of urine analyses for CIPC equivalent [a]

Cow no.	Sample-urination no.	Urine volume	Hours after CIPC ingestion	Avg ppm CIPC equivalent [b]
		(pt)		
505A	Control	....	0.0	0.04
	1	4	4.5	0.37
	2	2	6.5	0.17
	3	2	8.0	0.17
	4	3	12.0	0.16
506A	Control [c]	....	....	....
	1	1	1.25	0.04
	2	2	3.00	0.24
	3	3	5.75	0.25

[a] Analyses made by Pittsburgh Plate Glass Company, Chemical Division, Barberton, Ohio.
[b] Not corrected for blanks.
[c] Control sample not collected.

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Range
.1562-.1020
.1124-.0960
.1373-.1005
.1184-.1032

ding 100 ppm CIPC could ect to milk yield, appearance or body temperature, pulse, e. These physiological functions unaffected in the continuous the data indicated that this measurable effect on milk dy weight of the cows.

DISCUSSION

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after	Avg ppm 1-[14]C equivalent[b]
0	0.04
5	0.37
5	0.17
0	0.17
0	0.16
25	0.04
00	0.24
75	0.25

vision, Barberton, Ohio.

that 1-naphthol is not sufficiently stable to permit the detection of more than trace amounts after hydrolysis of Sevin in plants and animals.

This study supports the general carbamate metabolic pathway of hydrolysis to the acid and alcohol, in that neither CIPC nor 3-Cl-aniline appeared in the milk. The appearance of 3-Cl-aniline in the urine in small amounts following intake of 100 ppm, but not detectable in urine from the continuous feeding of 25 ppm, indicates that 3-Cl-aniline, as 1-naphthol in the Sevin study, is probably not sufficiently stable to permit the detection of more than trace amounts. No analyses of feces were made during this study.

CONCLUSION

When a ration containing 25 ppm CIPC was fed continuously for 4 wk neither CIPC nor its metabolite, 3-Cl-aniline, was detected in the milk or urine. Following the ingestion of 100 ppm CIPC in single feedings, only 3-Cl-aniline was present in measurable quantities in the urine and neither CIPC nor its metabolite appeared in the milk.

ACKNOWLEDGMENTS

The authors thank Mr. Richard Valentine and Mr. Leavitt Gard, Pittsburgh Plate Glass Company, Chemical Division, Barberton, Ohio, for conducting the urine analyses in this study.

REFERENCES

(1) ANONYMOUS. Why Doesn't Sevin Insecticide Show Up in the Milk? Station to Station. VI, June-July, 1960.

(2) GARD, L., AND FERGUSON, E. Determination of Micro Amounts of Isopropyl-N-(3-Chlorophenyl) Carbamate (CIPC) in Milk and Urine Excreted from Cows. J. Agr. Food Chem. (In press.) 1962.

(3) GYRISCO, G. G., LISK, D. J., FERTIG, S. N., HUDDLESTON, E. W., FOX, F. H., HOLLAND, R. F., AND TRIMBERGER, G. W. The Effects of Feeding High Levels of Sevin on Residue, Flavor, and Odor of the Milk of Dairy Cattle. J. Agr. Food Chem., 8: 409. 1960.

(4) U. S. DEPARTMENT OF AGRICULTURE. Special Rept., K-52. 1959.

(5) VALENTINE, R., AND GARD, L. Analysis of Urine Excreted from Milk-Producing Cows. Determination of CIPC and 3-Chloroaniline. Barberton Tech. Serv. Rept. No. BTS-10736, Pittsburgh Plate Glass Co., Chem. Div., Barberton, Ohio. 1961.

(6) WESTLAKE, W. E., AND SAN ANTONIO, J. P. Insecticide Residues in Plants, Animals and Soils. ARS 20-9, USDA, ARS Symposium, p. 105. September, 1960.

MONS 038709

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The Nature of the Octa
tadecatrienoic Acids of
at. Ph.D. dissertation.
ity, Columbus. 1960.
n, S. P., MAGIDMAN, P.
ISEA, R. W. Unsaturated
serfat. Agr. Food Chem.

DETECTION OF MILK FAT ADULTERATION BY MOLECULAR DISTILLATION[1]

E. H. SANDER[2] AND E. W. BIRD
Department of Dairy and Food Industry, Iowa State University, Ames

SUMMARY

An apparatus and a method are described for the molecular distillation at 250 C for 1 hr of food fats and oils without decomposition or polymerization.

Seasonal variations in milk fat composition were shown to influence the distillate yield.

Distillate yields from mixtures of milk fat, produced in different seasons of the year, and domestic food fats or oils, indicated that molecular distillation can detect additions of these fats or oils but not of coconut oil. If the production season of the milk fat were unknown, a minimum addition of 18-20% domestic food fat or oil could be detected; the detectable amount could well be less than 5% with milk fat produced at certain seasons of the year.

Deviations in the refractive indices of the distillates, obtained from milk fat-edible fat and oil mixtures, from those considered normal for milk fat, indicated a possibility of detecting additions of coconut oil but not of domestic food fats or oils. If the production season of the milk fat were unknown, a minimum addition of 30% coconut oil could be detected; the detectable amount could be less than 5% with milk fat produced at certain seasons of the year.

During a study of tocopherol contents of fats and oils, we found that different types of fats and oils distilled in different amounts under the same distillation conditions. The differences in amounts distilled suggested that the method might be used to detect adulteration of milk fat.

The molecular distillation of a mixture of fatty acids is dependent, among other things, upon chain length, degree of unsaturation, and concentration of the component fatty acids. The distillation rates of mixed triglycerides are determined largely by the chain length and concentration of the component fatty acids under a given set of conditions (3).

The chief concern, then, is the variation of the ratios of the low molecular weight fatty acids to those of high molecular weight. The influence of these ratios on the molecular distillation characteristics of some fats and oils including coconut oil has been reviewed (2). We will show later that, except in a critical iodine value (IV) range for a hydrogenated fat, the quantity of distillate is not greatly affected by the degree of unsaturation (Figure 3).

The success of distillation procedures in this study depend, to a large extent, on variations in the ratio of short- to long-chain acids, which accompany changes from stall to pasture feeding.

Our objectives were to determine (a) whether molecular distillation could be employed to detect reasonable additions of animal and vegetable fats to milk fat and (b) to obtain data concerning some distillation characteristics of some edible fats and oils.

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[2]A summary of a thesis submitted in partial fulfillment of the requirements for a degree Master of Science in Food Technology.

MATERIALS AND METHODS

Apparatus. Figure 1 is a line drawing of the distillation apparatus. The fore-pump, A, and the pump for the McLeod gauge were Cenco HyVac pumps. The distillation apparatus,[3] diffusion pump (Model G 4-01) and McLeod gauge (0-50 μ; 0-0.5 mm and 0-5 mm scales) were obtained from the Consolidated Vacuum Corp., Rochester, N. Y. Dry ice and acetone were used in the cold finger condenser, H, and trap, F. The desiccant tube (indicating Drierite) was necessary for the maintenance of a

[3]The ranges in still dimensions of the apparatus used were: Pots, internal diameters 6.81-6.89 cm, internal depths 14.0-15.1 cm; cold fingers, external diameters 5.72-5.74 cm and external lengths 13.5-13.50 cm.

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lited to 4 lb per calf daily), alfalfa hay, and reconstituted milk. The latter, containing 11.0% solids-not-fat and 2.64 or 0.88% fat (milk fat in cream, or lard oil) plus vitamins and an antibiotic, was fed daily at 8, 6, and 5% of birth weight for Weeks 1-4, 5, and 6, respectively. Mean body weight gains (lb) to 4, 8, and 16 wk for 2.64% milk fat, 0.88% milk fat, 2.64% lard oil, and 0.88% lard oil, respectively, were 26, 47, and 178; 26, 47, and 178; 22, 46, and 170; 20, 44, and 158. Differences in body weight gain to 16 wk, due to source of fat, were significant at $P = 0.05$, but those due to level of fat were not. Differences in increases in height at withers were not significant. Starter consumption was greater during the early weeks for groups fed the low-fat diets. Total starter and hay consumption was greater for the milk-fat groups. The incidence of diarrhea was low.

P106. Early effects of dietary glycerides and fatty acids on serum fatty acids (free and combined) levels in young dairy calves. A. P. MA, D. K. HOTCHKISS, AND R. S. ALLEN,* Iowa State University, Ames.

After approximately 2 wk on a reconstituted skimmilk diet, five Holstein calves (ranging in age from 3 to 7 wk) were fed, by nipple pail, single test meals of reconstituted skimmilk, to which were added various lipids at a 3% level. The lipids (triolein, tristearin, tripalmitin, monoolein, monostearin, and oleic, stearic, palmitic, and linoleic acids) were tested using a partially balanced incomplete block design. Serum fatty acids (free and combined) of blood samples taken at 0, 3, 6, 9, 12, and 24 hr after feeding the test meal were analyzed by gas-liquid phase chromatography. There were definite but variable changes in the serum fatty acid levels with respect to time after consumption of the test meals. Tripalmitin gave significantly higher ($P < .05$) serum palmitic acid levels than all other dietary lipids except oleic acid. Tristearin and monostearin gave higher ($P < .05$) serum stearic acid levels than triolein. Oleic acid and triolein gave higher ($P < .05$) serum oleic acid levels than tristearin and stearic acid. Linoleic acid gave higher ($P < .01$) serum linoleic acid level than the other lipids. Tripalmitin gave higher ($P < .05$) serum arachidonic acid levels than either monoolein or oleic acid.

P107. Fate of digesta throughout the alimentary tract of calves. M. G. YANG* AND J. W. THOMAS, Michigan State University, East Lansing.

Male Holstein calves fed equicaloric and equinitrogenous rations consumed significantly more of a 27% fiber ration per 100 lb of body weight than a 7% fiber ration. This increase in consumption was accompanied by a 66% increase in the dry matter found in the rumen, abomasum, small intestine, and cecum, although the proportion of dry digesta in respective parts of the tract was similar for both groups. Digestibility of nutrients between successive portions of the tract was measured, using the lignin ratio technique. Calves fed the 7% fiber ration had higher total and rumen digestibility for Ca, P, ash, dry and organic matter than those fed 27% fiber ration. The reverse was found for fiber. The rumen accounted for 75 to 106% of the total digestibility of these nutrients. Ration differences for other tract segments were small. More nutrients were secreted than absorbed in the proximal half of the small intestine. The whole tract contained two moles of VFA from the 7% fiber and six moles from the 27% fiber; 79 and 75% of this was in the rumen, respectively. Molar per cent of acetic and propionic acids were 66 and 24 versus 75 and 17 for the rumen and lower tract, respectively.

P108. Use of a re-entrant ileal fistula technique to study utilization of carbohydrates by the young bovine. J. L. MORRILL,* N. L. JACOBSON, AND A. D. MCGILLIARD, Iowa State University, Ames.

Four calves were fitted at 3 wk of age with re-entrant ileal fistulae located about 5 in. oral to the ileo-cecal junction. The calves were fed milk, or milk with sucrose or starch added, at various ages from one to four and one-half months. The diet was supplemented with vitamins, trace minerals, and an antibiotic. Polyethylene glycol (PEG) was added as a marker. Ileal and fecal samples were taken at 0, 3, 6, 9, and 12 hr after the morning feeding.

The utilization of lactose orad to the fistula was high, and digestion in the entire digestive tract was essentially complete. The average for apparent digestion of sucrose by the four calves was 84%. The recovery of sucrose at the fistula varied with time of sampling and was usually highest at 3 and 6 hr after feeding. Limited observations indicated that 87% of the ingesta that passed the fistula in the 12-hr period passed in the 6-hr interim from 1.5 to 7.5 hr after feeding. Based on these data, sucrose digestion orad to the fistula averaged 41% for the four calves. Digestion of starch orad to the fistula could not be determined, since the starch did not pass at the same rate as PEG.

P109. Forage-milk relationships of Cs^{137}, I^{131}, and Sr^{90} in one herd of cows. G. M. WARD* AND J. E. JOHNSON, Colorado State University, Fort Collins.

Composite milk samples were collected three times a week from two groups of cows in the University herd. One group received some hay and free-choice consumption from an irrigated pasture. The other group was fed

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**P111. Improved
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·ent ileal fistula tech-n of carbohydrates by Morrill,* N. L. Jacobson, and J. B. Holland, Iowa State

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nships of Ca^{45}, I^{131}, ows. G. M. Ward* ado State Univer-

were collected three cows in the ·oup, served some ·ed from an ·oup was fed (about 25 lb per head per day) green-cut alfalfa and free-choice hay. The milk levels of Ca^{45} and I^{131} were determined by gamma spectrometry. Forage samples were collected and analyzed bi-weekly. Composited weekly milk samples and forage samples were analyzed for Sr^{90} by the Health and Safety Laboratory, New York City.

Radionuclide levels were consistently higher and more variable in the milk of pasture cows than those in dry lot. Several peak levels of I^{131} were found during this period. On changing to stored feed, milk levels of the pasture group decreased within several weeks to levels produced by the control group.

Seasonal trends in Cs^{137} and Sr^{90} concentrations of the forage were reflected in milk levels, but on a day-to-day basis they were not, indicating that transport from forage to milk is very fast or influenced by other factors involved in the passage of fallout into milk.

P110. Relation of milk secretion to iodine in milk. J. K. Miller, E. W. Swanson,* and R. G. Cragle, UT-AEC Agricultural Research Laboratory, Oak Ridge, Tennessee.

Eight cows averaging 23.2 lb daily milk yield and their identical twins in later lactation averaging 10.7 lb were dosed with 2 mc NaI^{131}. Average seven-day I^{131} excretions for higher compared to lower yielders were 6.8 and 3.6% ($P < .01$) in milk, 42.8 and 46.6% ($P > .24$) in urine, and 31.5 and 24.6% ($P < .01$) in feces. Percentage of milk I^{131} associated with protein averaged 12.1 and 13.9 ($P < .01$), respectively. Iodine^{131}/milliliter milk indicated greater secretion of iodine by higher yielders was primarily due to greater yield. Milk I^{131}/plasma I^{131} ratios were 1.0 in higher vs. 1.4 in lower yielders. In eight experiments with five cows, right (R) and left (L) udder halves were milked at 8- and 32-hr intervals, respectively, resulting in 41% ($P < .01$) lower daily production from L. Two millicuries NaI^{131} were administered i.v. after R was milked and L contained a 24-hr milk accumulation. Concentration of I^{131}/ml L milk averaged 26% ($P < .01$) higher than R for 144 hr following dosing. R vs. L milk PBI^{131} values were 11.9 vs. 7.1% ($P < .05$) at 8 hr, 12.5 vs. 15.7% ($P < .05$) at 40 hr, and 14.3 vs. 17.6% ($P < .05$) at 72-hr post-dosing.

P111. Improved apparatus for perfusion of isolated organs. J. B. Holter,* R. D. McCarthy, and E. M. Kesler, Pennsylvania State University, University Park.

A perfusion apparatus was designed and built for maintaining an isolated organ under conditions simulating the in vivo state. Provision was made for maintenance of nearly constant temperature, control of humidity, oxygenation of the venous blood, and measurement of blood pressure and flow rate. The artificial heart, built by H. C. Reynolds, was designed so that the number of strokes and the volume per stroke could be varied. In routine use it was found that blood pressure could be reduced by the addition of dibenamine·HCl. If desired, evolved carbon dioxide can be collected. The apparatus is mounted on a cart, permitting easy transport. It is constructed mostly of plastic, thus eliminating contact between metal and blood. It is easily disassembled for cleaning. As built, it is of a size suitable for perfusion of livers, rumens from goats or sheep, and mammary glands from goats. These organs have been successfully perfused. Details of construction and operation will be presented.

P112. Ruminal tissue metabolism of blood organic acids and glucose. S. L. Spain,* F. M. Kesler, and J. B. Holter, Pennsylvania State University, University Park.

The metabolism of blood organic acids and glucose by rumen tissue of the goat was investigated using the rumen perfusion technique. Defibrinated blood with added glucose, butyrate, propionate, and acetate-1-C^{14} was perfused for 90 min through the circulatory system of an emptied rumen (Experiment 1) and a full rumen (Experiment 2). A vasodilator (dibenamine·HCl) was used to reduce vasoconstriction. In Experiment 1 blood concentrations of glucose, butyrate, propionate, acetate, and formate decreased, whereas concentrations of lactate + beta-hydroxybutyrate increased. In Experiment 2, considerable quantities of valerate, butyrate, propionate, and acetate were absorbed. Blood concentrations of glucose decreased, lactate + beta-hydroxybutyrate increased, and formate varied at different sampling times. In both experiments radioactivity in blood acetate decreased to about 50% its original level. These studies indicate that blood organic acids and glucose are metabolized by rumen tissue to a considerable extent. It is suggested that attempts to measure the rate of absorption of organic acids and glucose in intact ruminants should include not only blood flow rate, arterial and venous metabolite concentrations, but also metabolite production by the organ, utilization of arterial metabolites, and utilization of metabolites being absorbed.

P113. Oxidation of acetate by sheep liver homogenates. E. D. Mayfield,* Jack L. Smith, and B. Connor Johnson, University of Illinois, Urbana.

It has been previously reported (Proc. Soc. Exptl. Biol. Med., 99:560. 1958) that perfused goat liver did not remove acetate from perfusing blood which contained added acetate. In addition, Gallagher and Battery (Biochem. J., 72:575. 1959) could not demonstrate the oxidation of acetate by sheep liver mitochondria. However, in vivo the acetate

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Isotonic solutions buffered each at pH 3.0, 7.6, or 9.0 were perfused through the uterus at .0188 ml/min. Each solution contained 10 mg/100 ml of the drug. Perfusion was stopped after 4 ml had been introduced. The uterus was then blown out with a clean syringe, the material collected, and its volume and pH determined. Ten milliliters of drug-free solution were passed through the uterus, collected, and volume was measured. Total drug concentrations were determined and percentage absorption calculated. Lipid-solubility was determined by measuring percentage absorption of each drug in chloroform. Each drug was perfused into 10 uteri at pH 7.6. Statistical analyses showed that both the pKa and lipid-solubility of the drug have an effect on the percentage absorption ($P < .05$). Then each drug was perfused at pH 3.0 and 9.0. The percentage absorption increased significantly ($P < .01$) when the drug was in acid solution. These acids appear to cross the guinea pig uterine membrane by passive diffusion.

P121. Relationship of milk fat and body fat concentrations of organochlorine compounds in cows. G. F. Fries* and G. S. Marrow, Jr., Animal Science Research Division, USDA, Beltsville, Maryland.

Data were pooled from 4 experiments with dieldrin, DDT, DDD, DDE, or a polychlorinated biphenyl (Aroclor 1254). The constant intake ranged from 10 mg/day DDE to 200 mg/day Aroclor 1254. Samples of body fat were obtained at several times during and after feeding, and ranging from .15 to 60 μg/g. At any given time during feeding and at all times after feeding, the milk fat-body fat relationship was described for all compounds by the general equation $Y = bX$, where Y is μg/g in milk fat, X is μg/g in body fat, and b is a constant. During feeding, b was greater than 1 and decreased as the feeding period increased. At 60 days b was 1.53 (1.38 to 1.70, $P < .05$). After feeding stopped, pooled data for all times and all compounds were described by the same b, .74 (.71 to .77, $P < .05$). When the source of contamination is removed, body fat levels reliably estimate future milk levels of organochlorine compounds if the cows are not lactating. Similarly, compounds in milk fat reliably estimate those in body fat if the cow is lactating.

P122. Arsenic in milk and blood of cows fed organic arsenic compounds. C. C. Calvert* and L. W. Smith, Animal Science Research Division, USDA, Beltsville, Maryland.

Four lactating Holstein cows were fed dried manure from broilers fed 3-nitro-4-hydroxyphenylarsonic acid as a feed additive. The amount was slowly increased so that each cow received approximately 3.5 kg of manure per day for the last 5 days of 18 days. The broiler manure contained 18.1 mg/kg arsenic. Arsenic consumption averaged 40 mg/cow/day. Arsenic did not appear in milk from cows as a result of this arsenic intake. Therefore, in a second experiment four groups of two cows each were fed either 3.2 or 1.6 mg arsenic per kilogram of body weight from arsanilic acid or 3-nitro-4-hydroxyphenylarsonic acid. These arsenicals were fed by capsule daily for 5 days. Arsenic in milk increased from .015 to .026 mg/kg in cows fed the 3.2 arsenic from arsanilic acid. Arsenic concentration in milk did not appear to be increased in the other three groups. Blood arsenic concentrations increased in cows fed 3.2 mg of both arsanilic acid and 3-nitro-4-hydroxyphenylarsonic acid but not in those cows receiving 1.6 mg of either arsenical.

P123. Metabolism of phenobarbital-2-^{14}C by the lactating dairy cow. A. R. Bonnink, R. A. Frobish*, C. L. Davis, J. H. Clark, and B. O. Brodie, University of Illinois, Urbana.

The present recommendation for dairy cows contaminated with chlorinated hydrocarbons is to feed phenobarbital (PB) and activated charcoal to decontaminate the animal. However, little is known about the metabolism and excretion of barbituates in the lactating cow. To study this problem, sodium PB (6 g/day) was administered for 10 days into the rumens of two lactating Holstein cows. On the 10th day ^{14}C-labelled PB (5-ethyl-5-phenobarbituric-2-^{14}C acid) was mixed with the unlabelled material prior to dosing. Total milk, urine, and feces were collected with 08 and 92% of the isotope being recovered after 6 days. Percentages of the recovered doses in milk, urine, and feces were: 5.6 and 3.4, 93.1 and 94.1, 1.3 and 2.5. Half lives were: milk, 41.3 and 39.8 hr; urine, 30.6 and 28.5 hr; and feces, 40.5 and 40.5 hr. Highest specific activity occurred 10 and 16 hr after dosing in the milk and urine. If 6 g of PB/day is fed continuously, less than .5 ppm/day would be expected in the milk 7 days after the last dosage.

P124. Effects of feeding a low zinc diet to dairy cows on performance and zinc content of milk. M. W. Neathery*, W. J. Miller, R. P. Gentry, and D. M. Blackmon, University of Georgia, Athens.

Following a standardization period, a high beet pulp, low zinc diet (14 ppm) was fed without and with supplemental zinc (35 ppm total Zn) to 10 first-lactation Holstein cows for 6 weeks. The low zinc diet did not adversely affect milk production, fat-corrected and solids-corrected milk, milk fat, solids-not-milk, or feed intake, indicating that zinc intake was adequate for these functions. However, zinc content of the milk was 23% lower. Likewise, dietary zinc in milk increased from 9 to 18%. Thus, the first adjustment on the low zinc diet was a reduction in zinc content in milk combined with

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more efficient absorption and translocation of zinc to milk. Milk zinc content of a cow was highly repeatable from one measurement period to another, indicating that factors affecting milk zinc can be investigated more efficiently if standardization period data are used in covariance analyses.

P125. "Zinc metabolism in lactating cows fed low and normal zinc diets. P. E. Stake*, M. W. Neathery, W. J. Miller, R. P. Gentry, and D. M. Blackmon, University of Georgia, Athens.

Ten first lactation Holstein cows ware given a single tracer oral ^{65}Zn dose 4 weeks after initiation of a low-zinc diet (14 ppm) which was fed without and with supplemental zinc (35 ppm total Zn). Net ^{65}Zn absorption (not excreted in feces for 14 days) increased from 34.8 to 53.4% of the dose with the low-zinc intake. Following dosing, 6.2 and 14.3% of the dose were secreted into the milk of control and low-zinc fed cows over 14 days with highest amounts on Day 3. Thus, the low-zinc diet resulted in a higher percentage of the dose being absorbed, a higher percentage of which went into milk. The more biologically active tissues (such as liver, spleen, lung, and pancreas) contained higher ^{65}Zn concentrations than the less active ones such as muscle, bone, and skin. In every major body tissue ^{65}Zn was higher in cows fed the low-zinc diet. Likewise, zinc specific activity was measurably higher in milk and tissues of cows fed the low-zinc diet, indicating greater affinity for dietary zinc.

P126. Calcium, phosphorus and magnesium absorption in dairy cows fed starch supplemented diets. J. P. Bargeloh*, J. W. Hibbs, and H. R. Conrad, Ohio Agricultural Research and Development Center, Wooster.

In Ca, P, and Mg balances starch was added to a ration of alfalfa meal, diammonium phosphate, and alfalfa hay (Experiment 1) or starch replaced ground corn in a ration of alfalfa meal with either bone meal or monosodium phosphate and grass hay (Experiment 2). Phosphorus content of rations was equalized. In Experiment 1, Ca and P digestibility coefficients were 17.3 and 19.3, with starch, and 26.1 and 23.0 without added starch. In Experiment 2, Ca, P, and Mg digestibility coefficients were 4.7, 22.8 and 18.3, with starch, and 3.7, 23.8 and 17.4 where ground corn replaced starch. The marked increase in Ca absorption previously shown when grain was added to alfalfa diets did not occur when P was equalized. Rate of passage of undigested dry matter was the most important variable controlling Mg absorption. Fecal Mg increased at an increasing rate with increased fecal dry matter.

P127. Calcium:phosphorus ratio and intake effects on parturient paresis and milk production responses to methionine analog. R. W. Gardner*, and D. J. McClellan, Brigham Young University, Provo, Utah.

A ration of 2 kg alfalfa hay, 20 kg corn silage, and 1.8 kg soybean meal was group fed to 50 dry Holstein cows (D1) for comparison with a ration of 7.0 kg alfalfa hay, 4 kg corn silage, and 1.8 kg of a concentrate mix (87% soybean meal, 4% cane molasses, and 9% monosodium phosphate) fed to 45 dry cows (D2). Average daily calcium and phosphorus intakes were 62, 27 g (D1) and 140, 65 g (D2), with Ca:P ratios of 2.3:1 (D1) and 2.1:1 (D2). Incidences of parturient paresis were 0 of 50 (D1) and 1 of 45 (D2). Lactation rations were: 13.6 kg corn silage, 7.3 kg alfalfa hay, and 10 kg of a concentrate mix. Three protein sources were compared using 35 cows per treatment: cottonseed meal plus 22 g methionine hydroxy analog/cow/day (R1); meat and bone meal (R2); cottonseed oil meal (R3). Milk, fat, and solids-not-fat production (kg/day) for the first 105 days of production were: 29.2, 1.02, 2.47 (R1); 30.6, 1.07, 2.62 (R2); 30.0, 1.07, 2.57 (R3), ($P > .05$).

P128. Effects of dietary calcium:phosphorus on parturient paresis and blood composition. D. J. Burkhart*, D. C. Beitz, and N. L. Jacobson, Iowa State University, Ames.

Twenty-six Jersey cows (second lactation and beyond) were allotted to two groups according to lactation number, milk production, and previous incidence of parturient paresis (PP). Fourteen cows were fed (for up to 12 months before parturition) a complete feed of corn silage and concentrate with Ca:P of 1.1:1. The others were fed similarly except $CaCO_3$ was added to increase the Ca:P to 2.3:1. Phosphorus and total protein as percentage of dry matter averaged .25 and 14.5 for each diet. Venous blood was collected regularly from 4 weeks prepartum to 4 weeks postpartum. Plasma was analyzed for Ca and Mg by atomic absorption and for inorganic P (P_i) by colorimetry. Hypocalcemic animals were treated with a P- and Mg-free borogluconate solution. Seven of the 14 cows on the 1.1:1 diet and 9 of the 12 on the 2.3:1 required treatment for PP. Time on the diets before parturition had no apparent effect on incidence of PP. Plasma Ca and P_i were lower from 48 hr prepartum to 48 hr postpartum in PP than in non-PP cows. Magnesium was inversely related to Ca. There were no major dietary effects.

P129. Effects of sulfur source on ration digestion, nitrogen utilization and sulfur balance in growing steers. L. S. Bull* and J. H. Vandersall, University of Maryland, College Park.

A diet of corn silage, corn meal, and urea was fed to eight growing Holstein steers either alone (C) or supplemented with Na_2SO_4 (Na), DL-methionine (M), or M-analog (MA). Sulfur content (DM) of C was .19% and was .32% in

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Milk
Production

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MILK PRODUCTION

Public Health Pesticides.....A

Dairy Cattle Science, 1st Edition - M. E. Ensminger.....B

Milk Hygiene, by World Health Organization, Geneva, 1962.....C

Milk Pasteurization by Hall and Trout, 1968.....D

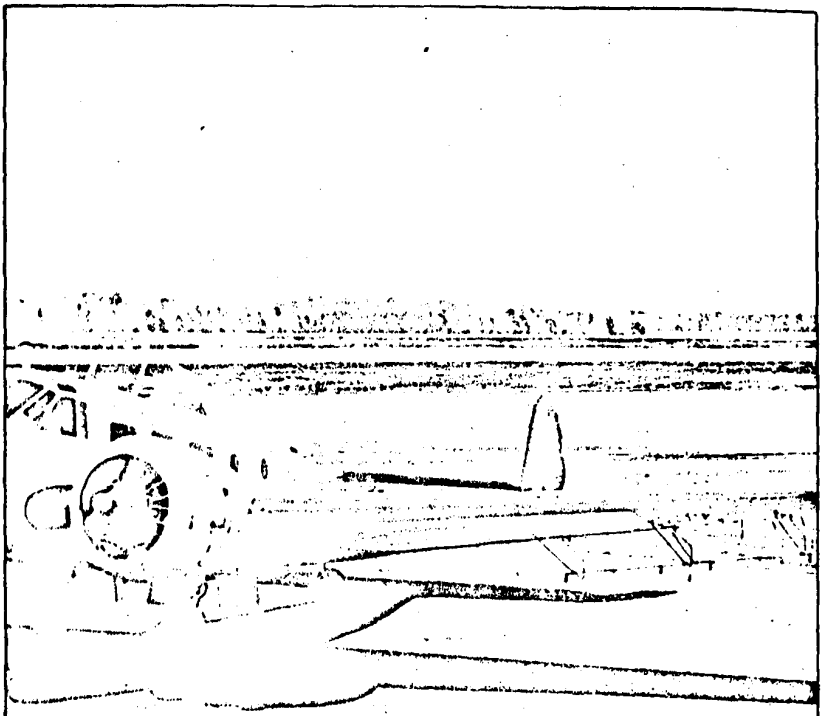
Suggested Guide for the Use of Insecticides to Control Insects Affecting Crops, Livestock, Households, Stored Products, Forests and Forest Products, 1967, USDA.....E

Grade "A" Pasteurized Milk Ordinance - 1965 Recommendations of the United States Public Health Service, HEW.....F

Milk Flow.....G

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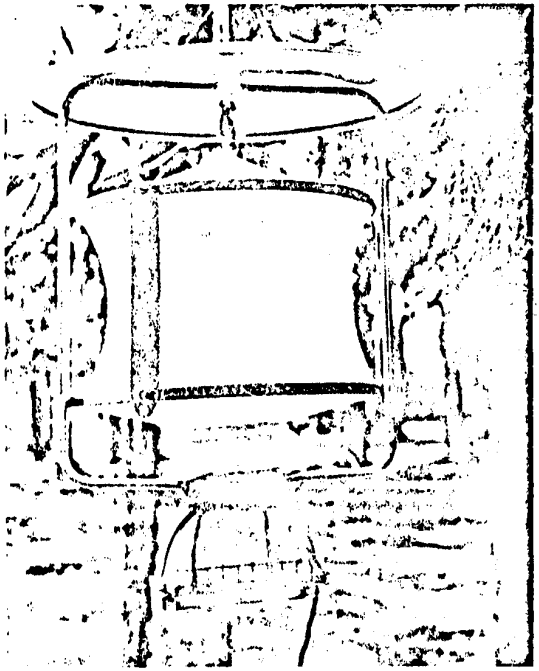
Technical Development Laboratories
Malaria Program
Center for Disease Control
Box 2167 — Savannah, Ga. 31402

PUBLIC HEALTH PESTICIDES

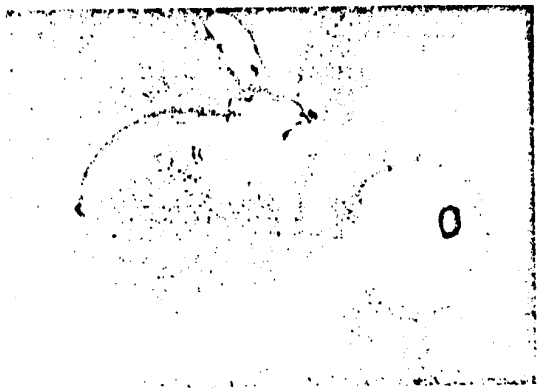
1972 Center for Disease Control Report on Public Health Pesticides for mosquitoes, flies, fleas, bedbugs, ticks, chiggers, lice, cockroaches, venomous arthropods, and rodents, from the Technical Development Laboratories, Malaria Program, Center for Disease Control, Public Health Service, Health Services and Mental Health Administration, U.S. Department of Health, Education, and Welfare, Savannah, Georgia 31402.

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CDC plane equipped for experimental studies of ultra low volume insecticide applications.



Updraft black light trap developed by Technical Development Laboratories for mosquito surveillance.



Developmental effect on Anopheles pupae from exposure of larvae to juvenile hormone mimic.

PUBLIC HEALTH Pesticides is the annual release of the Center for Disease Control (CDC) that presents current information on the use of pesticides in the control of arthropods and rodents of public health significance. The data included are from CDC investigations supplemented by published findings and unpublished experimental results furnished by certain research organizations[1]. Unpublished findings from the CDC are so designated.

The purpose of the article is to keep organizations and personnel engaged in the control of disease vectors and rodents currently informed on compounds that are effective and can be used safely. Emphasis is placed on new developments in the chemical control field and on those pesticides in current use by agencies engaged in control or eradication programs. When no marked changes have occurred in the data, the information may be presented unchanged from previous years. The sequence of listing of the toxicants in the text or in the tables is alphabetical where feasible and in no way implies any priority in the selection of a compound. **The decision to apply any compound is the responsibility of the agency or individual concerned. The comments on the various pesticides refer to experimental or reported results and should in no way be construed as a specific recommendation or endorsement of the pesticide or the application equipment involved. Each operator should be certain that the use he intends to make of a particular pesticide is in conformance with existing state and local regulations. In addition, since the pesticide application procedures mentioned are only outlined or described**

[1]Special acknowledgment is made to the organizations listed below for their cooperation in furnishing unpublished experimental data for inclusion in the resume. References to these organizations are shown by the capital letter indicated: Entomology Research Division, U.S. Department of Agriculture[A]; the Bureau of Vector Control, California Department of Public Health[B]; the West Florida Arthropod Research Laboratory, Florida State Board of Health[C]; the Environmental Biology Branch, Tennessee Valley Authority[D]; and the Metropolitan Mosquito Control District, St. Paul, Minnesota[E].

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briefly, anyone unfamiliar or inexperienced with a specific procedure should seek the advice of a person experienced in its use or obtain the necessary training from a recognized source.

Compounds included in this resume are commercially available. Information on compounds that have been tested or evaluated but are not yet on the market can be obtained by writing to the Technical Development Laboratories, Center for Disease Control, P. O. Box 2167, Savannah, Georgia 31402. *Inquiries should specify the compound and insect involved.*

In the text of the resume, the chemical is designated by its accepted common name which is indicated by lower case (*e.g.*, fenthion). If such a designation is not available, the capitalized trade name or code name is listed[2]. When a newly accepted common name replaces a trade or code name, the latter is included in parentheses the first year it is reported. Unfortunately, many chemicals are marketed under a variety of trade names and to quote all such names would be unfeasible editorially. To quote only one trade name would be interpreted as indicating Federal endorsement of the product when the same pesticide is available under other trade names. Such endorsement is not possible[1]. To assist the reader in identifying specific compounds several references on toxicants and their synonyms are given in footnote 3.

PESTICIDES AND ENVIRONMENTAL HEALTH

The controversy over the effect of pesticides on man and his environment has not diminished and many questions about the validity of the arguments advanced on the benefits and detrimental effects of pesticides still remain unanswered. Legislation has been introduced into the Congress but its consideration is still incomplete and until definite agreement is reached upon the specific regulations and restrictions involved, no attempt will be made to present such information here. One point appears certain: the ultimate legislation will contain more extensive regulatory practices on insecticide use than has previously been in effect. Statements on the impact of insecticide treatments upon the environment are required in large-scale programs under Federal sponsorship. The Environmental Protection Agency (EPA) is now the Federal agency which is responsible for the registration of pesticides and with regulations concerning their application.

The registration of DDT has been cancelled in regard to its use (1) on shade trees, (2) on tobacco, (3) in and around homes except for limited uses for the control of disease vectors as determined by public health officials and (4) in aquatic environments, marshes, wet lands and adjacent areas except those essential for the control of disease vectors as determined by public health officials. The Department of the Interior has prohibited the application of 16 pesticides including aldrin, DDT, dieldrin, heptachlor and lindane in programs under its control and has placed 32 other pesticides such as BHC, chlordane, diazinon, chlorpyrifos (Dursban), Kepone, parathion and 1080 under restriction. Restricted compounds are to be used only when nonchemical techniques are not available and the use is of a limited nature.

With reference to DDT the Public Health Service (PHS) has advocated that to protect the well-being of man throughout the world, the following should be done:

1. Permit the use of DDT for public health purposes in the United States under emergency
2. Permit the manufacture and export of U.S. DDT for public health programs outside the U.S.
3. Continue monitoring DDT and its effect in the environment, especially as the use of DDT gradually declines.
4. Investigate the effects of the alternative insecticides on the environment. Such studies should include the possible detrimental effects upon man resulting from use of such substitute pesticides, conditions with appropriate regulations on its control and application.

The known human health hazards from DDT are considered by PHS as essentially zero, and when examined in this light the benefits to man from its use for the control of malaria far outweigh even any potential hazard on the basis of the total accumulated knowledge on this compound.

Certain states have banned the use of DDT and other pesticides or stipulated that a particular compound can be used in certain instances when no other suitable material is available (*e.g.*, Michigan permits DDT to be applied in mouse and bat control).

Many of the states are considering or have adopted legislation restricting or regulating pesticides. BECAUSE OF THE CHANGES AND AMENDMENTS THAT MAY OCCUR IN THE REGULATORY ASPECTS OF PESTICIDES AT STATE AND FEDERAL LEVELS, ANY OPERATOR INVOLVED IN USING PESTICIDES SHOULD CONSULT AN APPROPRIATE AUTHORITY OR THE STATE REGULATORY AGENCY BEFORE APPLYING A PESTICIDE WHOSE USE STATUS IS IN QUESTION. *Any information in this release on pesticide use reflects the status as of February 1, 1972.*

In the control of arthropods of public health importance in the United States, DDT does not represent a critical chemical. It has only limited use at present in the control of encephalitis vectors in and around farmhouses in western United States and as a barrier woodland application against

[1]Use of trade names is for identification purposes only and does not constitute endorsement by the Public Health Service or U.S. Department of Health, Education, and Welfare.

[2]Frear, Donald E. H. Pesticide Handbook-Entoma. 1971. 23rd Edition. College Science Publishers, State College, Pennsylvania, 253 pp; Kenaga, Eugene E., and William E. Allison. 1969. Commercial and experimental organic insecticides (1969 revision). Bull. Ent. Soc. Amer. *15*(2):85-148; and Billings, S. C. 1969. Additions and corrections—Consolidated list of approved common names of insecticides and certain other pesticides. Bull. Ent. Soc. Amer. *15*(4):380.

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Culiseta melanura during outbreaks of eastern equine encephalitis. DDT also is used against mice. For the control of most arthropods, DDT has been supplanted by the organophosphorus and carbamate compounds, principally because many vector populations have developed resistance to DDT. The cheapness of DDT and its safety record to humans have made this compound the insecticide of choice, but its further use must now be limited to the prevention and control of human diseases and other essential uses for which no alternative pesticides exist. In certain instances DDT has caused injury to nontarget organisms which justifies the view that nonessential and indiscriminate applications of the compound are unwarranted.

In this release, DDT will be mentioned for domestic use only when no effective nonpersistent substitute is available or when its specified use does not constitute a hazard to the environment*. However, the user should contact the state agencies for agriculture, health and game management to be certain that there are no local restrictions on its application.

Other compounds considered as "persistent" are aldrin, dieldrin, endrin, heptachlor, chlordane, BHC, lindane and chemicals containing arsenic, lead and mercury. In the United States most of these compounds are of limited value as public health pesticides and, in general, they are applied for specific and limited purpose since certain ones, such as dieldrin and aldrin, are harmful to fish and other nontarget organisms.

Restrictions on DDT usage by the Federal Government apply only to the United States and do not relate to other countries which establish their own regulations on pesticides. Some countries, such as Sweden, Italy and Canada, have banned the use of DDT, although it may still be applied for specific purposes. However, internationally, DDT plays an important role in controlling public health diseases.

*Since further review of the Federal registration of DDT by EPA is still in progress, additional regulations may be issued on its domestic use. Other organochlorine compounds such as aldrin, dieldrin, chlordane, BHC, and lindane also are under review. The information contained in this Report reflects the status as of February 1, 1972.

The World Health Organization considers that the concept of malaria eradication rests completely on the continued use of DDT. In such programs DDT is the principal insecticide used in the residual treatment of dwellings. When so used, its application minimizes possible contamination of the environment as compared to situations where it is used out-of-doors as a general area treatment. DDT also has a definite value overseas in the control of trypanosomiasis, onchocerciasis, louse-borne typhus and bubonic plague.

Most alternate pesticides for DDT represent a material increase in cost, a factor considered of less consequence in the United States than in the developing overseas areas. In the United States the three elements, vector control, protection of nontarget organisms and contamination of the environment, must be considered *value for value*. With this viewpoint, the added cost of insecticides that are potentially less harmful to nontarget organisms is compensated for by the protection of the wildlife and the decrease in environmental contamination.

CONTROL PRINCIPLES

The major purpose of this release is to describe pesticidal measures, not to summarize the various methods of arthropod and rodent control. However, a brief discussion of control principles is essential to provide guidelines for establishing control operations.

The limited reference in the text to nonchemical methods is not to be interpreted as minimizing the significance of this phase of vector control. Inasmuch as nonchemical measures relate chiefly to specific problems and normally require longer periods of time to achieve control, chemical control remains a major weapon in many vector control programs. Nonchemical procedures are fundamental to vector control, since they reduce or eliminate the insect or rodent population at its breeding source. Included among these approaches are source reduction, environmental sanitation and education. Measures such as drainage, filling, or flooding eliminate mosquito breeding sites, whereas those involving the proper storage, collection, and disposal of garbage curb domestic fly breeding and reduce the rodent problem.

Educational efforts are essential to getting both the community and the individual to recognize the role each plays in preventing the creation and support of arthropod or rodent breeding sites. Education has become increasingly important in present day vector control because of the need to inform not only the public but also the groups concerned with the protection of wildlife and the environment of the control procedures being used. A concerted effort to exchange information can do much to create a better understanding among the various groups involved.

On any large-scale program the previously named fundamentals are basic to success. Insecticides support and supplement this basic approach and provide a higher level of control than might otherwise be achieved.

Chemical control measures are of prime importance during disasters or epidemics when rapid reduction of arthropod populations is mandatory. Under these circumstances, the use of nonchemical measures, which are relatively slow in their effect, is wholly unfeasible.

Failure to achieve control of a specific arthropod or disease with a chemical measure may be the result of local ecological conditions, the species, formulation or application of the insecticide, insecticide resistance, or faulty timing of the treatment. The supervisor must assess the possible influence of each of these factors in any control situation so that he can analyze the problems involved and then select those countermeasures that offer the best solutions. The control supervisor should establish a sound inspection program and know the sources and population trends of the vector species concerned. With such information he knows which control measure to apply, and when, where and how often treatment is necessary. An integrated control program is the key to effective vector control.

Any supervisor must have a sound knowledge of the biology and ecology of the species concerned and should have adequate background and experience with the chemical control and evaluative techniques available. Training courses to provide knowledge on the control of vector-borne diseases are available

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to sanitarians, mosquito abatement operators and others; these courses are given by the Laboratory Division of CDC, Atlanta, Georgia 30333.

RESISTANCE

Resistance to certain chemicals has occurred in a number of species. A recent review reported that whereas in 1958 thirty-five species were resistant to the organochlorine compounds and four were also resistant to the organophosphorus insecticides; in 1971 there were 104 resistant species, 18 of which had developed resistance to organophosphorus materials.

In the control of many species of mosquitoes and of house flies, the organochlorine compounds are no longer of value and in some species the same applies to a number of organophosphorus insecticides. In the United States this is particularly true of the *Musca domestica*. In California, *Culex tarsalis* in several counties is no longer controllable by organophosphorus larvicides. *Aedes nigromaculis* also is highly resistant to the available organophosphorus larvicides in various parts of the same state and in some localities is not susceptible to carbamates. Despite such discouraging developments, some species continue to succumb to the same pesticides even though the identical control measures have been in effect for many years. Although industrial know-how continues to synthesize new compounds, their usefulness remains unproven until tests demonstrate that cross resistance is not present. As a general rule such measurement of cross resistance should extend to several areas before a premature conclusion on the lack of usefulness of a new compound is known.

One of the principal problems in the use of new insecticides in public health is the fact that such compounds may have been used extensively in agriculture prior to their consideration in the control of a public health vector. As a result, the initial change of a susceptible field population of a vector species towards a resistant one may be stimulated by the application of pesticides in agriculture. Consequently, when the compound is first used in public health there may already be a slight or high resistance to it in the vector population. Such may be true whether it is the same compound used in agriculture or is a related one. Thus, an evaluation of the resistance levels of the species to new public health pesticides is extremely essential in any area where insecticides have been used for purposes other than vector control.

Since the development of resistance may not be common to a species throughout its distribution, a supervisor must be certain that poor control is not due to other factors such as careless spray techniques, lack of knowledge about insect habits, or faulty source reduction procedures. Resistance detection methods suitable for field use are now available for more than 35 species of insects as well as for rodents[5]. With some species, methods are available for both the immature and adult stages of the insect. Whenever these techniques are used, do not place undue emphasis on slight changes in the insects' response to the toxicant. *Any decrease in susceptibility should be substantiated by the observation of a loss of field efficacy of the chemical treatment before the operator seeks another toxicant or considers a change of procedure.*

PESTICIDE HAZARD

Pesticides must always be handled in such a way that the possibility of harm to nontarget organisms (including man), either through contamination of food and water or by contact, is kept to a minimum. All spraymen should be given intensive training in the proper handling of pesticides. Accidents are few when the individual knows and follows the proper procedures. Eight basic rules to minimize hazard are:

(a) Know the material being applied; *READ THE CONTAINER LABEL AND UNDERSTAND THE DIRECTIONS* for preparing and applying the pesticide, and then *FOLLOW THE DIRECTIONS.*

(b) Wear protective clothing and headgear, and avoid prolonged exposure to pesticides. Special care should be exercised to prevent inhalation and contamination of the skin when handling insecticidal concentrates (*i.e.*, use respirators, impermeable aprons and gloves).

(c) Avoid contamination of foods or drinking water of man and animals.

(d) When pesticide contamination of the body occurs, wash the affected area quickly and thoroughly with soap and water. Wash with soap routinely after each day of spraying.

(e) Keep spray equipment clean and in good condition. Flush insecticidal equipment only where contamination will not affect man or wildlife.

(f) *STORE PESTICIDES IN PROPERLY LABELED CONTAINERS OUT OF REACH OF CHILDREN AND ANIMALS.*

(g) Dispose of empty containers safely (*e.g.*, bury them under at least 2 feet of soil).

(h) *KNOW THE EMERGENCY MEASURES FOR TREATING ACCIDENTAL POISONING*[6].

Guides to the toxic hazard of pesticides to mammals and other animals are available from the various pesticide manufacturers and from the EPA, 4770 Buford Highway, Chamblee, Georgia 30341. These guides contain data obtained from toxicological studies conducted on rabbits, rats and other test animals (Table 1). Data on the toxicity of pesticides to wildlife are available from publications by the Department of Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife[7]. Such data are extremely valuable in comparing the relative toxicities of the different compounds. However, the KEY TO THE SAFETY OF HUMANS AND OTHER NONTARGET ORGANISMS IS A KNOWLEDGE OF THE HAZARDS INVOLVED IN HANDLING AND APPLYING PESTICIDES. To assess these

[5]These techniques are described in the World Health Organization Technical Report Series No. 443, Insecticide Resistance and Vector Control, Geneva, 1970.

[6]Information on this subject is included in the Clinical Handbook on Economic Poisons, which is available as Public Health Service Publication No. 476 from the Superintendent of Documents, Washington, D.C. 20402. Price, 55 cents.

[7]Information on this topic is available in the Handbook of Toxicity of Pesticides to Wildlife, Resource Publication No. 84, March 1970, which is available from the Superintendent of Documents, Washington, D.C. 20402. Price, $1.00.

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Table 1. Acute oral and dermal LD_{50} toxicity values of selected pesticides to female rats (mg./kg.).[a]

Chemical Class	Pesticide	Oral[c]	Dermal
Organochlorine:	chlordane	430	690
	DDT	118	2,510
	dieldrin	46	60
	lindane	91	900
	methoxychlor	6,000[b]	>6,000
Organophosphorus:	Abate	13,000	>4,000
	chlorpyrifos (Dursban)	82	202[b]
	diazinon	285	455
	dichlorvos	56	75
	dimethoate	245	610
	fenthion	245	330
	Gardona	1,125	>4,000
	malathion	1,000	>4,444
	naled	250[c]	800[c]
	parathion, ethyl	3.6	6.8
	parathion, methyl	24	67
Carbamate:	propoxur	86	>2,400
	carbaryl	500	>4,000
Arsenical:	paris green	100	2,400
Botanical:	pyrethrum	263[d]	—
Miscellaneous:	diphacinone	1.9[c]	—
	pindone	280[c]	—
	warfarin	3[c]	—

[a] All figures taken from tests performed by the Chamblee Toxicology Laboratory, Environmental Protection Agency, 4770 Buford Highway, Chamblee, Georgia 30341.
[b] Sex not specified.
[c] Data for male specimens.
[d] Unpublished data.

hazards, consideration must be given to the chemical properties of the toxicant formulation (absorption characteristics, stability, etc.), use concentration, site of application, amount of area involved, frequency of treatments and exposure time. For example, the application of an insecticide as a spot treatment inside homes offers little or no hazard to wildlife in comparison to aerial applications of a pesticide to an aquatic situation such as a marsh or lake. Likewise, repeated applications of a pesticide may pose a hazard not present when only a single or a few treatments are required. Full consideration must always be given to the fact that different species of animals may vary widely in their sensitivity to injury from a pesticide. Even among closely related animals there may be a marked variation in response.

A summary of the evidence concerning the impact of pesticides on nontarget organisms was issued in 1971[1]. This resume covers the effect of insecticides, herbicides, and fungicides on mammals, fish, birds, arthropods, plants, and other nontarget organisms as well as information on the environmental problems resulting from pesticide residues.

[1]Ecological Effects of Pesticides on Nontarget Species, Executive Office of the President, Office of Science and Technology, available from the Superintendent of Documents, Washington, D.C. 20402. Price, $2.00.

PESTICIDE SELECTION

In choosing a pesticide, the operator seeks a toxicant that is highly effective against the pest and yet, when used as directed, is not harmful to humans and other animals. The pesticide also should be economical, easy to apply and noninjurious to treated surfaces. Because each control situation is different, the relative emphasis placed on certain characteristics of the pesticide (*i.e.*, odor, cost, toxicity, persistence) may vary considerably. In most instances the decision reached will be a compromise to serve the interests of the groups involved. For example, where the use of an organochlorine insecticide may be detrimental to wildlife, the substitution of a more costly compound of lesser harm to nontarget organisms may be necessary. The advice and suggestions of other agencies with interests in the total environment should be sought so that the control program is considerate of the concern of the other groups and is amenable to their interests.

Throughout the major part of this release, the dosage of toxicant employed is expressed as technical material in terms of milligrams per square foot, pounds per acre, liquid ounces per acre, or parts per million. The dosage of the toxicant applied is dependent upon the concentration of the formulation used, together with the rate at which the material is dispersed. Thus, the addition of 5 milliliters of a 1% emulsifiable concentrate to 50 gallons of water provides the same concentration in parts per million as 1 milliliter of a 5% preparation.

ARTHROPOD CONTROL

MOSQUITOES

Mosquitoes are the most important group of arthropods that transmit diseases to man. Mosquito-borne diseases include encephalitis, dengue hemorrhagic fever, filariasis, yellow fever and malaria. Numerous species are involved whose breeding habits, behavior and dispersal are markedly different. The eggs of certain species are capable of surviving for months on damp or even dry soil; other species require water for egg deposition, and the eggs hatch within a short period. Dispersal of species like *C. tarsalis* may extend for more than 5 miles whereas others, such as *Aedes aegypti*, possess a limited range of less than 0.5 mile. Consequently, control measures for mosquitoes, whether larvicides or adulticides, must relate to the species or to a species group and cannot be considered as being applicable to mosquitoes in general.

The expanding picture of mosquito resistance to insecticides presents a major problem in the chemical control of mosquitoes, particularly in areas where extensive larviciding practices have been conducted (*e.g.*, California). In Florida[4] larvae and adults from a field-collected strain of *Aedes taeniorhynchus* were shown to be highly resistant to malathion. The

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strain was susceptible to fenthion, propoxur and Abate. Resistance is found in anopheline vectors in many areas of the world, but the problem has been a major cause of failure of malaria eradication programs in only a few countries.

The pesticides employed in mosquito control are discussed under the method of application and their uses are summarized in Table 2.

Residual treatment:

The interior spraying of houses is rarely practiced in the United States but is a standard procedure for malaria eradication programs in overseas areas. The insecticides, dosage and periods of efficacy are given in Table 2. Experimentally, several other insecticides, such as propoxur and carbaryl, have given satisfactory results for periods of 3 months, but carbaryl (200 mg./sq. ft.) has been inconsistent in its performance in Georgia and Haiti versus that in Arkansas and Africa. In contrast, propoxur has produced 3 months of effectiveness against three vectors in three different continents.

Methoxychlor (CDC), a biodegradable organochlorine compound, gave good results against dieldrin-resistant *Anopheles albimanus* in studies on outdoor panels and in experimental huts. At 200 mg./sq. ft. it gave 90% kills of *A. albimanus* on adobe panels for 9 weeks. When applied at the same dosage to a hut with mud-lined walls, the same level of kill of free-flying *A. albimanus* was obtained for more than 14 weeks. In laboratory tests against a DDT-resistant strain of *A. albimanus* methoxychlor was slightly less effective than against the dieldrin-resistant strain. Methoxychlor was ineffective against free-flying, DDT-resistant *Anopheles quadrimaculatus*. In Arkansas studies methoxychlor (200 mg./sq. ft.) was highly effective against field populations of *A. quadrimaculatus*, while in Africa the compound was ineffective against *Anopheles gambiae*.

Outdoor residual applications of DDT against *C. tarsalis* have lowered the encephalitis infection rates of sentinel chickens. The organophosphorus compounds do not have the persistency of DDT and, although malathion and diazinon have been tested against *Aedes* and *Culex* species, little success has been achieved. Recent tests in Florida[6] indicate that the treatment of individual premises with 2% malathion suspension at the rate of 16 pounds of toxicant per acre did not give satisfactory reduction of *Culex nigripalpus*.

Table 2. Pesticides Currently Employed in Mosquito Control.[a]
(State or local regulations may impose certain restrictions on the use of these compounds; therefore, the individual should consult local or state authorities on the accepted use practices.)

Type Application	Toxicant[b]	Dosage	Remarks
		Mg./sq. ft.	
RESIDUAL SPRAY	malathion	100 or 200	For use in United States as an interior house treatment. Particularly persistent on wood surfaces and remains effective for 3 to 5 months.
	BHC	25 or 50	FOR USE IN OVERSEAS ZONES AS A STANDARD APPLICATION FOR TREATING THE INTERIOR OF HOMES IN MALARIOUS AREAS. A suspension formulation is most effective. Dosage and cycle of retreatment depend on the vector, geographic area, and transmission period. DDT and dieldrin are effective for 6 to 12 months, BHC for 3 months. When the vectors are resistant to these organochlorine compounds, malathion or propoxur should be used. Their efficacy is from 2.5 to 6 months.
	DDT	100 or 200	
	dieldrin	25 or 50	
	propoxur	100 or 200	
RESIDUAL FUMIGANT	dichlorvos	1 dispenser per 1000 cu. ft.	Formulated in resin. Dispensers are suspended from ceiling or roof supports. Provides 2½ to 3½ months of satisfactory kills of adult mosquitoes. Do not use where infants, ill, or aged persons are confined or in areas where food is prepared or served.
		1 dispenser per catch basin.	Dispensers are suspended 12" below catch basin cover.
		Lb./acre	
OUTDOOR GROUND SPRAY	carbaryl	0.2-1.0	Dosage based on estimated swath width of 300 ft. Mists or fogs are applied during the dusk to dawn period. Mists are usually dispersed at rates of 7 to 25 gal. per mile at a vehicle speed of 5 mph. Fogs are applied at a rate of 40 gal./hr. dispersed from a vehicle moving at this speed; occasionally at much higher rates and greater speeds. Finished formulations contain from 0.5 to 8 oz./gal. actual insecticide in oil, or, in the case of the nonthermal fog generator, in a water emulsion. Dusts also can be used. For ground ULV application[c], technical grade malathion is dispersed at a rate of 1 to 1.5 fl. oz./min. and a vehicle speed of 5 mph or at a rate of 2 to 3 fl. oz./min. and 10 mph.
	fenthion[d]	0.01-0.1	
	malathion	0.075-0.2	
	naled	0.02-0.1	

(Continued on next page)

Residual fumigant:

Formulation of dichlorvos in wax or resin allows the gradual release of

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Table 1 (continued)

Type Application	Toxicant[b]	Dosage	Remarks
	Abate	Lb./acre 0.05-0.1	Apply by ground equipment or airplane at rates up to 10 quarts of formulation per acre depending upon concentration employed. Use oil or water emulsion formulation in areas with minimum vegetative cover. Where vegetative cover is heavy, use granular formulations. DO NOT APPLY PARATHION IN URBAN AREAS. For prehatch treatment on an area basis, use methoxychlor (1 to 5 lb./A.) or chlorpyrifos (0.1 lb./A.). Chlorpyrifos and fenthion provide prolonged effectiveness in contaminated water at dosages 5 to 10 times those listed.
L	chlorpyrifos (Dursban)[c,e]	0.0125-0.05	
	EPN[c]	0.075-0.1	
A	fenthion[c,d]	0.05-0.1	
R	malathion	0.2-0.5	
V	methoxy-chlor	0.05-0.2	
I	parathion[c], ethyl or methyl	0.1	
C			
I	paris green	0.75	Apply paris green pellets (5%) at rate of 15 lb./A. with ground equipment or airplane.
D			
E	fuel or petroleum oil	2 to 20 gal./A.	Apply to cover water surface in catch basins or at a rate of 15 to 20 gal./A. in open water courses. With a spreading agent at a rate of 0.5%, the volume can be reduced to 2 to 3 gal./A.

[a] When insecticides are to be applied to crop lands, pasture, range land, or uncultivated lands, consult agricultural authorities as to acceptable compounds and application procedures.

[b] Other compounds, such as Thanite, Lethane 384, propoxur and ronnel, may have uses in certain of the categories mentioned. If so, follow label directions.

[c] For use by trained mosquito control personnel only.

[d] Adhere strictly to label specifications and directions for use.

[e] Not to be applied to waters containing valuable fish, crabs, or shrimp.

[f] Label requires a 3-week interval between applications, except for fog treatments.

the insecticidal vapor over an extended period, the preparation thus acting as a residual fumigant. A concentration of dichlorvos in an enclosed space at or above 0.02 μg./liter of air will give complete mortality of adult mosquitoes. Thus, this type of treatment is effective against adult mosquitoes in homes, catch basins, cisterns and other types of confined areas. The amount of vapor produced by a dispenser is relatively uniform at a given temperature, but doubles for every 20° F. rise in the temperature range of 70° to 100° F. The number of dispensers required varies with the degree of ventilation in a room. In tropical dwellings constructed of mud with thatched or mud roofs, the number of dispensers used may vary from one unit per 165 to one unit per 500 cubic feet. This rate of treatment results in effective kills of caged mosquitoes for periods of 3 to 4 months. In catch basins, one unit per basin has remained effective for periods of 11 to 18 weeks against *Culex pipiens quinquefasciatus*. In situations where there is a minimum of ventilation, as in homes in the temperate zone, one strip per 1,000 cubic feet of enclosed space is the maximum acceptable rate of treatment. *In the United States these dispensers should not be used where infants or aged persons are continually exposed to the vapor or in areas where food is prepared, served, or stored.*

Space treatments:

Properly timed and applied, outdoor space treatments will temporarily reduce adult mosquito populations to low levels. Fog, dust, mist and ultra low volume (ULV)* applications have been shown to produce similar results against saltmarsh mosquitoes. For maximum operational efficiency, the performance characteristics of the equipment must be determined with each of the formulations employed. This assessment is of extreme importance with aerial or ground ULV applications in which undiluted concentrate of the insecticide is dispensed. Different weather conditions, various types of terrain, and vegetation greatly influence the results of space treatments.

The dosage rate of a space treatment normally is calculated on a pound-per-acre basis for ground applications and for some aerial spraying, and on the basis of fluid ounces of active ingredient per acre or per minute for ULV treatments. Dosage rates usually are calculated on a determined or assumed effective swath width (normally 200 to 300 feet with ground applications). The speed at which reinfestation of an area occurs determines the frequency of applications. Routine treatments are costly and *should be based on the need as determined by assessment of adult densities and by other evaluation measures.*

The organophosphorus compounds, malathion, naled and fenthion, particularly the first two, are the principal chemicals currently used as ground-applied space treatments. Studies show that there is little difference in the biological efficacy of thermal and nonthermal fogs, nor are "fog oils" superior to diesel oils as a formulation base. ULV ground applications, however, are somewhat less effective than thermal fogs in heavy vegetation as the larger ULV droplets tend to be filtered out more rapidly.

In Georgia, malathion (6 av. oz./gal.), chlorpyrifos (Dursban) (2 av. oz./gal.) and naled (2 av. oz./gal.) as thermal fogs against caged *C. p. quinquefasciatus*, *A. albimanus* or *Ae. aegypti* gave average kills of 88, 83 and 46-66%, respectively. Against *Ae. taeniorhynchus*, both propoxur (2 av. oz./gal.) and chlorpyrifos (2 av. oz./gal.) were inferior to malathion (6 av. oz./gal.). Abate (6 av. oz./gal.) was ineffective against these four species. In Florida[5], thermal fogs of chlorpyrifos (2.5 av. oz./gal.) gave more than 95% control of caged *Ae. taeniorhynchus* over a 330-foot swath but failed to give effective mortality (90% or higher) of *C. nigripalpus*. Com-

*ULV as used for labeling purposes is defined as application of a volume of ½ gallon or less of undiluted concentrate per acre

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purative tests of malathion (8 av. oz./gal.), naled (1.75 av. oz./gal.) and fenthion (1.25 av. oz./gal.) at 165 and 330 feet yielded average kills of 100, 91 and 97% of caged *Ae. taeniorhynchus*, respectively. At the same three dosages the mortalities of *C. nigripalpus* for naled, malathion and fenthion were 99, 88 and 78%, respectively.

In studies in Florida and Georgia, the efficacy of the ULV treatment has been compared with that of thermal fogs. In Florida an application rate of 2.9 fl. oz. of malathion per minute (0.018 lb./A., 600 ft. swath) and a speed of 10 mph produced an average kill of 93% of caged *Ae. taeniorhynchus*. At 5.7 fl. oz./min. (0.036 lb./A.) the kills were 92%. Fog treatments dispersed at 5 mph and at dosage rates of 0.018 and 0.036 lb./A. gave average kills of 65 and 85%.

During 1971, experiments in west Florida[c] with resmethrin (40%), a synthetic pyrethroid, resulted in 93% kill of *C. nigripalpus* at a discharge rate of 1.1 fl. oz./min. at 5 mph and 79% kill at 0.55 fl. oz./min. This compound, however, was ineffective against *Ae. taeniorhynchus*, giving only 28% and 16% kills at the above two dosages. Similar tests with malathion at 1.1, 2.1 and 4.3 fl. oz./min. at 5 mph resulted in 97, 98 and 99% kills of *Ae. taeniorhynchus*. At vehicle speeds of 10 and 15 mph and 3.3 and 4.3 fl. oz./min., 98 and 100% kills of *Ae. taeniorhynchus* were obtained. Against *C. nigripalpus* at 1.1, 2.1 and 4.3 fl. oz./min. and a vehicle speed of 5 mph the average kill was 79, 92 and 98%, respectively; and tests at the 3.3 fl. oz./min. rate and a vehicle speed of 15 mph and 4.3 fl. oz./min., and a vehicle speed of 10 mph gave average kills of 87% and 95%, respectively.

In Georgia (CDC), ULV malathion applications at flow rates of 3.1 fl. oz./min. and a vehicle speed of 5 mph gave unsatisfactory kills of caged *A. albimanus*, *Ae. taeniorhynchus* and *C. p. quinquefasciatus* in "open sites" at 150 and 300 feet from the machine. When rates were 3.6-4.1 fl. oz./min., kills of 99-100, 82-95 and 84-98% of *A. albimanus*, *Ae. taeniorhynchus* and *C. p. quinquefasciatus*, respectively, were obtained up to 600 feet. The mortalities of the three species obtained with ULV application and with thermal fogs (malathion 6 oz./gal. fuel oil) at 5 or 10 mph at equivalent dosages were essentially the same at "open sites." However, when the mosquitoes were held in wooded areas, fog applications were two to three times more effective. Limited tests in 1971 produced essentially the same results in the same test area. The variation in the flow rates required for a high level of biological efficacy in the studies mentioned previously arises from differences in the test areas, operation of machine, and the species involved. The "open sites" in Georgia were more protected than those in Florida, and this factor decreases the effectiveness of either fog or ULV applications. In 1971 the Chatham County, Georgia, Mosquito Control Commission reported that control effectiveness of ULV treatments was essentially equal to that from fog applications but the former were less costly. ULV applications also do not create a fog hazard to traffic. The primary concern with the ULV mode of application lies in the potentially greater hazard from misuse of the undiluted insecticide concentrate rather than from the misuse of the dilute fuel oil formulation.

Evaluations of other insecticides as ground ULV applications[A] indicate that fenthion, naled, propoxur and chlorpyrifos are equal to or better than malathion in biological efficacy. Tests in Minnesota[E] with chlorpyrifos dispersed with a backpack ULV showed good reduction of *Aedes* spp. 4 hours after treatment at 0.05 lb./A. The sprayman was walking at 2 mph and delivering a 50-ft. swath. At present MALATHION IS THE ONLY INSECTICIDE LABELED FOR GROUND ULV and the label stipulates that such treatment can be made *only by trained personnel of mosquito abatement districts or by pest control operators*. The label restricts the flow rates to 1 to 1.5 and 2 to 3 fl. oz./min. at vehicle speeds of 5 and 10 mph, respectively. Thus Florida does not recommend the use of ULV applications with malthion because the rates required for suitable biological effectiveness do not meet label restrictions[c]. The label also includes specific criteria relating to droplet size, tank pressure, nozzle elevation and vehicle speed. Failure to adhere to the label specification could result in hazard to nontarget organisms or cause damage to automobile paint; therefore, *ULV applicators are urged to comply fully with the label requirements*.

In public health work the first applications of the ULV technique were from aircraft. Aerial treatments were shown to be of great value as an emergency measure to curb mosquito densities during natural disasters or disease epidemics. In 1971 the lower Rio Grande Valley and a strip of the Texas and Louisiana Gulf Coast up to 30 miles wide were treated with malathion and naled to prevent the spread of Venezuelan encephalitis.

Critical to the successful use of the ULV technique is the adherence to the basic specifications on droplet size, droplet distribution, and climatic conditions at the time of application. The optimum size of the ULV droplet appears to be about 25 microns MMD; droplets can range up to 50 microns MMD but *greater* sizes should be avoided. Studies have revealed that more than 90% of the target insects collected are not contacted by droplets of >50 microns. Although mortality is favored by impingement of the smaller sized droplets, such droplets also are more readily influenced by air movement and turbulence. Laboratory tests[A] have shown that the amount of malathion in a droplet of 25 microns is sufficient to kill an adult *Ae. taeniorhynchus*. Droplets larger than 50 microns represent a waste of material as well as constitute an inefficient particle for producing optimum biological effectiveness. In addition, *the hazard to automobile paint increases with droplet size*.

Since droplet size, distribution and swath width are influenced by a number of factors related to equipment (*i.e.*, pump pressure, nozzle placement, nozzle size, air speed, etc.), the performance characteristics of the equipment must be assessed thoroughly, including biological evaluation, before it is employed in operational treatments. Evaluation must continue during operational applications to insure early detection of trouble due to equipment malfunction or improper calibration. *Currently, only malathion and naled are labeled for this purpose*. The dosage levels are 3 fl. oz. per acre for malathion and 0.5 to 1.0 fl. oz. per acre for naled. The higher rate for naled applies to terrain with

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heavy cover.

Aircraft which have been successfully employed for ULV dispersal of pesticides against mosquitoes have normally flown at a speed of 150 mph, producing a swath width of 300 to 500 feet. Greater swath widths have been used successfully with multi-engine aircraft. However, droplet size and density per unit area lose uniformity with increased swath because of natural sorting whereby small droplets drift further than large droplets. Altitudes of 100 to 150 feet above ground level are generally used.

The data available indicate that ULV treatments should be made during periods when temperatures are below 80°F. or before any temperature inversion occurs. Treatments should be applied only when wind currents are below 10 mph.

Studies on the prevention of encephalitis transmission by the use of ULV applications in Hale County, Texas, showed that applications of malathion (3 fl. oz./A.) reduced the *C. tarsalis* population but did not prevent infiltration of the species from adjacent untreated areas.

Recent studies in Canal Zone jungles[A] with fenthion (1 fl. oz./A.) indicate that two properly-timed applications of this insecticide which is effective against both larvae and adults can provide long-term protection from anophelines. Initial control in excess of 95% with each application resulted in an overall population reduction greater than 85% within the treated area at a distance of 1.0 and 1.3 miles from the breeding source for 31 days following the second application.

In west Florida[C], aerial spray tests of 35% naled in soybean oil applied at an overall volume of 2.8 fl. oz./A. in grouped swaths against salt-marsh mosquitoes resulted in average control of 94% and 68% after 1 and 2 days, respectively. The sprays were applied with a Stearman aircraft flown at an altitude of 150 feet in groups of five swaths—200 feet apart. No damage to automobile paint panels was observed.

In studies in California[B], one series of applications with naled at 0.06 lb./A. yielded a satisfactory reduction in landing rate counts of *Ae. nigromaculis* 6 hours after treatment. Other tests indicate that organophosphorus resistant *Ae. nigromaculis* populations were controlled by dichlorvos (0.1 lb./A.) or propoxur (0.05 lb./A.) In Minnesota[E] helicopter application of 0.1 lb./A. of naled produced good reductions in the biting rate of *Aedes vexans* 24 hours after treatment.

Evaluation of the comparative effectiveness of ULV (<7.0 fl. oz./A.) versus conventional aerial sprays (*i.e.*, 3 qt./A.) against salt-marsh mosquitoes showed that naled at 0.2 lb./A. gave similar results with either type of application. Fenthion produced 20% less reduction in landing rate counts at 6 hours with the ULV application than with the conventional sprays, but counts at 24 and 48 hours indicated similar levels with either type of treatment. In Kentucky, propoxur at 0.075 lb./A. and a 2:1 mixture of propoxur and fenthion at the same application rate gave essentially the same level of control of *Aedes sollicitans*. Naled yielded excellent kills at rates of 0.05 and 0.1 lb./A.

Table 3. LC_{95} levels (ppm) for various insecticides against three mosquito species resistant to organochlorine compounds.

Insecticide	*A. quadrimaculatus*	*C. p. quinquefasciatus*	*Ae. aegypti*
Abate	0.004	0.001	0.004
propoxur	0.5	0.5	2.5
carbaryl	2.5	2.5	2.5
dichlorvos	0.01	0.02	0.1
chlorpyrifos (Dursban)	0.004	0.004	0.004
fenthion	0.02	0.005	0.02
Gardona	>2.5	0.5	0.5
malathion	0.5	0.1	0.5
methoxychlor	0.5	0.5	>2.5
parathion, ethyl	0.01	0.01	0.02
parathion, methyl	0.025	0.005	0.01

Larvicides:

The LC-95 levels for 12 compounds against species of three genera of mosquitoes (Table 3) indicate that different species frequently vary in their response to a toxicant. Carbamate compounds (*e.g.*, propoxur, carbaryl) generally are less toxic to the larvae than the organophosphorus insecticides.

The degree of control obtained with larvicide applications often depends upon the degree of pollution and the type and amount of vegetative cover present. Where cover is heavy, it may be necessary to increase the dosage or the amount dispersed to obtain satisfactory results and granular formulations frequently provide better control than emulsions or oil sprays. In heavily polluted water, such as log ponds, a treatment may lose its effectiveness within 48 hours.

In California[B] the resistance in *C. tarsalis* and *Ae. nigromaculis* in 1971 has precluded the effectiveness against some populations of any registered organophosphorus or carbamate insecticides at the legal rates of application. In other areas of the State these species have developed resistance to certain OP compounds, notably malathion, fenthion and/or parathion. Resistance in larvae is primarily involved but tests confirm the observation that control of adults is also hampered. Aircraft applications of RE-11775 on pastures and ground applications to pastures and ponds produced 100% kills of *C. p. quinquefasciatus* and *Ae. nigromaculis* in California where OP resistant strains of mosquitoes are widespread.

In 1969 when chlorpyrifos (Dursban) and fenthion were applied by the ULV technique in California at dosages of 3 to 6 fl. oz./A., the results with each against *C. tarsalis*, the encephalitis vector, were considered excellent. These applications were made as part of an emergency encephalitis prevention program. Helicopter treatments of impoundments of the Tennessee Valley Authority with Abate or chlorpyrifos at 0.004 lb./A. gave excellent control of *A. quadrimaculatus* without marked destruction of nontarget organisms. Each compound was less effective

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against the culicine larvae than against larvae of *A. quadrimaculatus*. In Minnesota, trials[1] with 2% Abate Celatom granules at 0.03-0.06 lb./A., 10% malathion granules at 0.5-1.0 lb./A., 2% Gardona granules at 0.15-0.20 lb./A., 1-5% RE-11775 granules at 0.05-0.10 lb./A. and 1% chlorpyrifos granules at 0.075-0.15 lb./A. gave satisfactory kills of one or more *Aedes* species. Preflood applications of chlorpyrifos granules at 0.2 lb./A. continued to give kills of *Ae. vexans* larvae for periods greater than 60 days. Five percent methoxychlor granules applied as a presenson larvicide for *Aedes control proved to be effective in New* York at a dosage rate of 1.0 lb./A.

Small plot tests (CDC) in Georgia of 18 compounds as preflood treatments showed chlorpyrifos (0.5 to 2.0 lb./A.) to be the most effective against *Ae. taeniorhynchus* and *A. albimanus* larvae. At 2 lb./A. it gave 12 weeks of 90% kills of larvae exposed to sod samples treated with granules, emulsions or suspensions. Certain compounds varied in efficacy depending upon the type formulation used. At heavy dosages of 4 lb./A. carbaryl was effective for 10 weeks against *Ae. taeniorhynchus*. Propoxur (2 lb./A.) and Abate (4 lb./A.) produced 6 weeks of effectiveness against the same species. Abate, while equivalent to chlorpyrifos in its toxic effect on larvae (Table 3), is much less effective than chlorpyrifos in the presence of organic matter.

In polluted water, chlorpyrifos, fenthion and Abate have proved effective against *Culex*. Studies in Africa showed chlorpyrifos was superior to either fenthion or Abate at a concentration of 1.0 ppm. Periods of efficacy of chlorpyrifos have been as long as 144 days in a waste lagoon at 1.0 ppm and as long as 120 days in a Louisiana log pond at 0.5 ppm. In a large scale program in Burma, weekly applications of 0.3% fenthion emulsion were used to treat polluted ditches and cesspools. Over a 3½-year period >95% reduction of *Culex* populations has been obtained without any change in the response of the species to fenthion.

Chlorpyrifos, at the dosage levels indicated on its label and in Table 2, has not produced any apparent adverse effect on spraymen. In Florida trials, however, a regimen of daily premises spraying of 0.5% chlorpyrifos with power equipment against *Ae. aegypti* resulted in a decrease in the plasma cholinesterase level of the spraymen. The latter had applied from 30 to 85 gallons per man per day. Application of chlorpyrifos in this manner against *Ae. aegypti* should not be done.

In extensive field trials in Puerto Rico, premises treatments with Gardona suspension (2.5%) in urban areas of two municipios controlled *Ae. aegypti* breeding in tin cans, tires and other containers for 8 to >12 weeks. In rural areas no positive sites for breeding were found in the treated containers for 21 weeks. In Florida, propoxur (2.5%) and carbaryl (2.5%) failed to give satisfactory control of *Ae. aegypti* breeding in containers. Methoxychlor (1.25%) yielded satisfactory results for approximately 3 months and was equal to or better than DDT (1.25%).

Abate at a dosage of 1 ppm (sand granules) has been effective against *Ae. aegypti* larvae in drinking water, in bird baths and in animal watering devices. No accumulative increase of Abate has occurred in water treated at 3- or 6-week intervals nor were any clinical symptoms observed in a village population exposed to such treated water for 1.5 years.

Studies in Thailand indicated that a single application of Abate granules to *Ae. aegypti* breeding containers drastically reduced larval indices for 8 weeks and suggested that successive properly-timed treatments, made 2 months apart, might be a satisfactory preventive regimen for controlling dengue hemorrhagic fever.

In the southeastern United States, paris green pellets are highly effective against salt-marsh mosquitoes. The formulation is applied at a rate of 15 pounds of 5.0 to 7.5% granules per acre with ground or aerial equipment. Use on marshes for more than a decade has not resulted in any loss in the susceptibility of the mosquito populations to this compound.

Oil applications continue to be a suitable means of killing mosquito larvae. Fuel oil mixed with 0.1% Triton X-100 and applied at a rate of 2 to 3 gallons per acre has been used to treat water areas and marshy areas harboring valuable fish and wildlife.

Applications of Flit M.L.O. at 2-3 gal./A. were effective in operational use in California[9] and have shown promise in Minnesota[1]. The use of fuel oil with a 0.1% spreading agent (T-Det-MC) at 3 gal./A. gave results similar to Flit M.L.O. against *Ae. vexans* in Minnesota[1]. Effective kills of salt-marsh mosquito larvae in Georgia marshes also have been achieved with fuel oil and T-Det-MC or Triton X-45 (0.5%) at 4 gal./A. High temperatures and winds may necessitate an increase in dosage to 6 or 8 gal./A.

FLIES

Domestic flies include a variety of species that are closely associated with man, such as the house fly, little house fly, and various blowflies. The breeding sites of these flies are directly related to the occurrence of animal wastes, refuse and other organic debris produced by man so that effective control with chemicals results only when it is combined with adequate sanitational measures.

The house fly, *Musca domestica*, in contrast to blowflies, such as *Phormia regina*, *Phaenicia sericata* and *Phaenicia cuprina*, readily develops resistance to both organochlorine and organophosphorus insecticides. Populations of *P. cuprina* and *P. sericata* have developed resistance to organochlorine compounds, but only in areas outside of the United States. With the house fly the problem can be considered as being critical since this species has become resistant to many of the organophosphorus compounds generally used in its control. Studies in Florida[4] dairies and poultry houses have indicated that house flies from these sites have resistance to trichlorfon (3 to 310 X) and dichlorvos (1 to 23 X) in baits and to dimethoate (2 to 29 X) and ronnel (4 to 55 X) as aerosols. Tests with the house flies in Georgia showed that the LC-95 levels for dimethoate, Gardona, ronnel and an experimental compound were 16 to 25 times those for a susceptible strain. The LC-95 levels for Ciodrin and dichlorvos were only 3 to 6 times.

In New Jersey the LC-50 levels for Gardona against field-collected specimens were 8 to 17 times and for dimethoate, 13 to 48 times that of a susceptible strain.

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Residual treatments:

Although residual applications have long been used for adult house fly control, the resistance factor has rendered overall treatments of this type of little value in many areas. Compounds[10] such as dimethoate (1%), Gardona (2%), malathion (5%), naled (1%), ronnel (1%) and fenthion (1.5%) have been used for this purpose but the duration of their effectiveness as residues has been lessened to such a degree that other types of treatment (space or bait treatments) are more feasible. In Georgia dimethoate deposits formerly effective for 10 to 14 weeks now fail after 1 week. Gardona, ronnel and dimethoate treatments in New Jersey did not provide satisfactory control for more than 3 weeks. In some instances the first seasonal treatment was partially successful; the second was ineffective. The pyrethroid resmethrin (SBP-1382) did not produce satisfactory control in New Jersey but the resistance to it was less than for the organophosphorus compounds.

Residual treatments are effective against other flies that have resting habits similar to those of the house fly. The little house fly, *Fannia canicularis*, a frequent pest in chicken ranches and dairies in certain areas, is readily susceptible to residual applications of malathion (5%) or ronnel (1%). Deposits of these compounds are relatively short-lived, but each controls *Fannia*. *In making applications on interior surfaces of chicken ranches, extreme care should be taken to avoid contaminating feed and water.* DIELDRIN, LINDANE, DIAZINON AND TRICHLORFON ARE NO LONGER LABELED FOR USE IN POULTRY HOUSES.

Fannia frequently rests out-of-doors on vegetation and exterior walls during hot weather, and treatment should be applied to these surfaces as well as to the interior of the building. In California[8] it is recommended that trees and shrubs located more than 10 feet from the buildings not be sprayed because they serve as primary resting sites for certain natural enemies of flies.

In dairy barns or animal shelters the duration of effectiveness will vary from one premises to another, depending on the sanitational practices followed. If economically feasible, more frequent treatments with less volume per application may provide satisfactory control, particularly if the initial application is made before optimum fly breeding conditions occur. Successful control has been obtained in Wisconsin dairy barns by applying 5 gallons of 1% ronnel at 2-week intervals or 1.25% dimethoate at 4-week intervals, with the first treatment made at the beginning of the fly season. In Denmark, a 30% coverage with a 1% dimethoate treatment directed at the "preferred" resting sites produced satisfactory to excellent control for 2 to 3 months. In North Carolina, selective applications of a formulation of Gardona-dichlorvos to a poultry farm at intervals of 2 to 5 weeks combined with naled sugar baits gave satisfactory control, partially because *such applications did not affect the predaceous mites in the poultry excreta.*

In west Florida recent studies[c] have shown that one application of 1% methoxychlor emulsion gives 95% control of the adult *Stomoxys calcitrans* (dog fly) emerging from the grass. This effectiveness extends for more than 30 days, which is longer than the grass remains attractive to the fly. Application to the piles of decaying aquatic vegetation is at a rate of 100 gallons per mile per foot of width of grass. Although it is chemically related to DDT, methoxychlor is biodegradable and presents less of a potential hazard to aquatic nontarget organisms than DDT.

Impregnated cords:

Insecticide-impregnated cotton cords installed at a rate of 30 linear feet of cord per 100 square feet of floor area have produced fly control in dairies, chicken ranches and "pig parlors" for periods ranging from 6 weeks to an entire season. Diazinon and parathion are employed in commercially prepared products which have been labeled for installation in milking barns, calf sheds, poultry houses and feed rooms. In Georgia, dichlorvos-resin strips gave 95% reduction of all flies trapped from garbage pits (30 inches dia. x 72 inches deep) in a recreational area for 8 weeks when installed at a rate of one-half or one unit per pit. Such strips also are effective against house flies in indoor situations at the same dosage and under the same restrictions mentioned in Table 2.

Baits:

Dichlorvos, malathion, naled, ronnel, and trichlorfon (Table 4) are labeled for use as baits in dairy barns, but trichlorfon is not registered for use in poultry houses.

Bait applications generally produce spectacular reduction of fly densities within a few hours, but their effectiveness is of short duration unless further treatments are made. Successful use of baits requires diligence in applying them and in maintaining a reasonable degree of sanitation.

Permanent bait stations minimize the effort and time required for dispensing baits. Their use also provides continual insecticidal pressure in reducing the fly population. For dispensing dry baits, plywood trays (one to two trays per 1,000 square feet of floor area) are suitable. An effective liquid bait dispenser can be made from a chicken-watering unit modified by inserting a cellulose sponge in the trough to prevent clogging by dead flies. Toxicants such as dichlorvos or trichlorfon at a concentration of 0.1% in a sugar water solution have been used in these units. A continuous source of toxicant can be provided from a dichlorvos-resin strip inserted in the jar.

In Georgia dairies where house fly populations have become resistant to residual applications dichlorvos baits proved to be the only means whereby such populations could be controlled. Control was achieved even against populations that showed a threefold to fourfold resistance to the compound. In Florida, tests showed that house flies from six dairies had resistance to trichlorfon 19 to 138 times that of a susceptible strain, yet 1% trichlorfon sugar baits gave effective control. From such data it is apparent that the exposure route of a resistant insect to the toxicant is an important factor in determining the control efficacy of the compound.

Outdoor space sprays:

Space applications usually are more effective against resistant

[10] These insecticides have specific restrictions as to the type of food handling establishment and the areas wherein each may be used. Therefore, label directions must be strictly followed

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house flies than residual or larvicide applications with the same compounds, but their cost frequently precludes general use in municipal programs. However, such treatments are warranted at problem sites and in emergencies. Repeated daily applications will be required at problem sites (*e.g.*, refuse dumps), since the efficacy of the spray depends on the insecticidal particles impinging on the fly.

In field tests in Georgia, the pound-per-acre dosages required for effective kills at distances up to 200 feet for six compounds were: malathion >0.6, ronnel 0.4, fenthion 0.4, dichlorvos >0.3, naled 0.1 to 0.2 and dimethoate 0.1 to 0.2.

Quick knockdown sprays, dispersed mechanically or by hand, have been used to some extent by dairy and beef cattle farmers. Deodorized kerosene solutions of ronnel (2%), malathion (2%), or synergized pyrethrin or allethrin (0.1%) applied with an electric mist sprayer against house flies in dairy barns produced 70 to 98% reduction within 10 minutes after treatment. With most of these applications, not more than 50% reduction was evident 24 hours after treatment even when repeated daily for 5 to 21 days.

Studies (CDC) at a poultry ranch have shown that a synthetic pyrethroid, resmethrin (SBP-1382) was highly effective in reducing house fly populations. In applications of a resmethrin emulsion by a backpack mist blower, dosages as low as 0.025 lb./A. provided average reductions in grill indices of 95% within 2 hours after treatment. Dimethoate (0.15 lb./A.), naled (0.2 lb./A.) and Gardona (0.2 lb./A.) were less effective; naled gave the highest reduction of 84%.

In Florida, ground applied thermal fogs of propoxur, naled and fenthion (each at 4% in fog oil) gave 98, 94 and 86% kills of caged *S. calcitrans*, respectively. At 1%, propoxur also was superior to naled and fenthion. Malathion was ineffective. At a 12% concentration it produced only a 28% kill. In other more recent tests[c] thermal fogs of propoxur and naled (3.2 and 3.5 oz./gal. in fuel oil, respectively) produced mortalities of caged specimens at or above the 95% level. Treatments are applied in the daytime at a rate of 40 gal./hr. and a vehicle speed of 5 mph or at twice that gallonage and speed.

Table 4. Organophosphorus Insecticides Used as Baits, Space Sprays and Larvicides in Fly Control.[a]

(State regulations may impose certain restrictions on the use of these toxicants in dairies or at other specified sites; therefore, the individual should be certain that his usage conforms with local restrictions.)

Type Application	Toxicant	Formulation	Remarks
BAIT	diazinon	1# 25% WP plus 24# sugar; 2 fl. oz. 25% EC plus 3# sugar in 3 gal. of water.	Normal application is 3-4 oz. (dry) or 1-3 gal. (wet) per 1000 sq. ft. in areas of *high fly* concentration. Repeat 1 to 6 times per week as required. Avoid application of bait to dirt or litter.
BAIT	dichlorvos	3-6 fl. oz. 10% EC plus 3# sugar in 3 gal. water.	The use of permanent bait stations will prolong the efficacy of each treatment.
BAIT	malathion	2# 25% WP plus 23# sugar.	Available as commercial baits labeled for use in dairies and in food processing plants[b] except at sites where food is exposed. None of these baits should be employed inside homes nor should diazinon and trichlorfon be used in poultry houses. Diazinon also is not to be used in dairy barns.
BAIT	naled	1.0 fl. oz. 50% EC plus 2.5# sugar in 2.5 gal. water.	
BAIT	ronnel	2 pt. 25% EC plus 3# sugar in 3 gal. water.	
BAIT	*trichlorfon*	1# 50% SP plus 4# sugar in 4 gal. water.	DO NOT CONTAMINATE FEED OR WATERING TROUGHS.
OUTDOOR SPACE SPRAY[c]	diazinon fenthion	11 gal. 25% EC in 34 gal. water.	— Application rate is 15 gal. per mile.
OUTDOOR SPACE SPRAY[c]	dichlorvos	6 gal. 50% EC in 44 gal. water.	— Application rate is 15 gal. per mile.
OUTDOOR SPACE SPRAY[c]	*dimethoate*[d]	3 or 6 gal. 50% EC in 50 gal. water.	— Application rate is 20 or 10 gal. per mile.
OUTDOOR SPACE SPRAY[c]	malathion	5 gal. 55% EC in 41 gal. water.	— Application rate is 20 gal. per mile.
OUTDOOR SPACE SPRAY[c]	naled	1.5 gal. 65% EC in 50 gal. water.	— Application rate is 15 or 20 gal. per mile.
LARVICIDE	diazinon	1 fl. oz. 25% EC to 1 gal. of water.	Application rates are 7-14 gal. per 1000 sq. ft. as a coarse spray. Repeat as necessary, usually every 10 days or less. For chicken droppings, use only where birds are caged. Diazinon is not labeled for use in poultry houses.
LARVICIDE	dichlorvos	2 fl. oz. 10% EC to 1 gal. of water.	
LARVICIDE	dimethoate	0.5 pt. 43% EC to 2.5 gal. of water.	
LARVICIDE	malathion	5 fl. oz. 55% EC to 3 gal. of water.	AVOID CONTAMINATION OF FEED OR WATER AND DRIFT OF SPRAY ON ANIMALS.
LARVICIDE	ronnel	1 pt. 25% EC to 3 gal. of water.	

[a] For information on chemicals to be used against livestock and crop pests and for their residue tolerances on crops, consult your State Agricultural Experiment Station or Extension Service.

[b] Includes dairies, milk rooms, restaurants, canneries, food stores and warehouses, and similar establishments.

[c] Based on swath width of 200 ft.

[d] Not specifically labeled for outdoor space applications.

Larvicides:

The control of fly breeding with chemicals normally is relied on in situations where there are accumulations of organic matter, such as animal excreta, garbage, fruit culls, vegetable pulp and carcasses.

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Such conditions reflect a lack of or a low level of sanitation, since elimination of the organic accumulation would be the logical remedy. Further, the performance of pesticides in such situations is poor because the application frequently fails to penetrate the media to contact the larvae and may also break down rapidly under the moist conditions prevailing therein. In addition, larviciding frequently destroys mites and fly larvae (*e.g., Ophyra*) that prey on house fly larvae or soldier flies which create a medium not suitable for the breeding of *M. domestica*. The value of theses natural enemies in house fly control is indicated by data from North Carolina which showed that an integrated control program of poultry manure management and selective adulticiding (see Residual treatments) at 2- to 5-week intervals provided house fly control levels equivalent to those resulting from the weekly application of larvicides. The latter method which destroyed the predaceous mite populations required five times as much insecticide, as well as greater manpower than the integrated approach which was not detrimental to the mite fauna.

Most of the organophosphorus compounds (Table 4) are toxic to fly larvae, but diazinon has been most effective in initial kill and residual action. The maximum period of residual action of larvicidal sprays is 1 to 2 weeks. In larvicide tests in Florida poultry houses neither dimethoate nor Gardona was effective after 7 days. Dimethoate at 200 mg./sq. ft. gave 7 days of good control of larvae in poultry houses whether applied by conventional spray methods or by low volume, a method in which the undiluted concentrate is applied directly to the droppings. This procedure does not liquefy the droppings as much as do emulsion treatments. Volatile compounds in plastic formulations offer promise for treating larval media. In Florida three applications of dichlorvos pellets applied at 200 mg./sq. ft. of breeding area in poultry houses controlled both house fly larvae and adults for 7 weeks. Monthly sprays of 1 or 2% dimethoate or diazinon to garbage pits in a recreational area in Georgia failed to reduce materially the number of flies trapped from the pits.

The incorporation of insecticides in the feed or water of livestock or poultry is an approach that has been used to prevent or control fly breeding in animal excreta. Numerous compounds have been shown to be effective when so administered but none of the materials is labeled for use as a feed additive for poultry and only coumaphos can be added to cattle feed. Coumaphos fed to cattle at a level of 144 ppm produced 94 to 98% mortality of house fly larvae. Aspon (200 ppm) in chicken mash fed to 40 pullets produced good control of house fly larvae but was not effective against *Fannia pusio*. No residues of Aspon were found in the eggs or in the tissues of heart, muscle or fat during the period the chickens were fed treated mash or in the month after treatment was stopped. Gardona at 400 ppm in poultry feed gave good control of *M. domestica* but 800 ppm were required for similar control of *F. pusio*. Eggs from treated hens had a less desirable flavor than those from untreated hens. At the 800 ppm dosage, the chickens produced fewer eggs and did not maintain their body weight in comparison to untreated birds.

In comparative tests of 12 compounds added to poultry droppings and evaluated against larvae of *F. canicularis* in Massachusetts, malathion, carbaryl and dicapthon were ineffective, but initial and short-term efficacy was evident with fenthion, coumaphos, Ciodrin, dimethoate, diazinon, dimetilan, ronnel, trichlorfon and Zytron. Dimethoate was the most effective, producing high mortalities at 1 ppm. Larvae of *F. canicularis* showed approximately 90% mortality when exposed to droppings from chickens whose food contained 125 mg. of coumaphos per kilogram.

FLEAS

The principal vector of plague, *Xenopsylla cheopis*, remains susceptible to DDT except in parts of India, Egypt, Thailand and Vietnam. *Pulex irritans* L. resistant to DDT have been reported from Greece, Israel, Turkey, Egypt and South America. Species of *Ctenocephalides* infesting domestic pets and yards frequently cannot be controlled with chlordane and other organochlorine compounds in the United States as well as in French and British Guiana and Colombia.

In overseas areas, DDT (5 to 10%) dust applications to rodent runways and harborages are the chief means of controlling non-resistant *X. cheopis*. Lindane (1%), malathion (3 to 5%), diazinon (1 to 2%) and carbaryl (3 to 5%) should be considered for use against *X. cheopis* populations that fail to succumb to DDT dusts. Application should be thorough to insure adequate contact between the rodent-flea and the dust, since poor control from inadequate dusting can be mistakenly interpreted as resistance to the pesticide used.

The possibility of introducing plague-infected fleas into the United States via containerized cargo from plague endemic areas has led to investigations on suitable chemical control measures. Tests (CDC) conducted on the use of one-half or one dichlorvos-resin strip in "Conex" shipping containers (approximately 300 cubic feet) filled with simulated cargo gave 98 to 100% kills of *X. cheopis* on rats exposed for 48 hours at temperatures of 60° F. or above. Exposures of 6 hours at temperatures of 78° to 86° F. in empty "Conexes" gave average kills of 90% in 24 tests. With a 24-hour exposure at temperatures of 75° to 83° F., complete kills were obtained with one-half or one strip in empty or simulated cargo filled "Conexes." Tests in Florida with dichlorvos indicate that vapor concentrations of 0.25 μg./liter of air for 3 hours produce complete kills of *X. cheopis*.

The potential of high concentrate micronized dusts of various insecticides for use in disinsecting unoccupied aircraft was evaluated in cargo trailers in cooperative tests by the U.S. Department of Agriculture and CDC. Application of micronized dusts of chlorpyrifos (Dursban) (40%), resmethrin (SBP-1382) (25.5%), chlorpyrifos (20%) + resmethrin (12.8%), chlorpyrifos (13.3%) + resmethrin (8.5%) + propoxur (21.3%), chlorpyrifos (10%) + resmethrin (6.4%) + propoxur (16%) + Gardona (20%), DDT (42.5%) + carbaryl (42.5%), Gardona (80%), propoxur (64%), fenthion (20.2%), *d-trans* allethrin (14%), chlorpyrifos (10%), or fenitrothion (26.1%) at a rate of 2 g. of dust/1,000 cu. ft. produced complete kills of *X. cheopis* except for Gardona (80%), propoxur (64%)

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and chlorpyrifos (10%) which gave 62, 96 and 91% kills, respectively. Resmethrin (25.5%) also gave complete kills at 1 g. of dust/1,000 cu. ft.

Although human plague has not been a critical problem in the United States in recent years, this disease frequently is common among wild rodents such as prairie dogs and squirrels in the western United States. When epizootics occur among such rodents, the danger of human infection increases greatly. One method of controlling the fleas on these rodents is the use of bait boxes containing an insecticide. When the rodents enter the box to feed, they pick up sufficient insecticide to kill the fleas on them and those living in the nest or burrow. In a plague epizootic among the squirrels in Denver, Colorado (CDC), bait boxes, spaced at 500-ft. intervals, containing 10% DDT and peanut butter gave good control of the squirrel fleas. In trials in Colorado (CDC) 2% carbaryl dust was found to be effective against the prairie dog flea when applied at a rate of 3 ounces per burrow. The same dust used in bait boxes containing rolled oats gave 95% control of fleas on deer mice.

Experimental laboratory studies[A] have shown that several organophosphorus compounds and mirex are effective as systemics in killing fleas on rodents. The lowest percent concentrations of toxicant by weight in the food of the cotton rat/kangaroo rat/cottontail rabbit, respectively, that were effective were: fenthion—0.15/0.015/0.03; diazinon—0.03/0.03/0.6 and mirex—0.06/0.06/0.12.

The organophosphorus and carbamate compounds are the principal chemicals used for the control of *Ctenocephalides* fleas on animals and premises. For effective control of these fleas, treatment of the pet alone is not sufficient, since the animal soon becomes reinfested from the untreated premises. Sleeping quarters, bedding, kennels and other areas frequented by the animal should be treated at the time the pet is disinfested.

Flea infestations on animals can be controlled by use of the toxicants in Table 5. Resin collars containing dichlorvos have been labeled for use on dogs (except for whippets and greyhounds) and on cats (except Persian). Cotton webbing collars impregnated with 0.75 to 1.0% lindane may be used on either dogs or cats.

Table 5. Pesticides used on pets for flea control.

Toxicant	Formulation	Percent Concentration
carbaryl	Dip or wash	0.5[a]
	Dust	2.0-5.0[b]
coumaphos[c]	Dip	0.2-0.5
	Spray	1.0
	Dust[d]	0.5
lindane[c]	Dust	1.0
malathion	Dip	0.25
	Spray	0.5
	Dust	4.0-5.0
pyrethrum	Spray	0.2 + 2.0 synergist
	Dust	1.0
rotenone	Dust	1.0

[a] 1.0% acceptable for use by veterinarians only.
[b] Do not use on cats under 4 weeks of age.
[c] Do not use coumaphos or lindane on dogs under 3 months or on cats.
[d] Dust also contains 1.0% trichlorfon.

Certain treatments are labeled *for application only by licensed veterinarians.* Ronnel, as a 0.25% solution, can be used for external treatment (dip or sponge) of dogs and cats. These animals can be treated by oral administration of tablets of ronnel while tablets of trichlorfon or Cythioate can be used for dogs. Dichlorvos (0.02%) and dioxathion (0.2%) are labeled for external use on animals.

For treatment of infested sites inside the house, sprays of diazinon (0.5%), lindane (1%), malathion (2%), or ronnel (1%) can be used as spot applications. Yard infestations can also be controlled by treatment with these compounds at an application rate of 1 gallon per 1,000 sq. ft. Lindane, ronnel and diazinon as 1% emulsions were shown to eliminate infestations for 63 days; whereas with malathion, the effectiveness persisted for 7 days. Propoxur (1%) and fenthion (2%) are labeled for outdoor use by qualified pest control operators. Dusts of malathion (3 to 5%), lindane (1%) and carbaryl (3 to 5%) can be used against flea infestations in yards at application rates of 1 to 2 lb. per 1,000 sq. ft.

Organochlorine resistance in bedbugs is not a problem in the United States, but elsewhere in the world populations of *Cimex lectularius* L. and *Cimex hemipterus* resistant to the organochlorine compounds have frequently occurred. In Israel, *C. lectularius* populations also have been recorded as developing resistance to malathion and fenthion. This species remains susceptible to diazinon in Israel despite 4 years' use of this compound. In Russia *C. lectularius* has developed a high level of resistance to trichlorfon.

A single residual application of insecticide emulsion or solution to baseboards, wall crevices, bedsteads and mattresses of infested premises will usually control a bedbug infestation. Sprays containing trichlorfon (0.1%), ronnel (1%), dichlorvos (0.5%) or malathion (0.5 to 1%) are commonly used. Special care should be exercised in the treatment of mattresses and upholstery; only a light application should be used. *Under no circumstances should mattresses be soaked with spray. Infant bedding, including the crib, should not be treated. With dichlorvos or trichlorfon, spray only tufts and seams of mattresses and air until dry—at least 4 or 8 hours, respectively—before reuse.* If the infestation persists, re-treat at not less than 2-week intervals.

Since bedbugs hide in cracks and crevices, adding pyrethrin (0.1 to 0.2%) to insecticidal formulations will increase the effectiveness of the treatment by stimulating the bedbugs to leave their harborages, thereby insuring better contact between the insects and the residual insecticide.

Synergized pyrethrin sprays (0.2% pyrethrins) alone also are effective, but two or more treatments at intervals of 2 to 6 weeks may be required.

TICKS AND CHIGGERS

Ticks are vectors of various rickettsial and virus diseases throughout the world. In the United States, Colorado tick fever and American spotted fever are transmitted by ticks, and tick paralysis is also caused by these arthropods. Chiggers, although involved in scrub typhus transmission in the Far East, are primarily an annoyance to man in this country. Resistance to the organochlorine insecticides has been reported in the ticks *Dermacentor* and *Rhipicephalus* in the United States, but not in chiggers.

The brown dog tick, *Rhipicephalus sanguineus*, fre-

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quently causes severe annoyance to man by invading the home and by infesting domestic pets. As the species does not always respond to control by the chlorinated hydrocarbon pesticides, the problem of ridding dwellings of infestations has become more important in recent years. The ticks may be found throughout a dwelling. *Control demands treatment of both the infested premises and the dogs present.* Treat all infested areas thoroughly.

Compounds effective as sprays in treating homes for control of the brown dog tick are propoxur (1%), diazinon (0.5%), dioxathion (0.5%), fenthion (1.5%), lindane (0.5%), malathion (1-2%) or ronnel (2%). Dusts containing 5% carbaryl are also effective. The pesticides (except malathion and ronnel) should be employed only as *spot treatments* to baseboards, floor and wall crevices, window frames, and other harborage sites. Re-treatment of the home 1 or 2 weeks later may be required for severe infestations, but a single application will often suffice for light infestations. Five-foot-wide band treatments of 2% diazinon granules (8 oz. per 20 linear feet) around foundations may prevent ticks from entering.

Careful attention must be given to treating the dog's sleeping quarters and the animal itself. *Propoxur and diazinon should not be used to treat the animal.* However, dusts of lindane[1] (1%), carbaryl (5%), coumaphos (0.5%), trichlorfon[1] (1%) and malathion (3 to 5%) can be applied directly to the dog. Liquid washes may give better penetration of the hair than dust; coumaphos[1] (1%), lindane[1] (0.03%), or malathion (0.5%) are suitable. With severe infestations, it may be necessary to re-treat the household and the dog one or more times at weekly intervals. Dichlorvos (0.1%), naled (0.2%), carbaryl (1%), dioxathion (0.15%), or ronnel (1%) may be used as an animal dip by veterinarians. Successful control of ticks on dogs by oral use of ronnel has also been reported by veterinarians.

In treating outdoor areas for ticks or chiggers, avoid application to ponds, streams and other water courses or to their adjacent margins, since at the maximum dosages these pesticides (except lindane) are highly hazardous to fish. Where the use of chlorinated hydrocarbon insecticides is considered a hazard to nontarget organisms, the organophosphorus and carbamate compounds should be substituted.

In the United States area control of the various ticks can be obtained by applying chlordane or toxaphene at rates of 2 pounds of toxicant per acre, BHC at the rate of 0.5 to 1.0 pound of the gamma isomer per acre, Gardona, 1 pound per acre, or carbaryl at the rate of 2 pounds per acre. Suspension, emulsion, or dust formulations of these pesticides produce similar results. The level of control secured is dependent on the adequacy of the coverage. In brushy areas, 50 gallons of spray or 40 pounds of dust per acre of the proper concentration are required; approximately half these amounts are needed on thin cover sites, such as lawns. Because certain ticks (*e.g., Dermacentor variabilis*) congregate along roads, paths, and trails, treatment may be restricted to these areas. Treatments with these chemicals usually prevent reinfestation for 30 days or more. In overseas areas DDT (2 lb./A.) has proved highly effective against tick-borne disease vectors.

In small plot tests with ground equipment, diazinon, chlorpyrifos (Dursban) and fenthion were equally effective against the lone star tick, *Amblyoma americanum*, when applied at an approximate volume of 8 gallons per acre and dosages of 1 or 2 lb./A. Each compound gave 6 weeks of effectiveness within a range of 89 to 99% reduction. Propoxur, carbaryl, and naled were only slightly less effective. All were superior to malathion which gave poor kills. In small plot tests[p] chlorpyrifos (spray or granules) at 0.25 lb./A. gave satisfactory control for 5 to 6 weeks; DDT was much less effective. Mechanical clearing of nature trails also effectively reduced the number of ticks present. ULV applications of propoxur (0.5-2 lb./A.) with ground equipment reduced the tick populations 89-97% for a 6-week period.

Area infestations of chiggers, such as *Eutrombicula alfreddugesi*, can be controlled with spray or dust treatments of toxaphene or chlordane (1 to 2 pounds per acre), or lindane (0.25 or 0.5 pound per acre). In overseas areas dieldrin at a rate of 2 lb./A. has given greater effectiveness against the chigger vectors of scrub typhus than the aforementioned compounds. Thorough coverage of the area is required.

LICE

The body louse (*Pediculus humanus humanus*), the crab louse (*Pthirus pubis*) and the head louse (*P. humanus capitis*), a subspecies of the body louse, all attack man. The crab louse and the head louse stay on the body continuously, whereas the body louse remains on the clothing except when feeding.

The body louse, the vector of epidemic typhus, becomes a problem primarily among people forced to live under crowded or insanitary conditions such as refugees, migrants, or prisoners.

Insecticidal louse powders should be applied carefully to the inside surface of the clothing, particularly the undergarments, with special attention given to seams and folds. Usually 1 ounce of powder will suffice for adequate coverage of an individual. Treatments can be applied to the clothed individuals or to the garments.

For mass treatment under epidemic conditions, dusts of DDT (10%), lindane (1%), or malathion (1%) are effective against the body louse. DDT has been the insecticide generally used, but malathion is equal in efficacy (3 to 4 weeks), and a single application normally is effective against both the egg and crawling stages. It is also the insecticide of choice against louse populations in certain areas which have displayed resistance to DDT and lindane. Treatments with powders of lindane (1.0%), or synergized pyrethrum (0.2%) or allethrin (0.3%) usually necessitate a repeat application 7 to 10 days later to kill newly hatched lice. Pyrethrum or allethrin formulations are of more individual use than for mass treatments since they tend to clog mechanical application.

In recent sleeve tests employing treatments with 1% powders Abate was more effective than malathion against DDT resistant body lice.

For control of head lice, shampoo or lotion preparations are more acceptable than dust, since the latter suggests that the person is infested with lice. Several preparations are available to the public such as syn-

[1]Do not use on dogs under 2 months of age.

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ergized pyrethrins but those containing lindane (1%) or benzyl benzoate (12%); benzocaine (2%):DDT (1%) require a prescription. To obtain the full benefit of the application the treatment should remain in the hair as long as possible in accordance with label directions.

Crab lice can be controlled by dust applications of the same insecticides used for body louse control. Persisting infestations should be re-treated at 1- to 2-week intervals. Label directions on some of the lotion preparations for control of head lice indicate that they may also be used against crab lice.

COCKROACHES

The German cockroach, *Blattella germanica*, is the principal species associated with man and is of greatest concern because of its widespread distribution and its ability to develop resistance to many of the insecticides used for control purposes. The organophosphorus insecticides are used routinely for its control but populations resistant to diazinon, fenthion, or malathion have been detected in several parts of the United States. Resistance to malathion appears to be specific, but that to diazinon extends to related chemicals. A strain slightly resistant to propoxur, a carbamate, also has been reported from Louisiana. Despite the occurrence of organophosphorus resistant populations in certain localities, such resistance has not, as yet, created a widespread control problem.

The pesticides usually employed in cockroach control are given in Table 6. Of eight experimental compounds tested in 1971 none proved superior to chlorpyrifos (Dursban) or propoxur in their overall performance. In households or in food handling establishments, the toxicant should be applied as a spot treatment. A coarse or spot spray or a dust should be used to treat baseboards, cabinets, along water pipes, under refrigerators, behind stoves, and other cockroach harborages. Care should be taken to avoid contamination of food or food preparation surfaces. Staining problems may arise in treating certain types of surfaces. Furthermore, caution should be used when spraying oil-base solutions around asphalt or vinyl tile floors. Spillage on surface of this type causes softening and marring. The activity of insecticidal residues is markedly influenced by the type of material to which the formulation is applied. Compounds that are somewhat volatile persist longer on painted metal surfaces than on unpainted metal, whereas the reverse may be true with other toxicants. Formulations also may influence the efficacy of insecticide application. Emulsions generally have a longer residual life than solutions. In addition, certain solvents, masking agents and emulsifiers exert a repellent effort on *B. germanica* as shown in laboratory tests with treated and untreated panels in which a greater number of specimens frequented the untreated surfaces. Such data indicate that the so-called inert ingredients in a formulation could have a decided influence on the performance of products containing the same toxicant.

Table 6. Insecticides employed in cockroach control.

Insecticide	Formulation	Percent[a] Concentration
propoxur	Spray	1.0
	Bait	2.0
diazinon	Spray	0.5[b]
	Dust	1.0[b]
dichlorvos	Spray	0.5
	Bait	1.9
chlorpyrifos (Dursban)[c]	Spray	0.5
fenthion[c]	Spray	2.0
Kepone	Bait	0.125
malathion	Spray	5.0
	Dust	5.0

[a]Maximum allowable.
[b]1.0% spray and 2.0 to 5.0% dust for pest control operators only.
[c]Pest control operators only.

In simulated harborage studies (CDC), 2/3 of the wall surfaces of test boxes were treated. Samples of 100 *B. germanica* were then exposed at 30-day intervals for a maximum of 15 days each to wall panels of different materials. With propoxur applied at 50 mg./sq. ft., kills at or above 90% were obtained for 8, 23, 8 and 2 weeks on painted and unpainted metal, masonite, and tile, respectively. Diazinon tested in the same manner gave 21, 7, 37 and 52 weeks of satisfactory mortalities. Neither propoxur nor diazinon at 50 mg./sq. ft. was as effective as chlorpyrifos which provided 57, 19, 57, and 60 weeks of effective kills on these same surfaces, respectively. When the wall coverage was reduced to 1/3, the period of residual activity decreased for each of the three compounds approximately 33 to 50%, emphasizing the importance of adequate coverage in obtaining successful control.

Field tests with 1% solution of fenthion gave more than 90 days effective kills, whereas the dust formulation (3%) was effective for 30 days. Diazinon dust (2%) gave excellent results for this same time period. In public housing projects in California 1% emulsion of propoxur virtually eliminated heavy cockroach infestations in apartments but odor and staining problems occurred. In Florida, buildings infested with *B. germanica* and treated with 1.0% propoxur emulsion still showed 89% reduction in population at 120 days.

Compounds available as baits for cockroach control are listed in Table 6. Over a period of time some baits lose their effectiveness. In tests (CDC) dichlorvos bait after 6 weeks gave 68% kill of *B. germanica*, whereas propoxur and Kepone baits continued to give more than 90% mortality after 101 days. Dichlorvos and propoxur possess fumigant action, but Kepone does not. For quick kills, dichlorvos is superior to Kepone and propoxur but when long-term action is desired it is inferior. Baits applied in combination with spot residual treatments may be more effective than either application alone. Baits composed of 0.125% Kepone in a paraffin base were shown to eliminate *Periplaneta americana* breeding in sewer lines within 2 weeks.

Dust applications offer an advantage over liquid treatments in that they give better penetration of enclosed areas, such as beneath cabinets and in wall voids. Their use in visible areas is normally precluded because of their unsightly appearance. The drift qualities of dusts enable them to be used in any area that is difficult to spray. A disadvantage, however, is that cockroaches tend to avoid dust deposits. Certain dusts containing fluoridated silica aerogels are reported to act as a desiccant as well as a repellent to cockroaches.

Studies with boric acid solution (CDC) applied to 2/3 of the

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simulated harborage at 200 mg./sq. ft. showed only 18% kill over an 18-day test period but with boric acid powder applied to 1/2 of the simulated harborage, 90% kills were obtained for >14 weeks. Two formulations of silica aerogel and 2% diazinon dust under the same exposure conditions were not effective for more than 2 weeks. The poor kills resulted from the specimens tending to avoid the dusted harborage. Boric acid dusts have been used successfully against *B. germanica* infestations in dwellings and commercial buildings in California.

In cooperative tests with the U.S. Navy on seven ships, 0.5% chlorpyrifos emulsion applied to the food service areas gave an average reduction in the infestations of 90 to 99%. A 0.25% emulsion reduced the infestations only 45 to 62% in two ships. Propoxur (1.0%) emulsion applied in four ships decreased the infestations 10 to 63%. However, this same insecticide applied as a 1% solution in a commercial preparation produced 94 to 97% reduction of the *B. germanica* populations in three ships. Pyrethrum aerosols were applied immediately after each of the treatments. Other tests with the U.S. Navy were conducted aboard eight submarines that were treated with dichlorvos aerosol (6.5%) at a rate of 12 oz./10,000 cu. ft. Three of these vessels also were treated with 2% propoxur bait. Greater than 97% control was achieved with all dichlorvos treatments. The propoxur (2.0%) bait used to control newly hatched nymphs from eggs unaffected by the dichlorvos resulted in excellent control for 2 months after the aerosol application. Air samples taken aboard three of the submarines indicated that after 4 hours of ventilation the dichlorvos concentrations in the vessels fell rapidly to low levels of <0.2 μg./liter of air.

VENOMOUS ARTHROPODS

In recent years public awareness of venomous arthropods has increased greatly, partially because of a greater trend toward outdoor living and recreation. The venomous arthropods possess various mechanisms (stings, bites, urticating hairs, etc.) that normally are employed in capturing prey or as a means of defense. However, when they enter homes or when people invade the natural habitats of these arthropods, the contact between man and the arthropod may result in a severe allergenic and anaphylactic response in some individuals. Marked discomfort and even death can result from the toxins injected by the arthropod. Medical attention is the initial step in aiding persons stung or otherwise contacted by a venomous arthropod, but chemical control is of much value as a preventive measure.

Scorpions:

Scorpions, particularly in the southwestern U.S., are quite dangerous to man. The elimination of hiding places, such as boards or lumber piles, accumulations of debris or stored material in basements minimize the risk of scorpion stings. Chemical measures within dwellings should consist of spot treatment of baseboards, under furniture, closets, crevices, around plumbing or any areas where scorpions are observed. Attics and crawl spaces or basements should also be sprayed. Residual sprays containing 1-2% carbaryl, 2% chlordane, 0.5% dieldrin or 5% deodorized malathion may be applied with hand or power sprayers. Dusts containing 2% carbaryl, 5% chlordane, or 1% dieldrin also are suitable. The residual life of chlordane or dieldrin dusts make them particularly suitable for treating wall voids. Dusts (1%) or sprays (0.5%) of lindane tend to excite scorpions, thus increasing the danger of stings.

Outdoor structures such as outbuildings, with surfaces in contact with the soil should be treated to a height of 2 feet above grade. Hiding places, such as stacks of lumber, debris, or firewood, also must be treated. For this purpose use sprays of carbaryl (2%), chlordane (2%), or dieldrin (0.5%), or dusts containing 10%, 10% and 2%, respectively, of these materials. Granules of diazinon (10%) also are effective for area treatment.

Spiders:

Of particular concern to man are the so-called widow spiders (*Lactrodectus* spp., especially *L. mactans*, the black widow spider) and the "brown" spiders (*Loxosceles* spp.). Although the black widow spider has long been considered the most important venomous spider in the U.S., the brown recluse spider, *L. reclusa*, has assumed importance in recent years. The toxin of the latter species kills the tissue around the bite, a condition termed "necrotic arachnidism."

The black widow may enter homes, but is usually found in outdoor harborages, such as privies (particularly under the riser), woodsheds and other outbuildings, stacks of old lumber or brick and trash piles. This spider is attracted to the moisture around water meters and may be found in basements. The brown recluse spider and its relatives favor storage areas, such as closets and attics. They may inhabit stored clothing, packing boxes and similar places, also hiding in cracks, crevices and other dark recesses of buildings. In addition, the brown recluse spider frequents transformer boxes of utility companies.

Control may be achieved by eliminating or by treating the harborage sites with spot applications of sprays containing malathion (2-3%), chlordane (2%), propoxur or ronnel (1%), diazinon (0.5-1%), and dieldrin or lindane (0.5%). The brown recluse spider is significantly repelled by malathion. Dusts of chlordane or malathion (5%) or of fluoridated silica aerogel may be used in attics, crawl spaces and voids. Creosote has been used successfully on the wood of outhouses to kill or repel spiders.

Space treatments of dichlorvos or pyrethrins (0.5%) from aerosols or ground equipment kill spiders but exert little or no residual effect.

Wasps and related insects:

Wasps (yellow jackets, hornets, cicada killers) build nests in or around dwellings—beneath eaves, on porches or other structural surfaces—or in trees, shrubbery, rock fences and in holes in the ground. Nests, close to dwellings or in shrubbery, pose a particular problem to children. Direct treatment of nests with insecticide is the method commonly used to control these pests, whereas baits are feasible for treating larger recreational or suburban areas.

Liquid formulations of the following materials may be used to control these pests: propoxur (0.5%), carbaryl (2%), diazinon (0.5%), dichlorvos (1%) and malathion (2%). Use water-based sprays to avoid damaging vegetation. Dust preparations of carbaryl

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(5%), chlordane (3%) or lindane (1%) are suitable.

The insecticidal sprays or dusts are best applied at night or early morning when the wasps are less active and are in or on the nests. Emphasis is placed on treating the nest opening. In the case of underground nests, the opening should be covered with soil after treatment.

In recreational or camping areas insecticide baits are exposed in protected dispensers placed at ground level, in tree axils or suspended from tree branches. The dispensers are constructed so that the bait is inaccessible to children and other nontarget animals. Control of ground nesting yellow jackets in California has been reported by the use of baits—mirex (0.5%) in fish flavored cat food or chlordane (0.5%) wettable powder in suitable meat bases. Bait dispensers should be located no more than 200 yards apart at a minimum density of 1 per 2 acres and may require weekly servicing. With increased density of bait dispensers to 2 per acre, frequency of exposure can be reduced to 3 alternate days per week.

RODENT CONTROL

Three species of rodents live in close association with man, the Norway rat *(Rattus norvegicus)*, the black or roof rat *(R. rattus)*, and the house mouse, *Mus musculus*. Rats serve as an integral link in the transmission of plague and endemic typhus; man becomes infected with such diseases through the bite of certain fleas associated with these rodents. Rat-bite fever, salmonellosis and leptospirosis are other infections associated with rats. Rickettsial pox, a mite-borne infection of man, is carried by mice. In addition to the disease aspect, rats pose a critical problem in many cities by biting persons, particularly infants and invalids.

Rats thrive wherever ample food and harborage are available—conditions that may exist in and around homes, restaurants, or other food-handling establishments. Deficiencies in the handling and storage of human as well as animal food and refuse and in building construction foster the propagation of rodents. Community sewage systems have been found heavily infested with rats whose movement to above-ground harborages may cause a public health problem. Such invasions have led to city-sponsored programs to control rat infestations in sewers.

Successful rat control can be achieved only by diligently practicing proper refuse storage, collection and disposal, and food storage, harborage elimination and ratproofing. Rodenticides are *supplemental to* and *not a substitute for* good management.

Rodenticides fall into two categories: the single-dose type which is fatal to the rat through a single feeding (*e.g.*, zinc phosphide, red squill) and the multiple-dose type which requires repetitive feedings to be effective (*e.g.*, warfarin, diphacinone). The latter type has dominated the field of rodent control for more than a decade. These slow acting rodenticides are used in most situations because of their effectiveness and low level of hazard to human and domestic animals.

Table 7. Multiple-dose rodenticides employed against mice, roof rats and Norway rats.

Rodenticide	Percent Concentration		
	Mice	Roof Rat	Norway Rat
diphacinone	0.012-0.025	0.0015-0.005	0.0015-0.005
Fumarin	0.025-0.05	0.025	0.025
pindone	0.025-0.05	0.025	0.025
warfarin	0.025-0.05	0.025	0.005-0.025

Dilution factors:
0.05% (500 ppm) = 1 part of 0.5% concentrate to 9 parts of bait.
0.025% (250 ppm) = 1 part of 0.5% concentrate to 19 parts of bait.
0.01% (100 ppm) = 1 part of 0.5% concentrate to 49 parts of bait.
0.005% (50 ppm) = 1 part of 0.5% concentrate to 99 parts of bait.
0.0015% (15 ppm) = 1 part of 0.5% concentrate to 297 parts of bait.

Multiple-dose rodenticides:

Anticoagulant poisions include pindone, warfarin, diphacinone, and Fumarin, each of which can be used as a liquid or dry bait. Dependable control of the Norway rat and the roof rat generally can be accomplished with these rodenticides at the concentrations indicated in Table 7.

Laboratory tests (CDC) with a new anticoagulant, chlorophacinone, have given promising results against Norway and black rats. In free-choice tests of treated and untreated ground laboratory chow, containing 0.005% chlorophacinone, complete mortalities of *R. norvegicus* and *R. rattus* were obtained in an average of 7.3 and 9.2 days, respectively.

The cumulative rodenticidal action of the anticoagulants depends upon consumption of at least a small amount of the poison almost every day for several days. To achieve effective control, anticoagulant baits must be available to the rats for at least 2 weeks. Establishment of permanent bait stations in places subject to continued reinfestation gives good control, provided old baits are periodically replaced with fresh ones.

Resistance to the anticoagulant rodenticides has been found in Norway rats in Europe since 1958, with resistant populations occurring in Wales, England and Denmark. Resistant house mouse populations also have been detected in England. The resistance mechanism involved usually relates to the anticoagulants as a group adversely affecting the clotting ability of blood rather than to chemical composition. However, in England and Denmark some rats, although resistant to warfarin, pindone and other anticoagulants, still remain susceptible to coumatetralyl, a hydroxycoumarin. Until 1971 anticoagulant resistant populations had not been found in the United States despite the widespread use of these rodenticides. Now, however, field reports and laboratory tests confirm the existence of anticoagulant resistant populations of Norway rats on farms near Raleigh, North Carolina. Preliminary reports indicate the possibility that other resistant populations also may exist in this country. However, until resistance is confirmed in a population and the use of anticoagulant baits obviously fails to give adequate control, the operator should not discontinue their usage.

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Table 8. Single-dose rodenticides used against rats and mice. (The individual should be certain that his use of any of these rodenticides conforms with the regulations of the state concerned.)

Rodenticide	Concentration (%) in Baits		
	Rattus norvegicus	*Rattus rattus*	*Mus musculus*
ANTU	1.0-3.0	•	•
Arsenic trioxide	1.0-1.5	1.0-1.5	•
Fluoroacetamide (1081)	2.0	2.0	2.0
Norbormide	1.0	•	•
Red squill (fortified)	5.0-10.0[b]	•	•
Strychnine	•	•	0.3-0.5
Sodium fluoroacetate (1080)	0.2-0.3	0.2-0.3	0.2-0.3
Zinc phosphide	1.0	1.0	1.0

[a]Not used against these species.
[b]The percent concentration used depends on the toxicity of the fortified red squill, i.e., a formulation with an oral LD_{50} to rats of 500 mg./kg. would be prepared at the 10% level.

Single-dose rodenticides:

The single-dose or "direct" rodenticides are especially useful for the rapid reduction of large populations of rodents. This group of rodenticides generally requires fewer man-hours to apply and less bait material. Included in this group are sodium fluoroacetate (1080), fluoroacetamide (1081), norbormide, red squill, ANTU, and zinc phosphide (Table 8).

Sodium fluoroacetate and fluoroacetamide are each highly toxic to man and animals. THEIR USE IS RESTRICTED TO APPLICATION BY HIGHLY TRAINED PERSONNEL. The precautions necessary for safe use of 1080 are described in the manufacturer's instructions. The same precautions are applicable to fluoroacetamide. Both of these rodenticides are useful against rat infestations in sewers. Solid baits as well as water baits of fluoroacetamide should contain 2% toxicant. Baits of 1080 should be formulated at 0.2-0.3%.

Norbormide is highly toxic to rodents of the genus *Rattus*, particularly the brown or Norway rat. It is less effective against the roof rat and is non-toxic to mice. Its extremely low toxicity to other mammals and to birds allows its safe use in the presence of pets, livestock and poultry. This rodenticide is labeled at the 1% level for use against Norway rats. Field studies in Georgia with commercial products generally have given unsatisfactory results against Norway rats. However, when norbormide was experimentally prepared with yellow corn meal, good control was achieved on seven of eight rural premises.

Microencapsulation of norbormide has been attempted in an effort to improve its acceptability to Norway rats. Laboratory studies in England indicated that although a greater amount of microencapsulated toxicant was ingested, increased kills did not always result. In Georgia tests (CDC) with microencapsulated norbormide, a greater intake of bait and an increase in the toxicity of the norbormide to rats were obtained. Presumably, the variation in findings by different workers arose from differences in the microencapsulation procedures.

Fortified red squill, 1 part thoroughly mixed with 9 parts of meat or fish, is appropriate for use against Norway rats where there is a risk of human exposure. Since rats tend to develop shyness to red squill baits, it may be desirable to delay reapplication for at least 6 months. One operational program reports the successful use of frozen red squill baits. The red squill-fish-corn meal torpedoes were kept frozen until they were distributed in the field. Acceptability and rodent kill were satisfactory.

ANTU also is toxic to Norway rats, but it is not effective against roof rats. ANTU should not be used on any rat population more than once a year because of bait refusal and the development of a tolerance to the toxicant. The compound also has been applied as a tracking powder but this method is resorted to only when ANTU baits are not feasible. *ANTU is quite toxic to dogs, cats and hogs.*

Zinc phosphide is effective against rats and mice and has been used extensively as a rodenticide. Baits of 1% zinc phosphide are prepared with meat or with diced fresh fruit and vegetables. It is a stable compound and shows only slight loss of toxicity (<30%) on vegetable and fruit baits over a 90-day period. The gray color of this rodenticide and its strong garlic odor apparently make it somewhat unattractive to nontarget animals. The value of adding tartar emetic to zinc phosphide baits to decrease their potential hazard is questionable. The response of humans to tartar emetic is variable, and including it in the baits adversely affects acceptability to rats. Emphasis should be placed on the careful placement of baits where they are not readily accessible to children, dogs, cats, etc. Any unconsumed baits should be retrieved and destroyed within 48 hours after distribution.

Thallium sulfate is extremely hazardous, not only to the user but also to domestic animals, from the standpoint of secondary poisoning. Although they are still used for the control of wild rodents, *thallium-based rodenticides are banned for use in and around human dwellings.*

Gophacide[12], an organic phosphate, is highly toxic to a variety of rodents and has shown definite promise against domestic rats and mice. Few data are available on the response of domestic animals except chickens which are relatively unaffected. In field trials in Georgia (CDC), Gophacide (0.25%) baits of yellow corn meal, hamburger or dog food gave good control of Norway rats on four premises. Fair to good control was achieved in 7 of 10 trials with 0.5% Gophacide-yellow corn meal baits. In 6 of the 23 tests with suitably accepted baits, poor results were obtained. Against roof rats, 0.5% Gophacide baits of yellow corn

[12]This compound is currently labeled for use by trained personnel against pocket gophers at a 0.2% bait but is not labeled for domestic rodent control.

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meal or oatmeal produced good kills on four test premises. Satisfactory control of house mice was obtained on four premises with 0.5% Gophacide in oatmeal, yellow corn meal, or horse feed. No adverse effects on pets or domestic animals were noted in these field trials.

Under certain conditions, the fumigation of rat burrows is useful in reducing Norway rat populations. However, a single treatment may reduce the population only 50%, and unless the fumigation is repeated or supplemented by other rodenticidal measures, the reduction is of a temporary nature. Chemicals which have been widely used for this purpose include calcium cyanide powder, chloropicrin, and ethylene dibromide. Such fumigants should be used only by trained personnel.

Baiting:

Since the successful use of rodenticides depends on the acceptability of the bait to the rat, bait formulation often is the critical element involved. The operator may be forced to use a "trial and error" approach in finding a bait acceptable to a specific rodent population. Attention should also be given to the variability of response in rodent populations even in adjacent locations.

Yellow corn meal is a readily accepted inexpensive bait material that can be used as the initial bait in rodenticide operations. If a baiting problem develops, other cereals or bait combinations can be tried. Materials, such as bacon, salmon, rolled oats, sugar and corn, and mineral or salad oil, are frequently included in baits. The addition of liquids to baits containing acute poisons increases acceptability especially where water is not readily available. Tomatoes may be of value as baits under such conditions. Laboratory and field tests in England indicate Norway rats prefer oatmeal to other milled cereals. Up to 50% corn meal can be substituted for the oatmeal without decreasing its attractiveness. The addition of peanut oil up to 8% increased the acceptability of the 50/50 mixture of corn meal and oatmeal to both rats and mice. Baiting problems may be related to the food available to the rats rather than to the rodenticide employed. Improper distribution or placement of the baits may also contribute to failure to achieve satisfactory control. Therefore, a thorough knowledge of the habits of the rodent is essential for successful control operations.

In contrast to the anticoagulant baits which in effect serve as their own "pre-baits," maximum effectiveness and efficiency with "direct" toxicants often require a program of prebaiting in which a choice of several bait materials without the toxicant is offered to the rodents one or more nights prior to poisoning. This procedure permits the selection of the best possible bait for each situation, the most effective bait sites and the proper amount of bait to use, thereby preventing either gross over- or under-baiting. This prebaiting technique also decreases the suspiciousness of the rodents, and they may therefore accept the poisoned baits much more readily.

Under conditions where food is readily available to rodents at all times, *e.g.*, in food warehouses, none of the cereal baits may be accepted; a more productive approach may lie in the use of water baits. The inclusion of sugar (5%) as an attractant has improved the results when other sources of water were removed.

The presence of moisture, either as water or high humidity, frequently causes deterioration of semipermanent baits. Workers have found that such breakdown can be retarded by mixing the bait with melted paraffin at a ratio of 2:1. Such weather resistant baits have been reported effective against both rats and mice. Paraffin bait blocks are of particular value against rat infestations in sewers, but the blocks may mold and become less acceptable to the rats because of the extreme moisture conditions.

House mice:

Control of mice sometimes can be accomplished by the use of anticoagulant baits. Because mice do not forage widely, the use of many well distributed small baits is preferable over a few large ones. The tendency of mice to nibble when feeding requires the use of a higher concentration of anticoagulant (Table 7) to reduce control failures. Preliminary tests in England indicate that an increase of the warfarin concentration to 0.2% does not reduce the palatability of a bait, provided peanut oil is added. Mice are not attracted to old baits, so frequent renewal of baits is desirable. Water baits of anticoagulant rodenticides have been considered as feasible for mouse control. However, the water requirements of mice are low, so such baits are not considered useful.

Strychnine baits (0.3-0.5% strychnine) also are used against mice. Because it is highly toxic, strychnine and the finished bait should be handled with care.

DDT powder (50%)[13] is lethal to mice when applied to runways and to harborage areas. The powder should be placed at sites not accessible to children and pets. Red squill also has been suggested as a tracking dust against mice. Laboratory tests (CDC) with reground red squill (500 mg./kg.) have shown better kills than obtained with the standard red squill. Observations indicate that high humidity causes the red squill to cake, thereby decreasing its effectiveness.

[13]For use by pest control operators and trained personnel.

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DAIRY CATTLE SCIENCE

(Animal Agriculture Series)

by

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10. It helps to control weeds, which are often spread through hay or fodder.

11. It is the cheapest form in which a good succulent winter feed can be provided on most farms and ranches.

12. It is a better source of protein and of certain vitamins, especially carotene, and perhaps some of the unknown factors, than dried forage.

13. It is a very palatable feed and slightly laxative in nature.

14. It makes for less waste, the entire plant being eaten with relish; an important consideration with coarse stemmy forages.

15. It is without a peer from the standpoint of long-time storage; holding its feeding value, especially the carotene, better than any other method of preservation, and providing a desirable backlog against drought or any other crop failure.

16. It may be completely mechanized as a feeding system, thereby eliminating much labor and time.

Some *disadvantages* of silage are:

1. It requires a silo and other special equipment, for best results. In comparison with the simpler methods of field curing and storing hay, this is likely to mean higher costs—an important consideration with a small operator.

2. It possesses considerably less vitamin D than sun-cured hay.

3. It requires that almost three times as much tonnage must be handled as silage as when the same forage is dried for hay, due to the high moisture content.

4. It requires an added expenditure when preservatives are used.

5. It is seldom practical to rely on one kind of silage as the sole forage ration of cattle or sheep; however, a combination of high protein silage along with a high energy carbohydrate silage may be fed as the sole forage ration under certain circumstances.

THE SILO

Silage may be stored in almost any kind of container. The main requisites of a good silo, regardless of kind, are:

1. That its size be in keeping with the number and kind of animals to be fed daily, the length of the feeding period, and the amount of forage available for ensiling. Directions on how to determine the size silo to build are given in this book in Chapter XIV.

2. That it exclude air from the stored material, including entrance of air around the doors of tower silos.

3. That the sidewalls be straight and smooth in order to prevent the formation of air pockets.

4. That it be of adequate depth thus making for better packing and less surface area exposed; factors which will help to keep spoilage losses to a minimum.

5. That it be properly reinforced. This point is especially important where wet grass silage is made, because it exerts from ¾ to 2¼ times as much pressure on the walls as does corn silage. Thus, tower silos which were originally built for corn or sorghum silage but which are to be filled with wet grass silage should be either (a) reinforced with extra bands placed around the lower part to strengthen the walls if an inspection reveals that the existing strength is not adequate, or (b) not filled to more than half capacity.

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6. That adequate provision be made for the escape of surplus juices, either by a drain or by a gravel bottom.

7. That it be conveniently located and accessible in all kinds of weather, from the standpoint of both filling and feeding.

Silos may be classified according to the five basic methods used for processing forages. Each method is associated with the shape and material of the structure, which also influences the efficiency of preserving the silage. The different shaped structures are also adapted to different methods of filling and unloading. Within each classification there are many variations of each type depending upon the manufacturer.

The kind of silo decided upon and the choice of construction material should be determined primarily by the cost and by the suitability to the particular needs of the farm or ranch.

Silos may be classified as follows:

I. Conventional Upright (Tower) Silos
   1. Concrete stave
   2. Galvanized steel
   3. Wood stave
   4. Monolithic concrete (poured in place)
   5. Tile block
   6. Brick

II. Sealed Upright (Gas-Tight) Silos
   1. Glass-lined Silos
   2. Concrete stave
   3. Galvanized steel
   4. Monolithic concrete

III. Pit Silos

IV. Horizontal Silos
   1. Trench Silos
   2. Bunker or Self-Feeder Silos

V. Temporary Silos
   1. Enclosed stacks
   2. Open stacks
   3. Modified Trench-Stack Silos
   4. Plastic Silos

Some pertinent information relative to each main kind of silo is given in the discussion which follows, but it is not within the intent of this book to give detailed silo plans and specifications. The latter may be obtained from local authorities, from silo manufacturers, or by writing to the state agricultural colleges.

Conventional Upright (Tower) Silos

The upright or tower silo, which is sometimes referred to as the "watch tower of prosperity," is a cylinder built above ground. Its round shape withstands pressure well and is adapted to good packing.

The tower silo is a permanent farm structure, and, as such, should be constructed to withstand long usage. Although tower silos are usually both durable

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Some authorities seriously question that the lowered fermentation losses and increased forage accruing from adding sulfur dioxide gas, sodium metabisulfite, or Kylage is sufficient to justify their added cost of 35 to 50 cents per ton of silage. If this be true, then the justification for their use must be based largely on the importance of the better-smelling silage which they produce. In other words, how important is it to avoid off-smelling silage? More experimental work is needed relative to these and other products.

DISTRIBUTE FORAGE UNIFORMLY IN THE SILO

In order to avoid the presence of air pockets and spoilage, it is essential that any kind of chopped forage be distributed uniformly in the silo and that it be packed well. Proper silo distribution is obtained by keeping the material nearly level or slightly higher at the center, whereas added packing is obtained by having one or more persons tramping in the silo.

Corn, sorghum, and sunflower silage need not be tramped from the standpoint of preservation and quality of silage, but tramping will result in a somewhat larger tonnage being stored.

Where the forage, regardless of the kind, is harvested at a green, immature stage and cut into short lengths, tramping will not be necessary, but uniform distribution is very important. The only filling precaution under these conditions is to see that the top is carefully leveled and well packed whenever filling is stopped.

Grass silage (especially when wilted), hollow-stemmed forages, and forages that have matured or dried beyond the best silage stage should always be tramped well, especially near the wall.

Mechanical distributors are very helpful, especially in silos of 14-foot or larger diameters.

SEAL OR TOP-OFF THE SILO

Sealing or topping-off is necessary in order to avoid excess spoilage, especially with grass silage which tends to dry out on the surface and to shrink away from the silo walls. This may be accomplished as follows:

1. Following filling, level off the top and tramp thoroughly, especially near the walls.

2. Then cover the top with plastic or with a layer of roofing paper, lapped 5 to 8 inches at the seams and turned up against the silo wall a similar distance.

3. Cover the plastic or roofing paper with a 10- to 12-inch layer of green corn or sorghum stalks from which the ears or heads have been removed, green weeds, unwilted grass, wet sawdust, or other similar material. Do not waste preservative on this top layer.

4. Keep the top tramped 10 to 15 minutes and watered daily for the first 3 days, and then twice weekly for the next 2 or 3 weeks or until there is no more settling.

Where plastic or roofing paper is not used on top of the silo, the topmost layer of wet forage should be 4 to 5 feet thick. Also, it is then desirable to seed oats on top in order to obtain a better seal.

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With tower silos, it is also possible to use a special silage cap manufactured of rubber or plastic material for this purpose. The cover consists of an impervious water- and air-proof blanket which is held in place along the wall of the silo by a water-filled rubber tube which encircles the surface and holds the blanket tightly against the wall and in close contact with the silage.

Feeding Value and Economy of Silage

A common rule of thumb is that 3 pounds of 70 percent moisture grass silage are equivalent to 1 pound of hay of similar kind and quality; a difference due primarily to the high water content of silage.

Many factors enter into any figures which propose to show the comparative economy of silage vs. dry forages, among them (1) the comparative yield of total digestible nutrients per acre, (2) the cost per ton for preserving and storing, (3) the relative nutrient and feeding value, (4) the distribution of labor, (5) the control of weeds, (6) the kind of haymaking weather, (7) the hazard of curing so much hay without it becoming overripe, (8) the price per ton—for example, hay is relatively cheap in the irrigated districts of the West, (9) the machinery and efficiency of the methods used in each method, etc., etc.

Silage Pointers

Some additional pointers which may be of value to the farmer who is making or feeding silage follow.

COATING THE SILO

Since wet grass silage has a somewhat more corrosive action on concrete than does corn or sorghum silage, it may be desirable to apply a protective coating to the inside of concrete silos, whether of solid concrete or of stave construction. The problem is to find an effective and economical coating. For information on the latest recommendations, the dairyman should contact the local county agent, vocational agricultural instructor, or cement dealer, or write to the state college of agriculture.

NUTRIENT LOSSES IN LEAKAGE

Seepage losses vary with the moisture content, depth of silage, distribution of the silage, and the amount of nutrients in the seepage. Seepage losses may be up to 14 percent of the dry matter stored.

The nutrient losses vary, but generally they are in proportion to the run-off. The nutrients lost in seepage from a 100-ton silo may equal the nutrients in ¾ ton or more of hay.

EXPOSURE TO AIR

Spoilage begins the moment silage is exposed to the air. Therefore, once the silo is opened for use, feed should be removed daily. In the wintertime, a

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...production and make the enterprise unprofitable, no matter how good the ...ding of the animals or the feed being used. Still others are important tools ...the standpoint of enhancing good management. Some of these pointers ...be discussed in the sections that follow.

Common Dairy Health Problems

It is generally recognized that good nutrition and good health will alleviate ...disease and parasite problems. In particular, dairymen recognize the importance of proper nutrition from the standpoint of lessening the following ailments: bloat, calf scours, mastitis, and milk fever. (See Chapter XIII of this book for a more complete discussion of these diseases, as well as other diseases.)

BLOAT

Bloat causes losses in dairy cattle (including losses in milk) totaling $48,228,-... annually (*Losses in Agriculture*, Agric. Handbook 291, USDA, p. 73, 1965).

Dairymen have long known that some families of animals are more susceptible to bloat than others—that is, there is a genetic factor involved. Also, it is generally recognized that certain feeds, particularly legume pastures, cause a higher incidence of bloat than others.

Bloat may be lessened by (1) avoiding straight legume pastures, (2) feeding ... forage along with pasture, (3) avoiding a rapid fill from an empty start, (4) keeping animals continuously on pasture after they are once turned out, (5) keeping salt and water conveniently accessible at all times, and (6) avoiding ...ted pastures. Based on recent and limited experimental work and use in the ...d, Poloxalene—a non-ionic surfactant—appears to be very effective in controlling bloat in cattle fed lush pastures or green chop. The product should be ...ed according to the manufacturer's directions. As a top dressing, it is recommended that Poloxalene be used at the rate of ½ oz. daily for animals under 1,000 ...d weight, with additional quantities for heavier animals. It costs 5 to 10¢ per head per day.

CALF SCOURS

It is generally recognized that calf scours cause heavier losses in dairy ...es than any other disease.

Proper feeding, along with strict sanitation, appears to be the best method ...preventing and controlling calf scours. The use of colostrum and the feeding ...injecting of an antibiotic appear to be quite effective in the control of this ...disease.

MILK FEVER

Milk fever causes average annual losses in dairy cattle (including milk) ...$10,619,000 (*Losses in Agriculture*, Agric. Handbook 291, USDA, p. 73, 1965).

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Through increasing the phosphorus and achieving a more desirable calcium-phosphorus ratio, milk fever is lessened. The University of California (*Journal of Dairy Science*, Vol. 37, No. 4, 1954, p. 360) lowered the incidence of milk fever from 30 per cent to none by changing the calcium-phosphorus (Ca:P) ratio from 6:1 to 1:3.3 during the last month of the dry period. Similar evidence that a high calcium-low phosphorus ratio increases milk fever has been reported by the University of Arizona (*Journal of Dairy Science*, Vol 46, No. 6 1963, p. 635), and by Ender, *et al.* of Norway (*Journal of Dairy Science*, Vol 49, No. 2, 1966, p. 244).

There is also evidence that high vitamin D immediately before freshening is effective in lessening milk fever. It is recommended that cows be fed 20 million units of vitamin D daily in the form of irradiated yeast for four to seven days before calving (never longer than seven days). It is emphasized however, that such high levels of vitamin D cannot be fed for a longer period than seven days. Since calving time cannot be predicted with certainty, the use of high levels of vitamin D for this purpose is not without difficulty.

A recent report (Kendall, K. A., University of Illinois) indicates that high grain feeding three weeks prior to calving will lower the incidence of milk fever.

In summary, therefore, the most effective preventive for milk fever appears to be that of having the correct calcium-phosphorus ratio in the ration and feeding more concentrate three weeks prior to calving.

NITRATE POISONING

Sometimes cows are poisoned by nitrate (NO_3), which accumulates in plants and is converted to nitrite (NO_2) when consumed through the feed or water by ruminants. Upon absorption into the blood stream, nitrite reacts with the red oxygen-transporting pigment, hemoglobin, to form a chocolate-brown pigment, methemoglobin, that cannot carry oxygen. Prevention of nitrite poisoning consists in avoiding high nitrate feeds and water.

Beware of Pesticide Residues

Pesticides are chemicals that are used to kill pests—insects, weeds, and rodents. These products are very necessary for food and milk production. Our abundant supply of wholesome foods would not have been available without their use. Yet, it is important that they be properly used, and that certain precautions be taken. The following points are pertinent to their proper use.

1. Pesticides that have been associated with milk contamination.—This includes the chlorinated hydrocarbons, aldrin, dieldrin, heptachlor epoxide, DDT and its isomers, toxaphene, and lindane. Of course, other pesticides may become a problem in the future.

2. How pesticides contaminate milk.—They are absorbed by animal fat. Since milk contains fat, it is one channel through which the animal eliminates pesticides from its body.

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3. Length of time that a contaminated cow may give contaminated milk.—Cases are known where residues have been detected in milk for four to eight months after discontinuing the feeding of contaminated feeds.

4. Ways that milk may become contaminated.—Milk becomes contaminated (a) by spraying animals and non-recommended pesticides, (b) by using these materials in back-rubbers and vaporizers, (c) by feeding forages and concentrates which have been contaminated with these materials, (d) by allowing cows to drink pesticide-contaminated water, and (e) by using milk utensils that have become contaminated through their use for chores other than handling milk or in milk production. Hence, milk contamination can be prevented by avoiding any of these avenues of contamination.

5. The meaning of the word "tolerance" as applied to a chemical residue.—A given tolerance is that amount of chemical residue, usually expressed in ppm (parts per million) set by the FDA (Food & Drug Administration), that remain on or in a commodity at harvest and which is at least 100 times less than that amount of the chemical known to be toxic to experimental animals.

A zero tolerance, as applied to chemical residue, means that no amount of the pesticide chemical may remain on or in the raw agricultural commodity when it is offered for shipment. Recently, the FDA raised the tolerance level for pesticides in milk from 0 to 1.25 ppm on a fat basis. This means that there must be less than 1.25 parts of the pesticide (DDT, for example) to one million parts of milk fat figured on a weight basis.

Feeds Affecting Milk Flavor

Consumers want milk to taste like milk—not like silage, grass, or weeds. Although feeds are not the only cause of milk flavors, they are major contributors. Feed flavors enter the milk through the digestive system, respiratory system, and by direct absorption. Research indicates that most feed flavors are detectable in the milk 20 minutes after the feed is consumed, and that they are usually most pronounced at the end of two hours.

Feed flavors that enter the milk through the respiratory system can usually be detected much sooner than those entering through the digestive system. For example, if a cow breathes air reeking with silage odors, these flavors can be detected in the milk almost immediately. Flavors that are directly absorbed by milk are less common, but they appear if the milk is left exposed for a long enough period.

The following control measures are recommended to alleviate feed flavors:

1. Avoid sudden change to fresh, lush pasture.—Cows should be shifted from winter feeding, or old pasture, to new and lush pastures on a gradual basis. Also, cows should be taken out of such pastures two to three hours before milking. For the same reasons, freshly cut grass should not be fed immediately before milking.

2. Control and avoid undesirable weeds.—Many weeds when eaten by cows will impart a strong flavor to milk, among them are: wild onions, skunk

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cabbage, some members of the mustard family, bitterweed, carrot weed, ragweed, and others. It is easier to get rid of these weeds today than formerly, so they should be eliminated from pasture and hay fields utilized by milk cows.

3. Silage flavor.—Silage flavor is both common and objectionable. It can be avoided by feeding all silages after milking, never before or during milking. Usually one will be safe if silage is not fed within two to four hours of milking time, but it's safer to feed it shortly after milking. This permits the flavor-causing material to pass through the cow's digestive system before the next milking.

If cows breathe the odor of silage, it will appear as flavor in the milk. Thus, silage should never be left in the mangers or feed alleys. In fact, it is preferable that it be fed in the corral, and not in the area where the cows are being milked.

Marketing Dairy Herd Replacement Stock

Most established dairymen have surplus animals to sell—replacement heifers, cull cows and bulls, veal calves, and feeder animals for growing and finishing. Those establishing new herds, and to a more limited extent those maintaining herds, are on the buying end of the business. Dairy animals intended for slaughter are marketed through the same channels as beef animals sold for slaughter.

Dealers are the major outlet for dairy replacement stock, with most of their purchases made on the farm. Dealers resell replacement stock by either private treaty or auction. In addition to dealers, with some variation from area to area, replacement heifers are marketed through breed registry association sponsored sales (usually state or local sponsorship), cooperatives, artificial insemination associations, and dairy cattle sales associations.

In most areas, the following improvements would benefit both the seller and the buyer of replacement heifers:

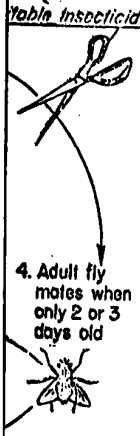
1. Establishing and using uniform grades.
2. Reporting market information on prices.
3. Maintaining high health standards, and getting uniform health regulations from state to state.
4. Keeping production records on all cows from which replacement heifers will be sold.
5. Lowering the stress and disease losses which accompany the transportation of heifers.

Dairy Beef Production

Marketing dairy animals—cows, heifers, steers, and veal calves—for slaughter accounts for 3 per cent of farm cash income, which amounted to $1.2 billion in 1965. The importance of dairy beef production will increase.

The results of earlier experiments in which steers of dairy breeding were

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PREVENTION, CONTROL, AND TREATMENT

The destruction of natural breeding grounds of the stablefly is the first and primary means of prevention. This calls for the frequent spreading of manure and the elimination of all fermenting or decaying organic material—such as straw stacks, piles of waste roughages, etc.

Sprays are the best secondary means for controlling stableflies. For recommended insecticides and formula for stablefly control, see Table 13-4, Handy Spray and Dip Guide for Control of External Parasites of Dairy Cattle (p. 376).

Handy Spray and Dip Guide for Control of External Parasites of Dairy Cattle

Table 13-4 contains recommendations for the control of external parasites of dairy cattle. Table 13-5 contains recommendations for the control of parasites inside and outside barns and on pastures. Because of cancellations of registrations of insecticides, the recommendations made in these tables supercede the earlier recommendations that appear in the other books by the same author. Also, there likely will be further deletions and additions. Hence, always follow the recommendations of manufacturers and local authorities.

HANDY GUIDE FOR CONTROL OF DAIRY CATTLE MITES

Scabies (mites) produce skin lesions and cause intense itching, which animals try to alleviate by rubbing and scratching. Infected animals do not feed properly and, as a result, calves do not grow and lactating cows do not produce milk at normal rates. Also, hides are often severely damaged by mites.

Table 13-6 contains recommendations for the control of dairy mites of cattle.

Precautions on the Use of Insecticides

Certain basic precautions must be observed when insecticides are used because, used improperly, they can be injurious to man and animals. So, when using insecticides, the dairyman should always follow the directions and heed all precautions on the labels. Additionally, the following precautions are noteworthy:

1. *Selecting Insecticides.*—Always select the formulation and insecticide recommended for the purpose for which it is to be used.

2. *Storing Insecticides.*—Always store insecticides in the original containers. Never transfer to unlabeled containers or to food or beverage containers. Store insecticides in a dry place out of reach of children, animals, or unauthorized persons.

3. *Disposing of Empty Containers and Unused Insecticides.*—Properly dispose of all empty insecticide containers. Do not reuse. Break and bury glass containers. Chop holes in, crush, and bury metal containers. Bury containers and unused insecticide at least 18 inches deep in the soil in a sanitary landfill, dump, or in a level isolated place where they will not contaminate water supplies.

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TABLE 13–4

HANDY SPRAY AND DIP GUIDE FOR CONTROL OF EXTERNAL PARASITES OF DAIRY CATTLE[1]

Insect	Insecticide	Tolerance (ppm)[2]	Formulation and Strength[3]	Amount of Formulation/Animal Unless Otherwise Indicated	Where and When to Apply; Safety Restrictions (Also see last page of this table)
Cattle grubs *(Hypoderma spp.)*	Coumaphos (Co-Ral [4])	*1 meat and meat fat*	*0.25% WP dip*		
			0.25% WP or S	Depending on size of animals and amount of hair, 1-4 qt.	*Make 2 applications not more than 90 days apart. Apply second spray soon after heel fly activity has stopped. Apply to nonlactating dairy animals only.*
			Solution, 4%	½ fl. oz./100 lb. body weight.	*Pour evenly along animal's backline. Apply to nonlactating dairy animals only.*
	Famphur (Warbex [4])	0.1 meat and meat fat	In feed	1.1 mg/lb. body weight	Daily for 30 days only. *Apply to nonlactating dairy animals only.*
				2.3 mg/lb. body weight	Daily for 10 days. *Apply to nonlactating dairy animals only.*
Face flies *(Musca autumnalis)*	Coumaphos (Co-Ral [4])	0.5 in milk-fat 1.0 in meat and fat	1% oil	1 gal./20 ft. cable	Saturate back rubbers. Construct to permit animal to rub its face.
			5% D		Use in self-treatment dust bags. Place bags so animals are forced to contact them periodically such as in fence gates between pastures.
	Crotoxyphos (Clodrin [4])	0.02 in milk, meat, and fat	EC or oil 2% S	1-2 fl. oz.	As mist spray daily to all parts of body.
			EC, 0.5-1% S	1-2 pt.	Spray thoroughly. Repeat once a week if necessary.

HANDY SPRAY AND DIP GUIDE FOR CONTROL OF EXTERNAL PARASITES OF DAIRY CATTLE[1]

Insect	Insecticide	Tolerance (ppm)[2]	Formulation and Strength[3]	Amount of Formulation/Animal Unless Otherwise Indicated	Where and When to Apply; Safety Restrictions

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HANDY SPRAY AND DIP GUIDE FOR CONTROL OF EXTERNAL PARASITES OF DAIRY CATTLE

Insect	Insecticide	Tolerance (ppm)[2]	Formulation and Strength[3]	Amount of Formulation/Animal Unless Otherwise Indicated	Where and When to Apply; Safety Restrictions (Also see last page of this table)
	Crotoxyphos (Ciodrin®)	0.02 in milk	EC, 0.5% S	1-2 qt.	Pen or corral spraying with high pressure equipment.[4]
Horn flies (*Haematobia irritans*)	Coumaphos (Co-Ral®)	0.5 in milk-fat 1.0 in meat and fat	1% oil	1 gal./20 ft. cable.	Saturate back rubbers.
			5% D		Use in self-treatment dust bags. Place bags so animals are forced to contact them periodically, such as in fence gates between pastures.
	Crotoxyphos (Ciodrin®)	0.02 in milk, meat and fat	3% D	1-2 heaping tbsp.	On poll, back, and upper portions of sides. Do not repeat application within 14 days.
			EC, 1% pyuron	1 qt.	Pour along backline.[4]
			EC or oil 2% S	1-2 fl. oz.	As mist spray daily to all parts of body.
	Crotoxyphos (Ciodrin®)		EC, 0.5-1% S EC, 0.15-0.3% S	1-2 pt. 1-4 qt.	Spray thoroughly once a week if necessary.[4]
			EC, 0.5% S	1-2 qt.	Pen or corral spraying with high pressure equipment.
			1% oil	1 gal./20 ft. cable	Saturate back rubbers.
	Malathion[5]	0.5 in milk-fat 4.0 in meat	4% D 5% D	2 oz. 1.5 oz.	Sprinkle on back and neck every 10-14 days if needed.
	Pyrethrins	0.5 in milk	EC, 0.1% S	1-2 qt.	As wet spray every 3-7 days.
		0.5 in meat, fat, meat by-products	Oil soln. or EC, 0.1%	1-2 fl. oz.	As mist spray daily with hand of automatic sprayer.

Note: See last page for all footnotes.

(Continued)

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TABLE 13—4 (Continued)

HANDY SPRAY AND DIP GUIDE FOR CONTROL OF EXTERNAL PARASITES OF DAIRY CATTLE[1]

Insect	Insecticide	Tolerance (ppm)[2]	Formulation and Strength[3]	Amount of Formulation/Animal Unless Otherwise Indicated	Where and When to Apply; Safety Restrictions (Also see last page of this table)
Lice	Crotoxyphos (Ciodrin®)	0.02 in milk, meat, and fat	EC, 0.15-0.3% S	1-4 qt.	Spray thoroughly; repeat after 1 week if needed.[4]
			EC, 0.5% S	1-2 qt.	Pen or corral spraying with high pressure equipment.[4]
			EC, 0.1-0.25% S	1-2 gal. (1 gal. 0.25%)	Apply second application 14 days later.
	Coumaphos (Co-Ral ®)	0.5 in milk-fat 1.0 in meat and fat	1 lb/100 gal. water of 25% WP	Wet to run off	Repeat as necessary.
	Pyrethrins	0.5 in milk-fat 0.1 in meat, fat, and meat by-products	EC, 0.025% S	Depending on size of animals and amount of hair.	Spray or dust thoroughly; repeat after 2-3 weeks.
Screwworm (*Cochliomyia hominivorax*)	Coumaphos (Co-Ral ®)	1 meat and fat 0.5 milk fat	5% D	Minimum needed, not more than 3 tsp.	On wounds as needed.
Stable flies (*Stomoxys calcitrans*) and mosquitoes	Crotoxyphos (Ciodrin ®)	0.02 in milk, meat, and fat	EC or oil 2%	1-2 fl. oz.	As mist spray daily to all parts of body.
			EC, 0.5-1% EC, 0.15-0.3%	1-2 pt. 1-4 qt.	Spray thoroughly. Repeat once a week if necessary.[4]
			EC, 0.5%	1-2 qt.	Pen or corral spraying with high pressure equipment.[4]
	Pyrethrins	0.5 in milk-fat 0.1 in meat, fat, meat by-products	EC, 0.1%	1-2 qt.	As wet spray every 2-3 days.
			Oil soln., or EC, 0.1%	1-2 fl. oz.	As mist spray daily, with hand or automatic sprayer.

Note: See last page for all footnotes. (Continued)

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TABLE 13—4 (Continued)

HANDY SPRAY AND DIP GUIDE FOR CONTROL OF EXTERNAL PARASITES OF DAIRY CATTLE[1]

Insect	Insecticide	Tolerance (ppm)[2]	Formulation and Strength[3]	Amount of Formulation/Animal Unless Otherwise Indicated	Where and When to Apply; Safety Restrictions (Also see last page of this table)
Ticks other than ear ticks	Crotoxyphos (Ciodrin®)	0.02 in milk, meat, and fat	EC, 0.15-0.3%	1-4 qt.	Spray thoroughly; repeat after 1 week if needed.[4]
			EC, 0.5%	1-2 qt.	Pen or corral spraying with high pressure equipment.[4]

TABLE 13—4 (Continued)

HANDY SPRAY AND DIP GUIDE FOR CONTROL OF EXTERNAL PARASITES OF DAIRY CATTLE[1]

Insect	Insecticide	Tolerance (ppm)[2]	Formulation and Strength[3]	Amount of Formulation/Animal Unless Otherwise Indicated	Where and When to Apply; Safety Restrictions (Also see last page of this table)
Ticks other than ear ticks	Crotoxyphos (Ciodrin®)	0.02 in milk, meat, and fat	EC, 0.15-0.3%	1-4 qt.	Spray thoroughly; repeat after 1 week if needed.[4]
			EC, 0.5%	1-2 qt.	Pen or corral spraying with high pressure equipment.[4]
			EC, 0.1-0.25%	1-2 gal. (1 gal. 0.25%)	Apply second application 14 days later.
	Pyrethrins	0.5 in milk-fat 0.1 in meat, fat, and meat by-products	EC, 0.1%	Depending on size of animals and amount of hair.	Spray animals thoroughly as needed.

SAFETY RESTRICTIONS
(Dairy Cattle)

Do not apply more than 2 fluid ounces per day per animal when using mist sprays containing *Ciodrin*. Do not wet the hide with the spray.

Do not apply *Ciodrin* to cattle more often than once a week except as a mist spray. Do not apply *Ciodrin* dust more often than every 14 days.

Do not apply *coumaphos* in conjunction with oral drenches or other internal medications, such as phenothiazine, or with other organic phosphates. Do not use with synergized pyrethrins, allethrin, or synergist. Suspend back rubber at a height that will prevent straddling.

Do not apply *malathion* dust on dairy cattle during or less than 5 hours before *milking*. Do not use malathion in sprays or dips on dairy cattle.

USE PESTICIDES SAFELY—FOLLOW THE LABEL

[1]Recommendations made by staff members of U.S. Department of Agriculture, Agricultural Research Service, Entomology Research Division, Beltsville, Md. Cattle grub and screwworm control recommendations made especially for this book by Dr. Clyde H. Schmidt, Chief, Insects Affecting Man and Animals Research Branch. Balance of recommendations made by Dr. R. L. Harris, USDA, ARS, Entomology Research Division, Kerrville, Texas, and taken from *Dairy Science Handbook*, Volume 4, 1971, Pub. by Agriservices Foundation.

[2]Legal tolerances for insecticide residues permitted on food or feed products.

[3]WP-wettable powder; EC-emulsifiable concentrate; Sw-spray; Dm-dust.

[4]Do not reapply more often than every 7 days.

[5]Do not apply malathion within 5 hr. of milking or during milking.

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TABLE 13—5

HANDY INSECTICIDE GUIDE FOR THE CONTROL OF PARASITES INSIDE AND OUTSIDE BARNS AND ON PASTURES[1]

Insect	Insecticide	Tolerance on grass (ppm)[2]	Min. Days from Last Application to Harvest or Feeding	Formulation and Strength[3]	Amount of Formulation/Area	Where and When to Apply
House flies (*Musca domestica*)	Malathion			3.5% dry 1.25% liquid		Broadcast or sprinkle dry baits or spot treat by brushing or spraying liquid as needed where flies congregate.
	Trichlorfon (Neguvon ®)			1% dry 0.1% liquid		
Mosquitos	Carbaryl[3] (Sevin ®)	100	0	WP or S	0.25-0.5	Apply as space spray or fog as needed.
	Malathion[3]	135	0	EC or in oil	0.1-0.5	For pasture and rangeland only.
	Pyrethrins[3] + Piperonyl butoxide	Exempt	0	EC or in oil 0.25% + 2%	0.1-0.5 Approx. 0.1-0.08	
Stable fly (*Stomoxys calcitrans*) and house fly	Crotoxyphos[4] (Ciodrin ®)			EC, 1%	1 gal/1000 sq. ft.	Thorough coverage of surfaces on which flies rest.
	Dimethoate[4] (Cygon ®)			EC, 1%	1 gal/1000 sq. ft.	Remove animals from building. Do not treat milk processing rooms.
	Malathion[4]			EC, or WP, 1.5%	1-2 gal./1000 sq. ft.	
	Pyrethrins[4]			0.25%		Space spray. Remove animals from buildings. Do not treat milk processing rooms.

[1]From *Dairy Science Handbook*, Vol. V, 1971, Published by Agservices Foundation. Recommendations made by Dr. R. L. Harris, USDA, Agricultural Research Service, Entomology Research Division, Kerrville, Texas.

[2]Remove animals from pasture before treating.

[3]Legal tolerances for insecticide residues permitted on feed or food products.

[4]WP = wettable powder; EC = emulsifiable concentrate; S = spray.

[5]Remove animals from buildings. Do not treat milk processing rooms.

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TABLE 13—6

HANDY GUIDE FOR CONTROL OF MITES ON DAIRY CATTLE[1]

(Dairymen who suspect scabies (mites) should immediately contact their local veterinarian and/or state or federal regulatory official. Then, if mites are found, follow his directions.)

TABLE 13–6

HANDY GUIDE FOR CONTROL OF MITES ON DAIRY CATTLE[1]

(Dairymen who suspect scabies (mites) should immediately contact their local veterinarian and/or state or federal regulatory official. Then, if mites are found, follow his directions.)

Insecticide	Tolerance (ppm)	Min. Days From Last Application to Use of Milk or Slaughter	Formulation and Strength	Amount of Formulation/Animal Unless Otherwise Indicated	Application	Remarks
Lime-Sulfur	—	None	2% spray or dip (heated and maintained at 95° to 105°F)	Wet animal thoroughly.	Two applications 10-14 days apart, in vat or spray-dip machine.	Lime-sulfur has been the time-honored treatment for scabies since the USDA approved it years ago. Lime-sulfur is the only insecticide for mite control acceptable for lactating animals.
Toxaphene	7 in meat	28	0.5-0.6% spray or dip	Wet animal thoroughly.	Two applications 10-14 days apart, in vat or spray-dip machine.	

[1]Provided for this book (in a personal communication of October 29, 1970, to the author) by Dr. J. L. Hourrigan, DVM, Senior Staff Veterinarian, sheep, goat, equine, and ectoparasites staff, USDA, Agricultural Research Service, Animal Health Division, Federal Center Building, Hyattsville, Md. 20782.

Because of cancellations of registrations of insecticides, the recommendations made in this table supersede the earlier recommendations that appear in other books by the same author. There may be further changes in insecticides; hence, always follow the recommendations of manufacturers and local authorities.

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4. *Mixing and Handling.*—Mix and prepare insecticides in the open or in a well ventilated place. Wear rubber gloves and clean, dry clothing (respirator device may be necessary with some products). Remove spilled insecticide from skin with soap and water. Change contaminated clothing immediately and launder before wearing again. Avoid prolonged inhalation. Do not smoke, eat, or drink when mixing insecticides.

5. *Applying.*—Use only amounts recommended. Apply at correct time to avoid unlawful residues in milk. Avoid treating calves younger than specified on the label. Avoid drift onto nearby crops, pastures, livestock, or other nontarget areas. Avoid prolonged contact with sprays and dusts. Do not eat, drink, or smoke until all operations have ceased and hands and face are thoroughly washed. Change and launder clothing after each day's work.

6. *If you swallow.*—If you accidentally swallow an insecticide, induce vomiting by taking one tablespoonful of salt in a glass of water. Repeat if necessary. Call a doctor.

7. *If you're poisoned.*—In many cities, there is a Poison Control Center that will have available information concerning symptoms and treatment of cases of actual or suspected poisoning by pesticides; consult the local telephone directory. If this information cannot be obtained locally, call the U.S. Public Health Service at Atlanta, Georgia, or Wenatchee, Washington.

DISINFECTANTS[34]

A disinfectant is defined as a biological, physical, or chemical agent capable of exerting changes in environment unfavorable for the continued survival of micro-organisms.

Under ordinary conditions, proper cleaning of dairy buildings removes most of the micro-organisms, along with the filth, thus eliminating the necessity of disinfection. In case of a disease outbreak, however, the premises must be disinfected.

Effective disinfection depends on five things:

1. Thorough cleaning before application.
2. The phenol coefficient of the disinfectant, which indicates the killing strength of a disinfectant as compared to phenol (carbolic acid). It is determined by a standard laboratory test in which the typhoid fever germ often is used as the test organism.
3. The dilution at which the disinfectant is used.
4. The temperature; most disinfectants are much more effective if applied hot.
5. Thoroughness of application, and time of exposure.

Disinfection must in all cases be preceded by a very thorough cleaning, for organic matter serves to protect disease germs and otherwise interferes with the activity of the disinfecting agent.

TABLE 13—7
HANDY DISINFECTANT GUIDE[1]

Kind of Disinfectant	Usefulness	Strength	Limitations and Comments
Alcohol	Effective against the less resistant disease germs provided there is adequate exposure.	70 percent alcohol—the content usually found in rubbing alcohol.	Limited application. Not recommended for general use. Often used as a local antiseptic in ob-

[34] The authors had the benefit of the authoritative review and suggestions of Dr. W. H. Gillespie, Professor of Veterinary Microbiology, Washington State University, Pullman, Washington, in the preparation of this section.

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TABLE 13–7

HANDY DISINFECTANT GUIDE[1]

Kind of Disinfectant	Usefulness	Strength	Limitations and Comments
Alcohol	Effective against the less resistant disease germs provided there is adequate exposure. As a skin disinfectant.	70 percent alcohol—the content usually found in rubbing alcohol.	Limited application. Not recommended for general use. Often used as a local antiseptic in obtaining blood samples or making hypodermic injections. Not reliable for sterilization of instruments.
Bichloride of Mercury (*mercuric* chloride; corrosive sublimate)	Destroys less resistant bacteria under favorable conditions. Tends to prevent growth rather than actually destroy bacteria. Organic mercurials, sometimes used as local antiseptics, are less poisonous and more reliable.	Tablets used in a dilution of 1 to 1,000.	Unreliable as a germ killer in the presence of organic matter. Also cattle are especially susceptible to mercury poisoning. For farm disinfection, bichloride of mercury is inferior to iodine, lye, saponified cresols, and the cationic bactericides.
Boric Acid[2]	As a wash for eyes, and other sensitive parts of the body.	1 oz. in 1 pt. water (about 6% solution).	It is a weak antiseptic. It may cause harm to the nervous system if absorbed into the body in large amounts. For this and other reasons, antibiotic solutions and saline solutions are fast replacing it.
Cationic Bactericides (many commercial products available, including QAC,	Primarily detergents but some are actively bactericidal. Often used in sanitizing dairy or other equipment and utensils. Use only as recommended by competent sanitarian.	Concentration varies with different products and under different conditions. Follow authoritative recommendations.	They have only a slight toxicity and are non irritant and odorless. They are neutralized by soap, anionic detergents, and even by mineral content of some waters.

(Continued)

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TABLE 13—7 (Continued)

Kind of Disinfectant	Usefulness	Strength	Limitations and Comments
i.e., quaternary ammonium compounds)			Superior to chlorine compounds in the presence of organic matter. They are not effective against TB organisms and spores.
Chlorine (Sodium hypochlorite)	Dairy utinsels. Udder wash.	200 pp. for dairy utinsels.	Corrosive; must be clean; low residual.
Cresols (many commercial products available)	A generally reliable class of disinfectant. Effective against brucellosis, shipping fever, swine erysipelas, and tuberculosis.	4 oz. per gal.; or according to the directions found on the container.	Cannot be used where odor may be absorbed, and therefore, not suited for use around milk and meat.
Heat (by steam, hot water, burning, or boiling)	In the burning of rubbish or articles of little value, and in disposing of infected body dischages. The steam "Jenny" is effective for disinfection if properly employed —particularly if used in conjunction with a phenolic germicide.	Exposure to boiling water will destroy all ordinary disease germs but sometimes fails to kill the spores of such diseases as anthrax and tetanus. Moist heat is preferred to dry heat, and steam under pressure is the most effective. Heat may be impractical or too expensive.	10 min. exposure to boiling water is usually sufficient.
Hypochlorites (chlorine compounds)	For deodorizing manure, sewers, drains, and for disinfecting milk cans and bottles and around dairy barns.	Excellent for disinfection, but with following limitations: not effective against the TB organism and spores. Its effectiveness is greatly reduced in presence of organic matter, such as milk, even in small quantities. Hypochlorites deteriorate rapidly when exposed to air.	200 parts available chlorine per million of water. Unstable: replace solution frequently as recommended.

Footnotes on last page of table.

(Continued)

TABLE 13—7 (Continued)

Kind of Disinfectant	Usefulness	Strength	Limitations and Comments
Iodine[2]	Extensively used as skin disinfectant, for minor cuts and bruises. Also used in treatment of ringworm and warts.	Generally used as tincture of iodine 2% or 7%.	Never cover with a bandage. Clean skin before applying iodine.
			An excellent disinfectant but with

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rites deteriorate rapidly when exposed to air.

Footnotes on last page of table.

(Continued)

TABLE 13—7 (Continued)

Kind of Disinfectant	Usefulness	Strength	Limitations and Comments
Iodine[3]	Extensively used as skin disinfectant, for minor cuts and bruises. Also used in treatment of ringworm and warts.	Generally used as tincture of iodine 5% or 7%.	Never cover with a bandage. Clean skin before applying iodine.
Iodophor (iodine complexed with a detergent which releases free iodine at a controlled rate).	For disinfecting milk cans and bottles around dairy barns and for area disinfection where large quantities of organic soil are not present.	75 parts available iodine per million is minimum under ideal circumstances. 150 ppm is recommended for most practical uses. Unstable—replace solution frequently.	An excellent disinfectant but with the following practical limitations: Germicidal agent rapidly consumed by organic matter necessitating frequent replacement. Functions best in a highly acid range. Solution strength must be increased to get necessary available iodine when mixture is made with alkaline water. Iodine slowly volatilizes from solution. Considerable control should be exercised.
Lime (whitewash)	Annual disinfection of barns, poultry houses, and corrals. To control spread of warts, ringworm and other diseases that may be harbored in cracks of walls, floors, and wood fences.		Not effective against organisms of TB and the spore formers. Wear goggles when adding water to quicklime.
(unslaked)	Spread on soil of poultry and other animal yards. Cover dead birds and other dead animals before burying. In the control of anthrax and foot and mouth disease.	Strong.	It serves as a deodorant when sprinkled on manure and animal discharges. It is also helpful in the prevention of foot rot.

Footnotes on last page of table.

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TABLE 13—7 (Continued)

Kind of Disinfectant	Usefulness	Strength	Limitations and Comments
Lye (sodium hydroxide, caustic soda)	On concrete floors; in milk houses because there is no odor. Use 2% solution in pens and stalls following outbreaks of vesicular exanthema, or erysipelas. Use 5% solution in pens and stalls following outbreaks of anthrax, blackleg and malignant edema.	To make 2% solution, add *one* 13½ oz. can/5 gal. water. To make 5% solution, add *one* 13½ oz. can/2 gal. water.	Damages fabrics, aluminum and painted surfaces. Be careful, for it will burn the hands and face. Not effective against organism of T.B., Johne's disease, or strangles or most spores. Diluted vinegar can be used to neutralize lye. Be sure floors and walls are dry before bringing in animals. Keep in noncorrosive container and away from children.
Lysol (the brand name of a product of saponated cresol plus soap)	For disinfecting instruments used in castration, dehorning, tatooing, and docking.	0.5 to 1.0%.	Has a disagreeable odor.
Merthiolate (marketed in three forms for animal use; Tincture Merthiolate, Merthiolate Aerosol, and Merthiolate Cream.)	Presurgical preparation of the skin. Treatment of minor cuts, scratches, and abrasions. Treatment of ringworm. As a dairy udder cream.	Tincture Merthiolate: 0.1 gm. thimerosal/100 cc. Metholate Aerosol: .033% thimerosal. Metholate Cream: 0.1% thimerosal.	Keep out of reach of children; do not use in eyes; and do not use in combination with or following the application of acids, salts of heavy metals, or iodine.
Phenolic Germicides, Synthetic (those containing odorless non toxic phenols such as orthophenyl phenol or orthobenzyl parachlorophenol)	A very reliable class of disinfectants effective against all disease-producing fungi and bacteria. Apply to buildings, corrals, vehicles, and in foot baths following outbreaks of brucellosis, hog cholera, shipping fever, erysipelas, and tuberculosis.	Varies with different formulations; follow directions on manufacturer's label.	Excellent for disinfection. They are not inactivated by soap, anionic detergents, hard water, or organic matter. They are effective against all bacteria and fungi including the TB organism but not the spores of anthrax and tetanus.

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(Continued)

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TABLE 13—7 (Continued)

Kind of Disinfectant	Usefulness	Strength	Limitations and Comments

TABLE 13—7 (Continued)

Kind of Disinfectant	Usefulness	Strength	Limitations and Comments
Pine Oil	For disinfection of surfaces, such as walls and floors.		Limited germicidal range when used alone, but range increased when combined with detergents, soaps, or ammonium salts. Irritating to skin and mucus membranes.
Sal Soda	It may be used in place of lye against foot-and-mouth disease and vesicular exanthema.	10½% solution (13½ oz. to 1 gal. water).	
Soap	Its power to kill germs is very limited. Greatest usefulness is in cleansing and dissolving coatings from various surfaces, including the skin, prior to application of a good disinfectant.	As commercially prepared.	Although indispensable for sanitizing surfaces, soaps should not be considered as disinfectants. They are not regularly effective, staphylococci and the organisms which cause diarrheal diseases are resistant.
Soda Ash (or sodium carbonate)	It may be used in place of lye against foot-and-mouth disease and vesicular exanthema.	5% solution (1 lb. to 3 gal. water). Most effective in hot solution.	Commonly used as a cleaning agent, but has disinfectant properties, especially when used as a hot solution.

[1]This table was authoritatively reviewed by each of the following: Mr. R. C. Jente, Vestal Laboratories, 4963 Manchester Ave., St. Louis, Mo.; Mr. E. Neil Scott, Elanco Products Co., Indianapolis, Ind.; Mr. Paul C. Nelson, Technical Service and Development, The Dow Chemical Co., Midland, Mich. In the use of these disinfectants, always follow manufacturer's directions and heed government regulations.

[2]Sometimes loosely classed as a disinfectant but actually an antiseptic and practically useful only on living tissue.

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TABLE 13–8[1]

SUMMARY OF STATE INDEMNITY PAYMENTS

Disease	No State Indemnity Paid	States That Pay More Than Federal Maximum	States That Pay Less Than Federal Maximum	States That Pay Amounts Equaling Federal Maximum
Brucellosis	Ala. N.D. Ark. N.Y. Colo. Ohio Ind. Okla. Kan. Tenn. Miss. Tex. Mont. Utah Nev. Va. Wyo.	Calif. N.J. Conn. Pa. Hawaii R.I. Md. Vt. Mich. W.Va. N.H. P. Rico	Fla. Neb. Ga. S.D. Ida. Ky. La.	Alaska Mo. Ariz. N.M. Del. Ore. Ia. S.C. Ill. Wash. Mass. Wisc. Me. Minn.
Tuberculosis	All states pay tuberculosis indemnity.	Calif. N.Y. Conn. Ohio Ill. Pa. Ind. R.I. Iowa. Tenn. Me. Vt. Mass. W. Va. Mich. Wyo. Minn. P. Rico Nev. N.H. N.J.	Ala. S.D. Fla. Utah Ida. Va.	Alaska Mont. Ariz. Neb. Ark. N.C. Colo. N.D. Del. N.M. Ga. (dairy only) Hawaii Okla. Kan. Ore. Ky. S.C. La. Tex. Md. Wash. Miss. Wisc. Mo.
Foot-and-Mouth Disease and other animal diseases which threaten the livestock industry, as covered in CFR, Title 9 Chapter I, Sub-chapter B, Part 53.	Most states have provision for the expenditure of emergency funds in the event of an outbreak of such foreign animal disease, and other funds would be forthcoming through special action of their respective state legislatures.			

[1]This summary was prepared especially for this book by Mr. E. E. Saulmon, Acting Associate Administrator, USDA, Agricultural Research Service, Washington, D.C.

Sunlight possesses disinfecting properties, but it is variable and superficial in its action. Heat and some of the chemical disinfectants are more effective.

The application of heat by steam, by hot water, by burning, or by boiling is an effective method of disinfection. In many cases, however, it may not be practical to use heat.

In choosing a chemical disinfectant, it should be realized that not all disease-producing bacteria are susceptible to the same chemical agents. Table

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13-7 gives a summary of the limitations, usefulness, and strength of some common disinfectants.

STATE INDEMNITY PAYMENTS

Although subject to change as the laws of the respective states change, Table 13-8 summarizes the information relative to state indemnity payments as it existed in 1970. It is suggested that each dairyman secure the regulations applicable to the state in which he resides by writing to the state department of agriculture.

QUESTIONS FOR STUDY AND DISCUSSION

1. Why are such publications as (1) The 1942 Yearbook of Agriculture entitled *Keeping Livestock Healthy*, and (2) the 1956 Yearbook of Agriculture entitled *Animal Diseases* of value to dairy producers?
2. What is normal temperature, pulse rate, and breathing rate of dairy cattle, and how would you determine each?
3. Select a specific dairy farm (either your own or one with which you are familiar) and outline (in 1, 2, 3, order) a program of dairy cattle health, disease prevention, and parasite control.
4. Obtain the following publications from the Animal Disease Eradication Division, Agricultural Research Service, USDA, Washington, D.C.: Subchapter B, Title 9, of the Code of Federal Regulations, parts 51 and 53. Also, write to your State Department of Agriculture for information about indemnity payments. Then determine the indemnity payments that you could expect were you to encounter an outbreak of (1) brucellosis or (2) foot-and-mouth disease.
5. Assume that a specific contagious disease (you name it) has broken out in your herd. What steps would you take to meet the situation (list in 1, 2, 3, order; be specific)?
6. Assume that a specific parasite (you name it) has become troublesome in your herd. What steps would you take to meet the situation (list in 1, 2, 3, order; be specific)?
7. Assume that you have, during a period of a year, encountered dairy cattle death losses from three different diseases. What kind of disinfectant would you use in each case?

SELECTED REFERENCES

Title of Publication	Author(s)	Publisher
Animal Diseases	Yearbook of Agriculture, 1956	U. S. Department of Agriculture, Washington, D. C.
Animal Sanitation and Disease Control	R. R. Dykstra	Interstate Printers & Publishers, Danville, Ill., 1961.
Brucellosis	A symposium—1949	American Assn. for the Advancement of Science, 1515 Massachusetts Ave., N. W., Washington, D. C.
Diseases of Cattle	1942	U. S. Department of Agriculture, Washington, D. C.
Diseases of Cattle	Walter J. Gibbons, Editor	American Veterinary Publications, Inc., 114 North West Street, Wheaton, Ill., 1963.
Farmer's Veterinary Handbook, The	J. J. Haberman	Prentice-Hall, New York, 1953.
Home Veterinarian's Handbook, The	E. T. Baker	Macmillan Co., New York, 1949.

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Title of Publication	Author(s)	Publisher
Infectious Diseases of Domestic Animals, The	W. A. Hagan D. W. Bruner	Comstock Publishing Associates, Ithaca, New York, 1957.
Insecticide Recommendations	Agriculture Handbook No. 331	U. S. Department of Agriculture, Washington, D. C., 1967.
Keeping Livestock Healthy	Yearbook of Agriculture, 1942	U. S. Department of Agriculture, Washington, D. C.
Livestock Health Encyclopedia	Rudolph Seiden	Springer Publishing Co., New York, 1951.
Losses in Agriculture	Agriculture Handbook No. 291	U. S. Department of Agriculture, Washington, D. C., 1965.
Merck Veterinary Manual, The		Merck & Co., Rahway, N.J., 1967.
Principles of Veterinary Science	F. B. Hadley	W. B. Saunders Co., Philadelphia, 1949.
Progress in Cattle and Sheep Practice: Part 1, Infections and Infestations. Part 2, Nutrition, mastitis, reproduction, herd health. Part 3, Noninfectious diseases, treatment procedures.	Edited by J. F. Smithcors E. J. Catcott	American Veterinary Publications, Inc., 144 North West Street, Wheaton, Ill., 1969.
Stockman's Handbook, The	M. E. Ensminger	Interstate Printers & Publishers, Danville, Ill., 1970.
Veterinary Guide for Farmers	G. W. Stamm	Windsor Press, Chicago, Ill., 1950.
Veterinary Handbook for Cattlemen	J. W. Bailey	Springer Publishing Co., New York, 1958.

In addition to the above selected references, valuable publications on different subjects pertaining to dairy cattle diseases, parasites, disinfectants, and poisonous plants can be obtained from the following sources:

Division of Publications Office of Information U. S. Department of Agriculture Washington, D.C.	Your state agricultural college Several biological, pharmaceutical, and chemical companies.

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Applied Science Dept.

MILK HYGIENE

Hygiene in Milk Production, Processing and Distribution

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TOXIC CHEMICALS AND OTHER EXTRANEOUS SUBSTANCES

Insecticides

During recent years, organic synthetic insecticides of high efficiency have been developed and have virtually pushed out of use the more expensive insecticides of plant origin (derris and pyrethrum). The large-scale use of these compounds in agriculture in the economically advanced countries has created some problems, among which is their appearance in milk, with consequent hazard for the health of the consumer. The two main sources of milk contamination are: (1) insecticides used on the cows and in the barn for the control of flies, lice, ticks and other ectoparasites, and (2) insecticides used on forage crops and grains to protect them from pests. In both cases, some of the insecticides are absorbed by the cow and partly excreted in the milk.

Of the two chemically distinct groups of synthetic insecticides, the chlorinated hydrocarbons were discovered first and have been used extensively in the barn as well as on the fields. Marth & Ellickson (1959b) have recently reviewed the use of these insecticides in dairying practice and have found that when used in dairy barns or on cows, all the following insecticides appeared in the milk: benzene hexachloride, DDT, dieldrin, dilan, lindane, methoxychlor, perthane and TDE (Rhothane or DDD); the concentrations in the milk varied from 0.4 p.p.m. for methoxychlor and perthane to 33.6 p.p.m. for DDT. In general, the residues in milk disappeared in a few days after application, but in some cases low levels persisted for a long time. When insecticide-treated feedstuffs were fed to cows, residues of benzene hexachloride, chlordane, DDT, dieldrin, endrin and toxaphene appeared in the milk at levels ranging from 0.05 p.p.m. for endrin to 26 p.p.m. for DDT.

Kästli (1955) stated that 0.5 %-20 % of a chlorinated hydrocarbon insecticide ingested with the fodder is excreted in milk.

A second group of synthetic insecticides, the organic phosphates, are coming into use primarily against flies and other insects that are resistant to DDT and other chlorinated hydrocarbons. Marth & Ellickson (1959b) have concluded from published reports that the organic phosphate insecticides do not as a rule appear in milk after use in the barn or after ingestion on feedstuffs. In the latter case, they are believed to be broken down in the rumen of the animal. It is, therefore, the insecticides of the chlorinated hydrocarbon group that constitute the principal health hazard to consumers of milk and milk products.

Surveys of market milk carried out in the USA in 1948, 1949 and 1951 indicated the presence of DDT in traces in 25 % of the samples tested. In 1955, 62 % of 800 samples collected from all over the country showed traces of DDT and BHC. No organic phosphate residues were found (Clifford, 1957). In a more recent survey made in 1958, 936 samples from

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48 dairies in 16 metropolitan areas, were examined and only 2.5 % were found to contain residues (0.1 p.p.m. or more) or chlorinated hydrocarbons. Of the original 936 samples, 168 were examined further by paper chromatography and a fly bioassay method. The former method showed that 3 % of the samples contained significant residues, and the latter showed that 33 % were toxic for flies (Clifford, Bassen & Miles, 1959).

Because of the affinity of these insecticides for fats, they become attached to the milk fat with the result that butter made from the contaminated milk contains a considerably higher proportion of the insecticide than does the liquid milk. Smith, Hoskins & Fullmer (1948) found 65 p.p.m. of DDT in butter made from milk that contained 2.3 p.p.m. Schechter, Pogorelskin & Haller (1947) reported the presence of 456-534 p.p.m. in butter made from milk that contained 3-26 p.p.m. High concentrations of these insecticides are also found in cream and cheese made from contaminated milk. They are stored in the fatty tissues of the body, which entails the risk of cumulative effects.

Although the toxicity of DDT and other chlorinated hydrocarbons when ingested by mouth is known, the tolerance levels for residues in milk and milk products have not been established.[1] It must be kept in mind that large quantities of milk are consumed by particularly vulnerable groups, such as infants and invalids. The problems of consumer safety in relation to pesticide residues in food have been discussed at a joint meeting of the FAO Panel of Experts on the use of Pesticides in Agriculture & the WHO Expert Committee on Pesticide Residues (1962).

To prevent the appearance of insecticide residues in milk, insecticides used in barns must be applied in such a way that the cows do not absorb them. Fodder treated with chorinated hydrocarbons that pass into milk should not be fed to dairy cattle. Contaminated milk should not be used for human consumption. The US Food and Drug Administration has fixed the tolerance level of DDT, methoxychlor and malathion at 0 p.p.m.—in other words these compounds should be altogether absent from milk. The difficulties of complying with this requirement have been discussed by Heineman & Miller (1961). Furthermore, pasteurization has little effect on DDT in milk (Mann, Carter & Ely, 1950).

Preservatives and Disinfectants

Chemical preservatives and bacteriostatic agents are sometimes added to milk to prolong its keeping qualities or to prevent or camouflage acid fermentation and decomposition resulting from faulty practices. They include hydrogen peroxide, formalin, boric acid and borax, benzoic acid

[1] Lu, F. C. (1961) *The establishment of tolerances for pesticide residues in food* (Unpublished document WHO/Food Add./20).

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and benzoates, alkaline salts, salicylic acid, potassium bichromate, hypochlorites and chloramine, and quaternary ammonium compounds. The last two groups of substances are often carried over from rinsing solutions used for milk utensils and machinery. The listed chemicals tend to mask unhygienic practices but do not provide any safeguard against pathogenic micro-organisms. In addition, certain of these substances (e.g., formalin, boric acid) can be highly toxic even in small amounts. Except for hydrogen peroxide (discussed in the chapter by Lück, page 423), their use as intentional bacteriostatics should be strongly condemned and guarded against. (For further information see the chapter by Jepsen, page 449, and American Public Health Association, 1960.)

Radionuclides and other Heavy Metals

Radionuclides

The possibilities of fall-out from nuclear weapon tests and the exploitation of nuclear energy have added an entirely new dimension to the potentialities of milk as a transmitter of disease. The detection of radionuclides in milk and the significance of the levels found are highly specialized problems which are being dealt with by many national and international authorities and will not be entered into here. Special expert groups of the United Nations are issuing periodic reports on this subject, and basic training courses are being given for food hygienists, including milk control authorities, jointly by WHO, FAO and the IAEA (International Atomic Energy Agency), as well as by national authorities. A recent review of the radionuclide problem as regards food in general, including milk, has been published by the Food and Agriculture Organization (1960).

As far as milk is concerned, the radionuclides at present regarded as the greatest hazard are strontium-90 and iodine-131, although the possible importance of other radionuclides such as caesium-137 is being carefully followed. Strontium-90 has a long half-life (about 28 years) and when ingested becomes localized in bone. This is important in children because they consume the greatest quantities of milk. Iodine-131 has a short half-life (about 8 days), but it concentrates itself in the relatively small volume of tissue of the thyroid gland. It was in fact iodine-131 that caused the greatest concern in the 1957 Windscale incident in England, the first occasion on which there was immediate public health concern with respect to the milk supply. In this incident, a breeder-type reactor overheated causing a uranium fire. The air going out of the exhaust stack was heavily contaminated with iodine-131, which is very volatile. Environmental contamination occurred and it was felt necessary to condemn some 250 000 gallons of milk from about 600 herds of cattle inhabiting an area of 200 to 300 square miles. Although the type of reactor used at

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Windscale is now considered obsolete, the incident underlines how important and necessary it is for milk hygiene authorities to become conversant with the problems of radionuclides in the food chain (see Food and Agriculture Organization, 1960; Joint WHO/FAO Expert Committee on Methods of Radiochemical Analysis, 1959; Lindell & Dobson, 1961).

Active research is under way to evolve effective and economic methods for the decontamination of milk, especially by the use of ion-exchange methods (see, for example, Food and Agriculture Organization, 1960; Easterly et al., 1960). Although laboratory results are encouraging, a commercially feasible procedure has not yet been developed for strontium-90 or caesium-137. Because of its shorter half-life, iodine-131 can be dealt with by the relatively simple procedure of storing the product until the contamination has been reduced to an acceptable level.

Other heavy metals

Potentially dangerous salts of metals such as cadmium, lead, zinc, tin and copper may gain entry into milk and milk products from corroded metal surfaces of utensils, dairy implements and containers (see the chapter by Rice, page 457). The quantities of such salts in a given samples of milk depend on their solubility, the acidity of the milk, and the length of contact between the two. Serious cases of poisoning from such contamination are rare, possibly because of the change in taste and often in colour caused by these salts. Also, relatively large quantities of these salts are required to produce toxicity when ingested in milk, probably because of partial absorption or neutralization by milk proteins. Such large quantities of the dissolved salts often cause vomiting.

Plant Toxins

Cattle grazing in a new locality or in pastures affected by drought are liable to ingest poisonous plants. In the majority of cases, there is little evidence to indicate that the toxic principles of these plants are excreted in milk in quantities sufficient to cause a toxic effect in human consumers. In the following instances, however, such a toxic effect has been observed or strongly suspected:

1. *Milk sickness or tremetol poisoning.* In certain parts of the USA two species of poisonous plants, the white snakeroot (*Eupatorium urticaefolium*) and jimmy weed (*Aplopappus heterophyllus*), produce a disease in cattle known as "trembles"; the animals continue to yield milk, but on analysis it is found to contain the active principle tremetol ($C_{16}H_{22}O_3$), derived from the plants (Khlentzos, 1950). Persons who consume such milk develop

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When there are only a few infested cattle or labour is inexpensive, an alternative method of control may be to squeeze out the living grubs by hand. However, the process is painful to the cattle and unpleasant for the operator.

The methods described above are the only ones recommended for lactating dairy cows in the USA when their milk is being used for human consumption.

Two organophosphorus insecticides, ronnel (O,O-dimethyl O-(2,4,5-trichlorophenyl)phosphorothioate) and O-(3-chloro-4-methylumbelliferone) O,O-diethylphosphorothionte (sold under the trade name Co-Ral, and also known as Bayer 21/199) have been found to be much superior to rotenone for practical grub control. Ronnel is given as a drench or bolus at 100 mg/kg, and Co-Ral is applied as a 0.5 % spray in sufficient quantity to wet the animals to the skin. Either treatment is made only once, between the end of the heel fly season in the summer and before grubs start migrating to the backs in the fall. The treatments are about 90 % effective in destroying first-instar larvae within the body of the host before they do any apparent harm. Unfortunately, both insecticides appear in the milk for a time after administration and in the USA, where no tolerance has been established, they cannot be recommended for lactating cows or for dry cows due to be milked within 60 days. They should not be used on baby calves, but they can be recommended for heifers which are more than three months old but not old enough for milking within the next 60 days.

Botflies

In the American tropics cattle grubs are not a problem, but a related insect, the human botfly (*Dermatobia hominis* (L.)), is even more damaging to cattle than are grubs in the temperate zone. This botfly captures such insects as biting flies or mosquitos and glues its eggs to their bodies. When the egg-bearing flies or mosquitos visit any warm-blooded animal, the larvae hatch from the eggs and penetrate the skin of the host, where they make sores much like cattle-grub cysts. A cow may have hundreds of larvae growing in these painful sores over all parts of the body. There are several generations per year, but the infestations are most severe following periods of mosquito abundance.

There are two approaches to the control of this botfly. One is to apply chemicals to repel or kill mosquitos and thus prevent infestation. Occasional treatment with toxaphene and DDT have been reported as valuable for reducing mosquito populations in beef herds. Where regulations forbid the use of chlorinated hydrocarbon insecticides on dairy cattle, daily applications of pyrethrum sprays may be used.

During the last few years research workers have reported on successful experiments with ronnel and Co-Ral applied in the same manner as for

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cattle-grub control, and several other systemic insecticides have been found promising in small-scale tests. These organophosphorus compounds do cause slight milk contamination, but it would still seem desirable to use them and discard the milk for a few days after treatment. In livestock-raising areas, cattle are the source of breeding most of the human botflies; so it is desirable to prevent breeding in both meat and milk animals.

Ticks

Many species of tick attack dairy cattle. In the USA the most important belong to the genera *Amblyomma*, *Dermacentor*, and *Ixodes*, but from the world-wide standpoint, ticks of the genus *Boophilus* are of greatest concern, since they are the vectors of Texas fever, or piroplasmosis. The cattle tick (*Boophilus annulatus* (Say)), has been eradicated from the USA except for a small area along the Mexican border, and is kept out of the country by quarantine measures. This species is common in Mexico, and the tropical variety, *Boophilus microplus* (Can.), is common in Australia, South America, Asia, and Africa.

The cattle tick was eradicated from the USA by dipping cattle in an arsenic solution (0.175 %-0.19 % As_2O_3). This old-fashioned treatment has been largely displaced by modern insecticides, but it is still used by many regulatory agencies in connexion with quarantines. In many parts of the world where this dip has been used extensively, ticks have become resistant to arsenic, and the treatment is now ineffective.

For the past ten years the most generally used control for cattle ticks has been to spray or dip cattle in a chlorinated hydrocarbon insecticide (see Fig. 3). Toxaphene (chlorinated camphene containing 67 %-69 % of chlorine) at 0.5 % and 0.5 % DDT (2,2-*bis*-(*p*-chlorophenyl)-1,1,1-trichloroethane) plus 0.03 % gamma-BHC (gamma-isomer of 1,2,3,4,5,6-hexachlorocyclohexane) have been very popular. Dipping is essential in eradication efforts in order to ensure that every tick is reached; but for practical control, where eradication is not the goal, spraying is preferred because cattle are often injured by the rough treatment involved in dipping.

In recent years the fever ticks in many countries have become resistant to the chlorinated hydrocarbon insecticides, and these are being displaced by organophosphorus compounds. At present sprays or dips containing 0.25 %-0.5 % of Co-Ral, 0.15 % of 2,3-*p*-dioxanedithiol S,S-*bis*(O,O-diethylphosphorodithioate) (sold under the trade name of Delnav), or 0.75 % of ronnel are reported to be effective against ticks resistant to arsenic or chlorinated hydrocarbons.

In many countries where piroplasmosis is not a problem two other cattle diseases are caused by ticks. Several species of tick are vectors of anaplasmosis, and tick paralysis is a direct reaction to tick bites.

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FIG. 3
DIPPING CATTLE FOR FEVER TICKS



Because the chlorinated hydrocarbon insecticides cause detectable milk contamination, and in the USA there are no tolerances for insecticide residues in milk, the only treatment substances currently recommended for controlling ticks on lactating dairy animals are rotenone and pyrethrum sprays. However, these substances are expensive and have poor residual effectiveness, and where milk contamination is not involved, the chlorinated hydrocarbons or organophosphorus insecticides are recommended as being vastly superior.

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Horn Flies

The horn fly (*Syphona irritans* (L.)) is a major pest of dairy cattle. The flies live on cattle almost continuously, leaving them only to oviposit on fresh droppings. Since these droppings are scattered over entire pastures, it is impracticable to prevent breeding in the manure by sanitary procedures. Therefore, the use of insecticides is essential.

In the USA, where regulations concerning milk contamination are stringent, the only treatments at present recommended are: (1) mist sprays of 3 %-5 % of an organic thiocyanate as an oil solution, or 1 % of pyrethrins plus 10 % of a synergist, as an oil solution or emulsifiable concentrate,

FIG. 4
WET SPRAY WITH TWO-GALLON SPRAYER FOR HORN FLIES



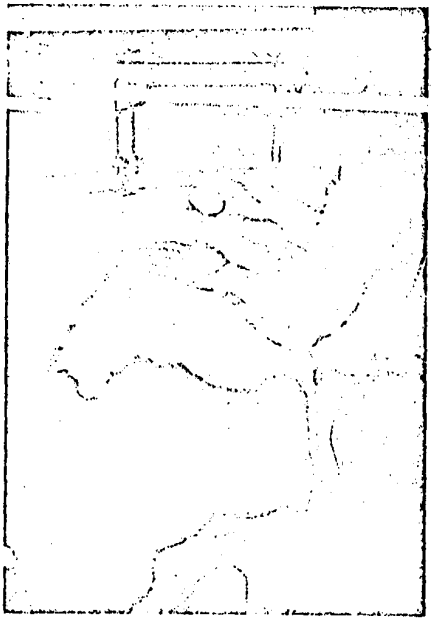
applied once or twice daily at 1-2 US fluid ounces (about 30-60 ml) per animal; (2) water-base sprays containing 0.05 % of pyrethrins plus 0.5 % of a synergist applied at 1 or 2 quarts (about 1 or 2 l) per animal every 3-7 days (see Fig. 4); (3) methoxychlor (2,2-*bis*-(*p*-methoxyphenyl) 1,1,1-trichloroethane) dusted by hand over the back at the rate of 1 tablespoonful of 50 % powder per animal every three weeks (see Fig. 5).

In areas where health authorities do not object to the small amounts of methoxychlor that appear temporarily in milk following the use of sprays, an economical method of treatment for horn flies is to spray dairy cattle

tectable milk
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mmended for
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FIG. 8
SPRINKLING METHOXYCHLOR WETTABLE POWDER ON BACK OF COW FOR HORN FLIES



with 0.5 % methoxychlor at the rate of 2 quarts per animal. This treatment protects the animals from reinfestation for about three weeks. DDT and toxaphene at 0.5 % similarly applied are equally effective, but the contamination of milk is greater than with methoxychlor. The organophosphorus insecticides, Co-Ral at 0.25 %-0.5 %, ronnel at 0.5 %, Delnav at 0.15 %, and malathion (S-(1,2-diethoxycarbonylethyl)-O,O-dimethyl phosphorodithioate) at 0.5 % are all excellent in sprays with residual effects of a week or longer.

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Stable Flies

Stable flies (*Stomoxys calcitrans* (L.)) are as common as horn flies and much more difficult to control with chemicals. Around dairies stable flies breed in decomposing organic matter, such as spilled feed under the troughs and wet hay or straw bedding. In such situations the best control is proper sanitation. In addition it is often necessary to apply residual sprays to the surfaces of farm buildings where the flies rest between attacks on cattle. These treatments are described in detail in the section on pest control in farm buildings.

Stable flies are strong fliers. Many of them invade dairy premises from breeding sites beyond the control of the dairymen, and chemical treatment of the animals becomes essential. The only approved treatments are pyrethrum and organic thiocyanate sprays used as recommended for horn fly control. Since stable flies prefer to feed on the lower parts of the body, special attention should be given to the legs and belly. If cattle walk through wet grass or wade through mud and water, treatment may be needed twice daily.

Mosquitos

Mosquitos can cause considerable damage to livestock. Where breeding is uncontrolled—such as near salt marshes producing myriads of *Aëdes*, or in freshwater pastures flooded by melting snow, overflowing rivers, or heavy rain—mosquitos may attack cattle in such numbers as to kill them in a single night. The organophosphorus and chlorinated hydrocarbon insecticides cannot be recommended, for two reasons. First there is the constant problem of residues in milk, but even more important is the fact that they do not protect cattle attacked by millions of mosquitos since they do not kill the insects fast enough to prevent them from feeding. The only treatment substances known to be effective are sprays of pyrethrum or thiocyanates. When freshly applied, these insecticides are both toxic and repellent to mosquitos.

Horse-Flies and Deer Flies

Many species of the family Tabanidae, known as horse-flies and deer flies, attack dairy cattle. The larvae may be aquatic, some species are found along shore lines, and still others breed in well-drained upland pastures. Generally they breed over such huge acreages that the dairyman is helpless to prevent breeding and his only recourse is to protect cattle from the flies. When "outbreaks" of tabanids occur, cattle left unprotected in pastures may be killed through loss of blood from the slashing bites of the flies. Even when the flies are not present in outbreak numbers, the bites are so painful that even a few insects can cause the cattle to group together and

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time required for development varies widely with the species, ranging from six weeks to more than a year for a complete generation.

Sanitation

Sanitation is the first and most important step in the control of insect pests, despite recent advances in the use of insecticides. Sanitation will be much easier if the barns and holding pens are properly located and constructed. They should be situated on the highest available ground, so that neither rain nor subsurface water will collect and create conditions favourable for fly breeding. Good drainage is essential and is more easily achieved on high than on low ground. Concrete floors in barns are also essential to the best sanitation. Properly designed concrete floors improve drainage and make cleaning easier. Keeping the soil of holding pens or corrals dry and hard-packed will also help to minimize fly breeding. Where the soil is moist or the drainage poor, 4-6 inches (10-15 cm) of gravel on the ground-surface of the holding pens will create a fairly hard surface in which few flies will breed, provided wastes are raked up and disposed of regularly.

The most important sanitation step in fly control is the proper disposal of manure. If possible, manure should be removed daily from barns and scattered on fields, spread thinly so that it will become too dry to support fly-breeding. If this is impracticable, the manure should be stored in boxes or pits where flies are unable to reach it. Boxes or pits made of concrete are the most satisfactory. Another method is to pile the manure in a rectangular stack, preferably on a concrete base. The manure should be packed down with a spade and the sides of the stack made vertical. A ditch should be dug around the stack and filled with crude oil. Heat generated in the tightly packed manure will kill many maggots and drive the others to the surface, from which they will fall into the oil-filled ditch and be killed.

Spilled feed, vegetable refuse, and garbage should not be allowed to accumulate in the open, as they provide breeding-places for flies and food for cockroaches. Such materials should be cleaned up promptly and kept in tightly closed containers until they can be burned or buried. Damp straw, hay, and other vegetable refuse should be eliminated to prevent *Stomoxys* breeding, and carrion should be eliminated to prevent blow-fly breeding. In some regions privies may require attention to prevent blow-fly breeding. Trash should not be allowed to accumulate, as it provides harbourage for cockroaches.

Screens and Electric Grids

Well-fitting screens on windows and doors assist in keeping flies out of barns and milk-rooms. Screened doors should swing outwards. Screens of copper, bronze, aluminium, plastic, or one of the rust-resistant alloys

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should be used in humid climates, but galvanized screens are satisfactory in dry climates. Screens with 14 meshes to the inch will keep out houseflies, but finer screens will also keep out some other insects.

Electric grids, mounted in the open or attached to windows and doors, help in the elimination of flies. They consist of parallel wires, about 1/4 inch (or 6 mm) apart, connected to a high-voltage, low-amperage circuit, which electrocute flies that land or try to pass through. Flies can be attracted to the grids with a bait, such as molasses, milk, or fruit waste.

Insecticides

Some use of insecticides may be needed to maintain a high degree of pest control, since some breeding will probably occur despite the best efforts at sanitation. Insecticides may be used as residual applications in sprays or dusts, as space or contact sprays, in baits, and in ribbons or cords. In many areas flies have become highly resistant to some of the best insecticides, which greatly complicates the problem of control. Some countries restrict the kinds of insecticides that may be used in dairy barns or other situations where they might contaminate milk.

Residual applications

Residual treatments provide the best control of flies where the problem is not complicated by resistance. Sprays may consist of a solution of the insecticide in deodorized kerosene, an emulsion made by adding an emulsifiable concentrate to water, or a suspension of a wettable powder in water. The sprays should be applied to all surfaces where the flies settle—not only the walls and ceilings of the dairy barns themselves, but also the surrounding vegetation, other barns, stables, sheds, pig pens, poultry houses, fences, and garbage cans. The surfaces should be wet to the point of run-off. The amount will vary with the type of surface and the formulation. Usually 1-2 US gallons per 1000 square feet (or 4-8 l per 100 m^2) will be required.

DDT is the most effective insecticide in areas where flies have not become resistant to it. Emulsions or suspensions containing 5 % of DDT will provide residues that control flies for several weeks or months. However, after DDT was found in the milk of cows kept in treated barns, it was no longer approved for use in the USA in dairy barns or other situations where it might contaminate milk or food. It can be used, however, in other farm buildings and out of doors. When flies have become resistant to DDT, other insecticides must be used.

Gamma-BHC at 0.5 %, methoxychlor at 5 %, chlordane (1,2,4,5,6,7,8,8-octachloro-3a,4,7,7a-tetrahydro-4,7-methanoindane) at 2%, or toxaphene at 5 % in emulsions or suspensions, may also be used as residual insecticides. Their residual action is not as long as that of DDT. In the USA chlordane and toxaphene are not approved for use in dairy barns because of residues

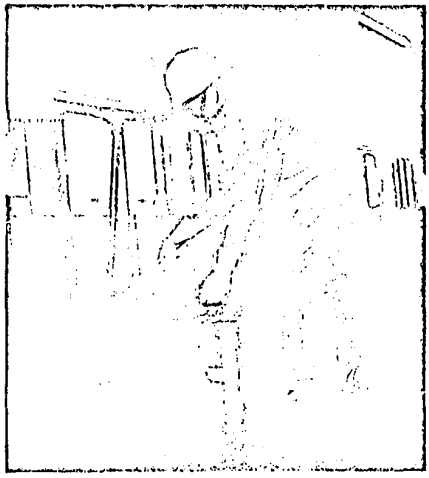
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in milk; gamma-BHC and methoxychlor may be used in some parts of dairy barns but not in milk-rooms. All these insecticides usually give control of DDT-resistant flies for a few years, but, like DDT, they are chlorinated hydrocarbons and DDT-resistant flies become resistant to them also.

A number of organophosphorus insecticides have given control of flies that were resistant to the chlorinated hydrocarbons, but in some countries flies have also become resistant to these insecticides. Their residual action is not as prolonged as that of DDT. Those that have been approved for use in parts of dairy barns, but not in milk-rooms, in the USA include malathion, ronnel, and diazinon (O,O-diethyl O-(2-isopropyl-4-methyl-pyrimidinyl-6) thiophosphate at 1 % in emulsions or suspensions. In some countries Co-Ral and other compounds have also been used successfully.

Attempts have been made to lengthen the period of control obtained with the organophosphorus insecticides by adding 2.5 %-5 % of sugar to

FIG. 8
TREATMENT OF COCKROACH HIDING-PLACES



In spraying for the control of cockroaches it is necessary to treat the hiding-places. An inspection with a flashlight has shown these hollow stanchion pipes to be heavily infested.

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the sprays. Although this has extended the effectiveness of deposits under some conditions, it has not been uniformly successful, the added periods of protection have usually been short, and it has caused mould to grow on the treated walls under warm, humid conditions. The use of sugar in this way is not at present recommended by the US Department of Agriculture.

Insecticides applied for the control of houseflies will kill many cockroaches, but for the best results residual insecticides should be applied to their harbourages. To find the harbourages it may be necessary to move objects next to walls, and to search behind and below hard-to-move objects with a flashlight (see Fig. 8). Very heavy infestations often occur inside hollow walls if any access holes are available. A careful search at night, with a light, will often reveal infestations many times more heavy than suspected from a daytime inspection. It will ordinarily be necessary, as a minimum, to spray the floors, walls up to about 1 metre, baseboards, and under and around feed-troughs and cabinets.

The best residual insecticide for the control of cockroaches is chlordane, but its use in dairy barns is restricted. Gamma-BHC may be used in places where chlordane is not approved, but the residual effect does not last as long. In the USA one species, *Blattella germanica* (L.), has become resistant to these insecticides, and malathion or diazinon are employed as substitutes. Malathion should be used at 2 % and diazinon at 0.5 % in an emulsion, suspension, or oil solution. They may also be applied as dusts in situations where the visible residue is not objectionable, will not be removed by cleaning operations, and will not contaminate milk or feed. Sodium fluoride applied as a dust will also control cockroaches, but it is less effective than the other materials, must be applied more heavily, and must be handled carefully because of its hazard to warm-blooded animals.

Space sprays

Space sprays generated with hand or power sprayers or aerosol dispensers are employed to kill the flies that are active in barns at the time of treatment. They are released in finely divided mists or aerosols that remain suspended in the air for an appreciable period and permeate all the space in the barns (see Fig. 9). They have little or no residual action and must be applied daily to maintain good control. They are not effective in open barns. The insecticide most widely used is pyrethrum at 0.1 %-0.2 %, together with 1 %-2 % of a synergist such as *n*-propyl isome, piperonyl butoxide or sesame oil.

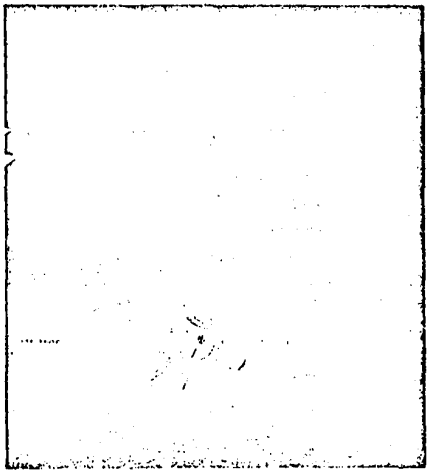
Space sprays rarely give satisfactory control of cockroaches.

Baits

Poisoned baits control houseflies in some places where sprays fail, including unscreened dairy barns in some regions. If properly applied they

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FIG. 9
SPACE-SPRAYING



An electrically driven generator produces a space spray by mechanically breaking the insecticide solution into an ultrafine mist or aerosol.

can be used in most farm buildings without harming animals or contaminating milk. They may be applied as scattered dry or liquid baits, as paint-on baits, or in bait stations.

Commercial ready-to-use baits are satisfactory and convenient; if they are not available baits can be made with emulsifiable concentrates or wettable powders of malathion, diazinon, ronnel, DDVP (2,2-dichlorovinyl dimethyl phosphate) or O,O-dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate (sold under the trade name of Dipterex).

Liquid baits are made by mixing 10 % of sugar, molasses, or syrup and 0.1 %-0.2 % of the insecticide with water. A convenient dry bait is made by mixing 1 %-2 % of the insecticide with dry sugar; it is well to add a little lampblack so that the bait will not be mistaken for ordinary sugar.

A cornmeal bait is recommended for use on moist surfaces, where a dry sugar bait would dissolve. While stirring 1 pound (450 g) of coarsely ground cornmeal, slowly add 1 tablespoonful of peanut oil, 6 tablespoonfuls of a

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and drainage cocks should be fitted at intervals. To check the slope of any system, a pint of water can be poured in at the highest tap. If most of the water runs out of the drainage valve or cock furthest away from the point of entry in about two minutes the slope may be considered satisfactory. If the water is not clear when it comes out, this indicates that the pipeline should be washed. Drainage cocks should always be fitted at any point where the slope is interrupted to go across a passageway. Pipelines should be frequently examined for sagging, as this constitutes a danger.

Most manufacturers give instructions regarding the washing of the pipeline. Frequently these stipulate monthly washing and additional washing each time it is known that milk has entered the pipeline. Milk can gain access to the pipeline when the milking bucket or glass jar is overfilled during milking or cleaning, or when a bucket is overturned. A 1 % detergent solution at 160°-170°F (about 71°-77°C) may be used to wash or flush the pipeline. Two gallons should be used for each branch line. Most of the solution should be drawn to the furthest tap, a portion being drawn through each of the other taps. If the line has been badly neglected, washing should be continued until the wash-water in the trap comes through clear. It is important not to overfill the sanitary trap, otherwise liquid may be drawn into the vacuum pump. If the line smells, it may be necessary to sterilize it with a chemical disinfectant. A solution of about 300 p.p.m. should be used (steam can of course be used if this is available). Drain-cocks and stall taps should be left open for several hours after washing to assist drainage. When a new plant is being erected it is worth while to ensure that drainage valves empty on to a washable floor and not into a feeding-trough.

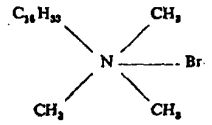
Other chemical disinfectants

In addition to the hypochlorites, there are three main types of chemical disinfectant used in dairying: the organic chlorine-containing compounds, the quaternary ammonium compounds and the iodophores.

Organic chlorine-containing compounds. Probably the most widely used of these materials are the compounds of chlorine and ammonia, the chloramines, of which there are several. Two other organic chlorine-containing compounds are commonly used, namely, dichlordimethyl hydantoin and trichloroisocyanuric acid. All three materials are in solid form and can be combined with detergents. They are more stable than the hypochlorites, but slower in action. Some formulations may be slow in going into solution, but providing they are dissolved satisfactorily before washing commences, a contact time of two minutes between these disinfectant solutions and the surfaces to be disinfected gives an adequate time for disinfection.

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The quaternary ammonium compounds (QAC's). These are cationic materials, one of the commonest being cetyltrimethylammonium bromide (CTAB).



There are hundreds of QAC's but only a few of them have disinfectant properties. The most useful are colourless, virtually odourless, tasteless and non-corrosive, and therefore very suitable as disinfectants for food plant. These compounds are highly surface-active and therefore produce considerable reduction in surface and interfacial tension. Since the cationic part of the molecule is hydrophobic, the disinfectant tends to form a layer one molecule thick on any surface—for example, the cell wall of a bacterium. Thus the disinfectant is automatically concentrated at the point required. QAC's are said to have good bacteriostatic properties, because the molecules are not readily detached from the surfaces to which they have become adsorbed, and as they are very stable, disinfected surfaces may remain sterile for many hours after treatment.

Because the QAC's are cationic they can be inhibited by certain anionic detergents. Therefore, manufacturers usually prefer to formulate QAC's with a compatible detergent rather than supply them as separate sterilizers which might be used in the combined washing and sterilizing process with an incompatible detergent. Soda-ash is usually compatible with these materials, but wetting agents sometimes are not. Some of the phosphates are not compatible, but there is no rule to act as a guide. Usually the QAC's are more effective against Gram-positive than against Gram-negative bacteria, especially in low concentration.

The iodine compounds. Iodine is an excellent bactericide, but its use as a disinfectant for dairy equipment is new. Hitherto, its corrosiveness, toxicity, and low solubility have made it unsuitable for the food industry. These difficulties have largely been overcome in the new products called "iodophores", in which the iodine is loosely combined with a suitable non-ionic wetting agent, which acts as a carrier; an acid, generally phosphoric acid, is also added to increase the germicidal activity and to promote stability. The carrier or wetting agent acts as a solubilizing medium for the iodine, favourably modifying its undesirable properties. In this combination the germicidal activity of iodine is enhanced and the vapour pressure reduced to a very low value—a necessary requisite for stability. The characteristic odour of iodine is reduced to a minimum, permanent

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staining prevented, and the intense stinging sensation, which accompanies the use of tincture of iodine, is eliminated. Hard water does not affect the germicidal efficiency of the iodophores.

Usually, these materials are recommended for use at a strength of 25 p.p.m., but Cousins, Clegg & Hoy (1959) have shown that it requires 50 p.p.m. of this material to be equivalent to 100 p.p.m. of hypochlorite in laboratory tests. No large-scale field trials have yet been made on these materials, but they have been used fairly extensively in North America with apparent success. Because of the inclusion of phosphoric acid with some of these materials, a build-up of milk-stone is prevented; under these circumstances it is possible that the disinfectant can act more readily. With pipeline plant a low concentration of disinfectant can easily be overcome by increasing the contact time.

The iodophores would appear to be well suited for udder washing and in the prevention of spread of mastitis, since they have strong bacteriostatic properties and give a much more lasting effect on the skin of the cow's udder than do hypochlorites.

The Combined Use of Heat and Chemicals

What is the best method of cleansing farm utensils? How can this be done most efficiently? Many producers ask these questions. Without doubt steam is the best method, but of course it is not popular because of the cost of installing steam-raising equipment. However, if this is a secondary consideration then steam will undoubtedly give the best results. With regard to efficiency, there is now considerable evidence that once-a-day steaming is adequate if a chemical rinse is used after the second milking, except perhaps in the hottest weather (Great Britain, Ministry of Agriculture, Fisheries and Food, 1959).

The different methods of cleaning equipment are represented graphically in Fig. 5. This shows that the double-strength chlorine rinse is recommended as adequate for chemical sterilization. This is also based on experimental evidence (Clegg, 1955). Since this method has proved satisfactory with chemical sterilization it is obvious that it will be at least as satisfactory with steam. The combined use of heat and chemical sterilization has been practised in the dairy at the National Institute for Research in Dairying, Reading, England, for over a decade with excellent results.

Immersion Cleaning

The development of immersion cleaning in Great Britain (Thiel, Clough & Clegg, 1955) was designed primarily to cut out the personal factor, which is the biggest variable in the cleaning of utensils, and by this means to pro-

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RESIDUES OF DISINFECTANTS AND ANTIBIOTICS IN MILK

A. JEPSEN *

Disinfectants

The use of chemical disinfectants in many instances has become an indispensable part of proper milk hygiene practice when thermal disinfection is not practicable. The widest field of application no doubt is found in the dairy barn, where large amounts of disinfectants are used for cleaning the teats and udders of the animals and for the disinfection of milking machines and other milking utensils; disinfectants also have their place, however, in dairy plant sanitation.

Bacteriostatic effects. Off-flavours

As long as chlorine compounds, hypochlorites and chloramines were practically the only type of disinfectant used in the dairy industry, the problem of residues of disinfectants in milk did not attract much attention, because the marked instability of chlorine compounds in the presence of milk constituents results in rapid decomposition with the formation of inactive ions. Experiments have shown that good disinfection practices, as normally applied in the dairy barn, may leave up to 0.25 % of the disinfectant solution in the milk (Swartling, 1959). With chlorine solutions —200 parts per million (p.p.m.) available chlorine—an addition to milk of more than 2 % produces off-flavours, and the bacteriostatic level (inhibition of lactic acid streptococci) is at about 10 %. With solutions of iodine compounds, iodophors (25 p.p.m.), similar findings have been reported (*Danish State Experimental Dairy Reports*, 1951, 1959).

Since about 1940, the introduction of some new types of disinfectant, especially the quaternary ammonium compounds, has, however, made the problem of residues of disinfectants in milk one which cannot be ignored. Quaternary ammonium compounds are remarkably stable in milk and retain a high residual effect. Levels of 0.00001 %-0.00005 % still show a bacteriostatic action in milk, and hence careless use of such compounds

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in milk hygiene practices involves very real risks of starter failures in cheese- and butter-making. Some results from the *Danish State Experimental Dairy Reports* on minimum bacteriostatic levels of various disinfectants in milk are as follows:

	Minimum bacteriostatic level for starter cultures in milk. (mg per litre)
Calcium hypochlorite	25
Chloramine	25
Jodophor	6.25 - 12.5
Alkyl-dimethyl-benzyl-ammonium-chloride	5
Cetyl-pyridinium-chloride	0.2
Cetyl-trimethyl-ammonium bromide	2

The inhibitory action of disinfectants in milk may also interfere with the grading of the milk by means of the methylene blue reduction test. However, this would hardly result from ordinary use of disinfectants, but may well occur when disinfectants have been added to the milk on purpose. On an average, concentrations must be increased tenfold above the figures listed in the above tabulation to cause a definite delay of the reduction process.

Laboratory methods for the detection of disinfectants and preservatives in milk

For screening of unknown samples the use of specific chemical tests for each individual compound is, of course, a rather uncertain and troublesome procedure. Considerable work has therefore been devoted to developing non-specific microbiological tests which would be well suited for the sorting-out of suspect samples. Recently such a method, which is a modification of the Kluyver (1914) fermentation test, has been investigated and authorized by the Nordic Committee for Food Analysis (1961). The method consists of a test to show whether fermentation can be brought about in the sample under investigation by adding pressed yeast, yeast extract and glucose to the sample and adjusting the pH to 3.25. The fermentation test is carried out in a flask connected to a water-filled test-tube, in which any gas evolved is collected. The minimum levels of some preservatives in milk detectable by this method are listed in the following tabulation.

	Threshold levels in milk by fermentation test (mg per litre)
Sodium benzoate	200 - 250
Monobromoacetic ester	2 - 2.5
Formaldehyde	100 - 200
Alkyl-dimethyl-benzyl-ammonium-chloride	1000 - 1500

The fermentation test is not effective in detecting antibiotics because *Saccharomyces* is not inhibited by most antibiotics. Attention is drawn to the fact that proper interpretation of the fermentation test can be achieved

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only when the examiner determines for himself the threshold values of the preservatives in current use under local conditions. Presumptive qualitative chemical tests which may serve as supplementary in cases where the fermentation test is not sensitive enough are Wode's (1933) test for chlorine compounds, the amidol test for formaldehyde and the Miller & Elliker (1951) test for quaternary ammonium compounds. Wode's test shows definite positive reaction with about 20 mg available chlorine per litre. It will react also with hydrogen peroxide. The amidol test is a reaction for aldehydes and is very sensitive. Positive results thus must be confirmed by specific chemical tests (distillate with chromotropic acid). Identification of preservatives of the aromatic acids group can be performed by means of paper chromatographic methods (see also American Public Health Association, 1960).

Antibiotics

Starter failures

Soon after the introduction of antibiotic therapy in bovine mastitis, the dairy industry began to suffer from technical difficulties, especially in the manufacture of hard ripened cheese. These difficulties were due to the inhibitory action of antibiotics in the milk which prevented normal development of the starter cultures used in cheese-making. Since about 1947 this problem has been extensively studied in many countries. The lactic acid bacteria of starter cultures (*Streptococcus cremoris, Str. diacetactis* and *Leuconostoc citrovorum*) are inhibited by various antibiotics at low levels. With the delay in acid production, the pH of the milk and the fresh curd remains high and favours vigorous growth of gas-producing coliform bacteria that will spoil the cheese. Off-flavours develop, combined with faulty texture with large and irregular holes. When starter cultures are used in butter-making and in the production of buttermilk and sour-milk products, similar difficulties may arise.

The inhibitory levels of some antibiotics against starter cultures in milk are approximately as listed in Table 1.

TABLE 1

INHIBITORY LEVELS OF CERTAIN ANTIBIOTICS AGAINST STARTER CULTURES IN MILK *

Antibiotic	Inhibitory level (per ml)	Complete inhibition (per ml)
Penicillin (units)	0.05	0.1
Chlortetracycline (μg)	0.02	1.0
Oxytetracycline (μg)	0.01	2.0
Chloramphenicol (μg)	0.20	10
Streptomycin (μg)	0.04	10

* After Overby, 1952

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Public health aspects

Public health authorities began to object to the presence of antibiotics in milk and dairy products. In particular, the observation of severe allergic reactions in humans after the administration of penicillin gave reason to suspect that penicillin in the milk supply might play some role in sensitizing the human population and also in setting off allergic shock symptoms in sensitized individuals. A case report by Borrie & Barrett (1961) proves beyond doubt that penicillin in milk can produce remittent eczematous eruption in sensitized persons who drink such milk. The patient reacted severely to a dose of 15 units in a day. This represents only 500 ml of milk with a penicillin content of 0.03 units per ml.

Today it is the general consensus that even slight traces of antibiotics in milk and food for human consumption should not be tolerated.

Elimination of antibiotics in milk

(1) *After intramammary treatment:* Antibiotics may be excreted after intramammary treatment as well as after systemic treatment or, for instance, intra-uterine application. By far the highest levels in milk are obtained when the drugs have been introduced directly into the mammary gland. Parts of the dose introduced are absorbed into the bloodstream or inactivated, but the main part is eliminated with the milk on subsequent milkings. In penicillin therapy it has been found that the concentration of the drug in the milk after treatment will decrease at an approximately exponential rate. When plotting the logarithms of the penicillin concentrations, an approximately straight-line regression appears within the first 10- to 12-hour period (Jepsen, 1950). For how long low-level residues will persist depends upon the type of preparation and especially upon the physical qualities of the solvent base used. The level of concentration and the total amount recovered in the milk vary widely within individual cows, even when identical schemes of therapy are followed. Variations of from about 8 % to 80 % in the amount recovered have been recorded. On an average about 50 % of the total dose of penicillin introduced into the mammary gland will reappear in the milk, the main part in the first two milkings following treatment (Jepsen & Overby, 1951).

(2) *After systemic or intra-uterine treatment:* When large doses are used for intravenous or intramuscular injections or in intra-uterine treatment, a limited excretion of the drugs may take place through the mammary gland. Milk from cows which have received 6 million units of penicillin intramuscularly (about 10 000 units per kg of body-weight) may contain 0.1-1 unit per ml 12 hours after treatment, and 0.01-0.2 ml after 24 hours. In cows with low yields nearing the dry period, higher concentrations may be found (Hovmand & Overby, 1955).

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Stability of antibiotics in milk

Antibiotics follow the water phase of the milk; when whole milk containing antibiotics has been separated, a higher level of the drug will be found in the skim milk, and a lower level in the cream. This is illustrated by the following figures: a whole milk containing about 6 % butterfat and 2 units/ml of penicillin was separated, and the skim milk contained 2.4 units per ml whereas the cream (about 50 % butterfat) contained only one unit/ml (Jepsen & Overby, 1951).

The stability of penicillin is known to be about maximal at the usual pH of milk, and it does not suffer any appreciable loss of activity through pasteurization. Momentary heating of the milk to 80°C likewise does not affect the biological activity of tetracyclines, chloramphenicol or streptomycin (Overby, 1952).

Antibiotics have also been found in an active state in cheese, butter and spray-dried powdered milk.

Preventive measures

To prevent the contamination of market milk and milk products with antibiotics, the milk of treated animals (whether treatment has been intramammary or systemic) must be detained on the farm and not delivered to any dairy plant until mammary excretion of the drugs has ceased. It is, however, difficult to make a general statement as to the duration of the period during which the milk will contain residues of the drugs. In the USA the labelling of antibiotic drugs for treatment by the intramammary route is required to bear a statement that milk from treated cows must not be used for human consumption for at least 72 hours after treatment, unless the manufacturer has provided evidence to the authorities that his drug will be eliminated from the milk within a shorter time. There are, however, drugs of which residues will remain for as long as 6 days. Table 2 lists the duration of the period of elimination observed for various antibiotic drugs (Overby, 1955).

TABLE 2

DURATION OF PERIOD OF ELIMINATION FROM MILK OF CERTAIN ANTIBIOTICS

Antibiotic	Minimum number of days for which residues remain present in milk
Administered by intramammary route:	
Penicillin (aqueous solutions)	2
Penicillin (ointment base)	4
Penicillin (long-acting)	6
Chlortetracycline	6
Oxytetracycline	4
Chloramphenicol	3
Streptomycin	4
Administered by intramuscular route:	
Penicillin	1

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In Denmark since 1954 regulations have been in force to the effect that antibiotics for intramammary treatment must be administered by veterinarians only, and that the owner of the treated cows is responsible for the detention of the milk from the treated quarters for four days after intramammary treatment. The veterinarian must instruct the farmer accordingly and inform the dairy plant manager of the treatments performed.

This system—which of course will work only with a disciplined and well-organized farming community—has proved very useful under Danish conditions. At present a revision of the existing regulations is under way which will also cover systemic treatment of milking animals with antibiotics, and will request manufacturers of pharmaceuticals to state the duration of mammary excretion of their products, because the duration of elimination actually varies a great deal with different types of preparation. The correctness of these statements will be checked by the public health service, and it is to be expected that the once-popular long-acting formulae after this will disappear.

To facilitate the detection of milk containing penicillin, Dalgaard-Mikkelsen & Folke Rasmussen (1957) suggested the addition of Green S (Food Green No. 4) as a tracer dye to penicillin preparations for intramammary treatment. With penicillin contents above 0.1 units per ml the milk shows visual discoloration. With lower concentrations (down to 0.002 units per ml) a simple ion-exchange method for concentrating the dye is applicable as a platform test to be performed upon receipt of the milk at the dairy plant (Folke Rasmussen, 1961).

Testing of milk for antibiotics

Microbiological plate assay methods are used in screening milk samples for antibiotics. For details of technical procedures reference is made to Grove & Randall (1955) and Jensen (1959). It is interesting to note that certain strains of lactic acid streptococci (*Str. saccharolactis*) commonly present in pooled milk produce an antibiotic substance which also may cause inhibition of starter cultures and give false-positive results on testing milk for antibiotic residues. Except for the specific inactivation of penicillin by penicillinase enzyme employed as a control, there are at present no specific identification tests for antibiotics when present in milk in small concentrations. Andersen & Jørgensen (1959) reported findings of *Str. saccharolactis* in infected udders and as a cause of clinical mastitis. They also frequently found the streptococcus in high-count pooled milk, and under favourable conditions of growth it will produce enough antibiotic to render the milk unsuitable for souring by starter cultures, and to effect distinct zones of inhibition on assay plates. No doubt this explains the findings reported by Jester, Wright & Welch (1959) in their survey of antibiotics in milk in the USA when they state " the antibiotic-like activity found may have been due to natural inhibitory substances that are sometimes present

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in milk. These inhibitory substances often increase as milk ages. In fact, fresh milk that contains no measurable antibacterial activity when first tested, may develop such activity after it has aged." Further references on antibiotics produced by lactic acid bacteria are given by Overby (1954). It seems necessary, therefore, to be aware of this source of error when making surveys of antibiotics in fluid milk. To prevent formation of the antibacterial substance from growth during incubation of assay plates with milk it is recommended that high-count milk should be submitted to a heat treatment before assay (61°C for 30 minutes).

REFERENCES

American Public Health Association (1960) *Standard methods for the examination of dairy products*, New York

Andersen, P. & Jørgensen, L. (1959) *Nord. Vet.-Med.* 11, 316

Borrie, P. & Barrett, J. (1961) *Brit. med. J.*, 2, 1267

Dalgaard-Mikkelsen, Sv. & Folke Rasmussen (1957) *Nord. Vet.-Med.* 9, 852

Danish State Experimental Dairy Reports, 1951, No. 72; 1959, No. 121, Copenhagen, Mejeriteknisk Bogforlag

Folke Rasmussen (1961) *Medlemsbl. danske Dyrlaegeforen.* 44, 868

Grove, D. C. & Randall, W. A. (1955) *Assay methods of antibiotics; a laboratory manual*, New York, Medical Encyclopedia (Antibiotics Monographs, No. 2)

Hovmand, H. C. & Overby, A. J. (1955) *Medlemsbl. danske Dyrlaegeforen.*, 38, 519

Jensen, P. T. (1959) *Nord. Vet.-Med.* 11, 573

Jepsen, A. (1950) *Nord. Vet.-Med.* 2, 447

Jepsen, A. & Overby, A. J. (1951) *Neth. Milk Dairy J.*, 5, 157

Jester, W. R., Wright, W. W. & Welch, H. (1959) *Antibiot. & Chemother.*, 9, 393

Kluyver, A. J. (1914) *Biochemische suikerbepolingen*, Delft (Thesis)

Miller, D. D. & Elliker, P. R. (1951) *J. Dairy Sci.*, 34, 273

Nordic Committee for Food Analysis (1961) *Fermentation test for non-specific, qualitative detection of preservatives in foods* (Standard Method no. 37), Copenhagen, Teknisk Forlag

Overby, A. J. (1952) *Nord. Vet.-Med.* 4, 993

Overby, A. J. (1954) *Dairy Sci. Abstr.*, 16 (Review Article no. 25)

Overby, A. J. (1955) *Medlemsbl. danske Dyrlaegeforen.* 38, 524

Swartling, P. (1959) *Dairy Sci. Abstr.* 21, 1

Wode, G. (1933) *Svenska Mejeritidn.* 25, 145

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Dairy Buildings

It has been well established that certain structural and other requirements must be insisted on for dairy buildings if the desired hygienic standards are to be consistently maintained under commercial conditions (see Appendix, page 492). Dairy buildings designed and equipped for functional efficiency, including hygiene, also aid in saving time, reducing labour and other operational costs and facilitating the turn-out of products which comply with legally prescribed bacteriological quality standards.

Structural requirements

From the viewpoint of hygiene, the following may be regarded as essential principles for structural requirements.

Floors must be constructed of material impervious to water, smoothly finished, effectively sloped and efficiently drained by means of tile drains (or other approved drains), to enable water to be quickly removed.

The walls should be of adequate height (at least 14 ft (4 m) in rooms used for processing), and have smooth, cleanable surfaces, which should preferably be of vitreous tiles or cement plaster finish up to a minimum height of 6 ft (2 m). The ceilings should be smooth and have a light-coloured surface.

In the processing sections, all doors should be self-closing and windows and other external openings should be screened to give protection from insects and vermin.

Lighting, whether natural or artificial, should be sufficient for the purpose for which the room is used. However, dairy products must be protected from direct sunlight, which causes their spoilage by the oxidative effect of the ultraviolet rays.

All rooms must be well ventilated for the purpose of reducing odours and condensation of moisture.

The milk- and cream-reception platform or area should be separated from the processing section. Separate rooms should be provided for the different stages of treatment. If this is not possible the washing of cans and bottles should be carried out quite separately from the processing room so as to avoid the possibility of contamination of products and of equipment. In multiple-product dairies, each product should be treated in separate rooms or on separate floors.

Other requirements

Special mould-resistant gloss paints should be used for interior painting, which should be done as often as is necessary to maintain effective sanitation.

Adequate hand-washing facilities, fitted with running water, should be provided in processing rooms.

Sufficient water-closets (preferably sewered or of a septic-tank type) should be provided, and any room in which they are situated must not

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should be continued for 10 minutes after the exhaust steam at the distant end reaches 210°F (98.9°C).

Steaming in an enclosed compartment is sometimes done with the compartment completely closed. This is the autoclave principle, for which the compartment must be strongly constructed to withstand the pressures built up. Usually 15 pounds pressure per square inch (1.05 atm.) for 15 minutes is maintained. Some milk factory autoclaves have been designed to take lengths of pipeline plus all fittings. This is the ideal method, which achieves absolute sterility, but the necessary plant is fairly costly.

The steaming is more commonly done in a chest which has a steam escape vent and which consequently never comes under pressure. Practical sterilization of a tank or chest full of equipment can be achieved by continuing steaming for 10 minutes after the temperature of the contents of the compartment have reached 210°F (98.9°C).

Boiling water

Boiling water has one advantage over steam in that it has a considerable flushing effect. However, it is bulky compared with steam for any given amount of heat to be transferred. The water must be near boiling-point as the destructive effect on bacteria declines rapidly at lower temperatures.

After heat sterilization equipment should be allowed to drain and dry. Bacteria cannot grow without moisture.

Chemical sterilants

Various chlorine compounds were the only chemical sterilants used in dairies for many years. Recently other chemical sterilants such as quaternary ammonium compounds and the iodophors, which are also surface-active and thus have detergent effects, have come into use. However, these new sterilants are not yet widely employed and are not officially approved in some countries. Chemical sterilization differs from steam and hot water, which achieve bacterial destruction by heat alone. Chlorine and iodine destroy bacteria by inactivation of specific enzyme systems essential for their respiration, while with quaternaries the bactericidal effect appears to depend partly on this and possibly also on interfering with cell surface activity. Further fundamental work is required fully to elucidate their bactericidal action. All chemical sterilants function well in cold water. For effective sterilization the solution must be of the correct strength and have adequate time of contact with the surface of the equipment. The pH of the solution is also important, but practical considerations often preclude use at optimum pH.

Chlorine sterilants

Chlorine sterilants are very corrosive to aluminium and copper and to alloys of these two metals. Tinned surfaces are also attacked if the

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contact time is long, but stainless steel is not affected if recommended procedures for sterilizing are carefully followed. Corrosion by chlorine is increased by higher temperatures and concentrations. For this reason hot chlorine rinses should be avoided and the concentration of chlorine should be kept to a level recommended for a specific purpose. Hypochlorites should never be mixed with acids because of the danger from the toxic gases which result. If scrupulous care is exercised in following recommendations for use, tainting of dairy products by chlorine sterilants should not occur. Chlorine rinses have poor wetting power, but this can be improved by including a wetting agent. In order to avoid corrosion, equipment should generally only be treated with chlorine sterilant solutions immediately prior to use.

One or more of the following methods of application can be used according to the equipment to be sterilized.

(1) Circulation: Pumps, pipelines and coolers can be sterilized by circulating a solution of 200 parts per million (p.p.m.) for 5 minutes.

(2) Immersion: Small items can be immersed for 5 minutes in a bath containing a 200-p.p.m. solution.

(3) Brushing: Cheese-vat surfaces and agitators, weighing vats and similar open vessels can be brushed with a 400-p.p.m. solution.

(4) Spraying: Large open holding vats can be sprayed with a 300-p.p.m. solution, allowing 5 minutes' contact time with the surfaces before rinsing off with clean water.

(5) Fogging: Closed vats and tankers can be fogged with a 500-p.p.m. solution atomized with special equipment to give a fine mist which settles on the surface and is then rinsed off with clean water.

Exceptions to the above general methods are the cleaning of butter churns and the treatment of water. An alternative to hot water for the treatment of churns before cream is churned is to run into the churn 50 to 100-p.p.m. gallons (225-450 l) of water containing 100-p.p.m. available chlorine and revolve for at least 10 minutes, or a 200-p.p.m. concentration for 5 minutes. A churn which is not clean or is in poor repair cannot be sterilized by a chlorine solution. In the treatment of water, sufficient chlorine should be added to give a residue of 0.3-0.5 p.p.m. as judged by the orthotolidine test (American Public Health Association, 1960b; Houghton, 1950) at the point of use. Different waters and reticulation systems use up varying amounts of the chlorine, and hence the original dosage cannot be specified. A turbid water must be filtered or the sediment otherwise removed before chlorination. Thorough agitation of the water during chlorination is important. This makes it impossible to get the best results if settling and chlorination are performed in the one tank.

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Quaternary ammonium compounds

There are numerous quaternary ammonium compounds which differ markedly in their respective bactericidal efficiencies. All are non-corrosive, colourless, odourless, non-irritant to the skin, and less affected by organic matter than hypochlorites. However, the bactericidal efficiency is greatly reduced in hard waters, but this can be overcome by including a sequestering agent or non-ionic wetting agent. They are incompatible with anionic wetting agents. They are more specific in their effect on different bacterial species than hypochlorites, and the pH of the solution affects them more than it does hypochlorites. They have a bacteriostatic action on treated surfaces of equipment. Resuggan (1951) deals with their chemistry, physics, bacteriology and industrial application.

Iodophors

The use of these sterilants is still in the experimental stage and is mainly confined to the USA and Canada. They are not yet available commercially in most countries, but considerable research is taking place with them in many countries. They depend for their bactericidal effect on the liberation of free iodine. They are prepared from iodine and a non-ionic wetting agent. The properties of the iodophors are rather similar to those of chlorine compounds, but they are non-corrosive to equipment, and more stable in the presence of organic matter. The temperature of the solution in most cases should not exceed 120°F (or about 50°C) to avoid staining of equipment by liberated free iodine.

Influence of detergents and chemical sterilants on milk quality and milk products

With careful use of appropriate methods negligible residual quantities of detergents and chemical sterilants, in the strengths used for treatment of equipment in dairies, should gain access to milk. Nevertheless, the public health and technological implications cannot be ignored. Swartling (1959) has reviewed this subject. Provided every care is taken to drain equipment after treatment, residual quantities would appear to be harmless to human health and no technological problems should arise, but precautions must be taken to avoid their intentional or unintentional addition to milk. It may be mentioned that in most countries negligence in their use would render an offender liable to legal proceedings for adulteration of milk.

Cleaning and Sterilizing of Equipment in Dairy Practice

A plan should be evolved and the necessary facilities provided for the cleaning and sterilizing of equipment to ensure that this important work

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is carried out efficiently and economically, consistent with the objective of producing safe, high-quality products. The mental approach to the work is also important, and in this regard employees should be trained in the techniques and instructed in the reasons for the various operations they perform.

Methods of cleaning certain equipment are often specified by the manufacturer, and alternative methods should be followed only after expert advice has been obtained. Manufacturers of detergents and chemical sterilants, too, often supply detailed instructions for particular detergents, concentrations of solutions and cleaning procedures recommended for various kinds of equipment. The British Standards Institute has made recommendations for specific cleaning operations for much of the equipment in dairies (B. S. 3756, 1956), but sterilizing or bactericidal treatments are not included.

Milk- and cream-cans

If cans are washed manually in small dairies, first rinse them with warm water, scrub both inside and outside with a warm mild detergent solution, rinse with hot water, place over a steam jet for two minutes and invert to drain and dry.

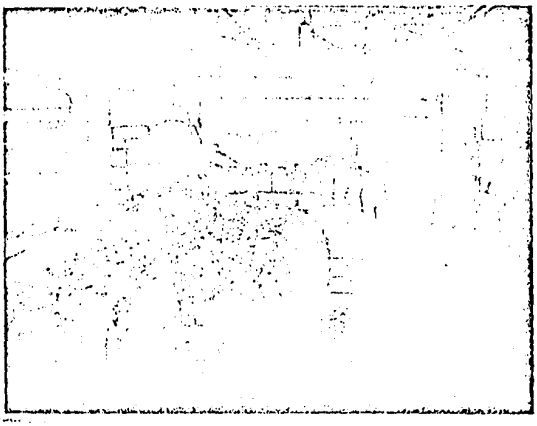
Rotary can-washing machines (see Fig. 1) provide for several operations to take place in a number of compartments (usually five). The compartments each hold a can and lid, and rotate until the can is removed at the site where it entered. The machine may be either manually or automatically operated. As the compartments rotate the cans and lids come opposite jets which spray the inside and outside of the cans. A cold or lukewarm water rinse for milk-cans or steam-jetting for cream-cans is followed by hot detergent solution (160°F; 71°C), hot water (190°F; 88°C), steam and hot-air-jetting.

In straight-through machines the cans and lids are usually carried through by means of a ratchet drive which moves them through jetting sequences, with draining pauses between each jetting. A common sequence is cold or lukewarm water rinse, hot detergent jetting (160°F; 71°C), hot-water-jetting (190°F; 88°C), steam-jetting, hot-air drying (230°F; 110°C).

Where the water used for can-washing machines is moderately soft, a detergent based on soda ash and sodium metasilicate gives satisfactory results. If the water is hard a sequestering agent should be added to the detergent solution. It is important to maintain the strength of the detergent solution by periodic additions of detergent during operation. Provision for automatic feeding-in facilitates this work. The prescribed temperatures of solutions and the steam supply must be maintained for efficient operation of can washers. Cans should leave the machine in a dry condition. The jets need periodic attention to avoid blockage. The tanks should be emptied and cleaned daily.

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FIG. 1
ROTARY CAN WASHER



Mechanical aspects of can washing are discussed by Briscoe (1947) and bacteriological aspects by Scarlett (1947). McDowall (1953) also deals exhaustively with can washing.

Open vats or vessels

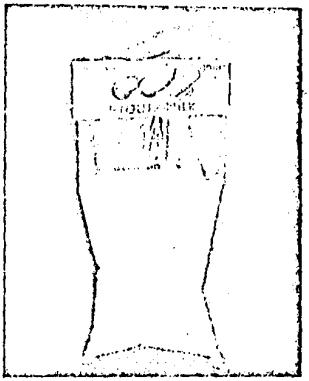
These are used for weighing, dumping, balancing, neutralizing cream, cheese-making, etc. (see Fig. 2, 3). After use, they are hosed out with cold or warm water, which is run to waste. The outlet valves are closed, and about 50 gallons (225 l) of warm water, to which is added about 2 pounds (1 kg) of general-purpose detergent, are let in. The internal surfaces and any covers and strainers are scrubbed with a long-handled brush, and if the vessel is fitted with coils they are set in motion and scrubbed with a brush. The outside is then scrubbed with this solution and, as it is draining away, the outlet valves are cleaned. The vat is rinsed with hot water and allowed to drain and dry. It is sterilized just before re-use by brushing or spraying with a 200-p.p.m. chlorine solution. Sterilization of a weighing or dumping vat is often done in conjunction with pipelines and other equipment by placing a chlorine solution in the vat and pumping it through the

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empties) have made the distribution of pasteurized milk impossible, the single-service container is developing direct.

Within a few years Tetrapak equipment has spread to the five continents, and paper factories have been established to supply it. Continual improvements are being effected in the plant for making single-service containers, and although at present they are used only in dairies of a certain size, there is every reason to believe that equipment will be rapidly perfected that will meet the needs of smaller establishments.

FIG. 5
PLASTIC CONTAINER



Reproduced by courtesy of de Stoutz Actini-France S. A. R. L., Larringes-sur-Evian, France

Plastic containers. Packaging of milk in plastic bags (see Fig. 5) is still in its infancy, and it is not yet possible to judge its hygienic value. The problem is to find a plastic material that is absolutely inert and non-absorbent with respect to milk and is able to withstand the temperatures needed for effective sterilization.

Polythene is inert to milk up to a temperature of about 50°C. Untearable bags of polythene are available which can be individually filled either by an automatic valve (patent W. P. de Stoutz), or by a small-flow filling machine. Current research may result in the development of plastics resistant to high temperatures, which will change the situation.

Packaging of Sterilized Milk

Sterilized milk should contain no viable bacteria. The principle of milk sterilization is to transport milk in hermetically sealed containers to a chamber under pressure and keep it at a temperature and for a time sufficient to destroy all existing bacteria. Theoretically, it could then be kept indefinitely.

In fact, the term "sterilized milk" is accepted in certain countries for milk which can be kept longer than pasteurized milk, but nevertheless only

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Applied Science Dept.

Milk Pasteurization

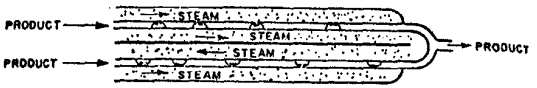
by Carl W. Hall, Ph.D.
Professor and Chairman,
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SIDE VIEW (SECTION)

Fig. 27. Roswell heat exchanger

perheated steam. Each heater tube contains approximately 13 sq. ft. of heating surface. It is designed to heat the product through 70°F. (21°C.) per tube at 1200 gal. per hr. capacity. The heat transfer rate is from 600,000 to 750,000 B.t.u. per hr. per tube. A common arrangement uses two tubes to give double the heat transfer. A U-value of 350 B.t.u./hr.-sq. ft.-°F. is obtained.

To prevent burn-on and product damage, the product must move through the heater rapidly and uniformly. Steam pressure in the unit may reach 200 p.s.i., but a 100 to 125 p.s.i. steam pressure is normally used. For lower heat transfer rates, 70 p.s.i. steam pressure is used, with saturated steam providing more rapid heat transfer. A vacuum treatment unit may be placed ahead of the Roswell unit to remove air and to speed product flow.

Most of the steam in the heat exchanger moves in the same direction as the product (Fig. 27). The unit has been approved for a pasteurization temperature of 200°F. (93°C.) with a calculated holding time of 3 sec. by the U.S. Public Health Service. When used without a specially designated holding time the effective holding time for a flow rate of 6000 lb. per hr. is 0.5 sec. for heat-up; 0.2 sec. for discharge from heater; and 0.1 sec. for cooling, making a total of 0.8 sec. effective holding at 187°F. (86°C.) for Z-values equal to 8.9° and 10.2°F. (4.9 and 5.6°C.).

DIRECT STEAM HEATERS

Steam heaters may be used which inject steam directly into the product ahead of the temperature control. The steam may be admitted by either an injector or infuser, (Fig. 28), if local and state codes permit such procedures. With the injector the steam is admitted directly into the product, generally in the direction of flow of the product. With the aid of the infuser, the product moves into a chamber to drop vertically through a steam bath. Generally the steam moves upward while the product moves downward. Such direct-steam heating is widely used. In addition it forms the basis of the European-developed process of uperization (Fig. 29).

The word "uperization" itself is a shortened form of ultra-pasteurization. The uperization process uses steam to heat the milk continuously to 300°F.

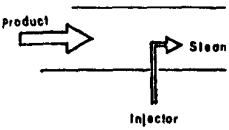


Fig. 28.

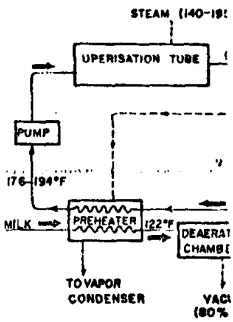
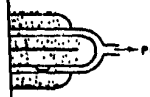


Fig. 29. Syst

(149°C.) for less than 1 sec. (r product must be preheated and tube where the product is heat p.s.i. (361° to 386°F.). After expansion chamber at near atm evaporation of moisture. The into storage.

If steam is injected into a prod perature difference between stea ple dry, saturated steam at 70 p.

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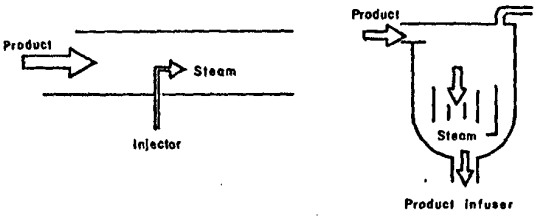


Fig. 28. Direct steam heating

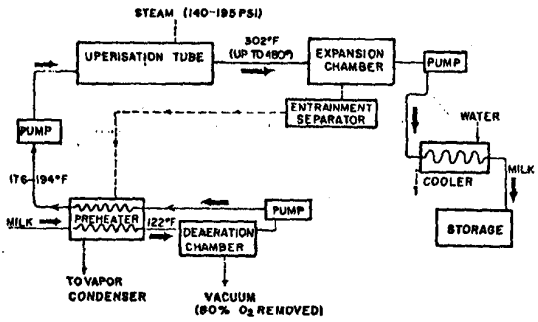


Fig. 29. System for uperization of milk

(149°C.) for less than 1 sec. (reported more exactly as 0.75 sec.). The product must be preheated and de-aerated before it reaches the uperization tube where the product is heated with high-pressure steam at 140 to 195 p.s.i. (361° to 386°F.). After this heating the product moves into an expansion chamber at near atmospheric pressure, therefore forcing some evaporation of moisture. The product is then moved to a cooler and on into storage.

If steam is injected into a product as in the above process, the mean temperature difference between steam and milk should be reached. For example dry, saturated steam at 70 p.s.i. pressure is discharged into a vat of milk

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(e) Complete drainage of the H.T.S.T. system is not possible without losses exceeding those from the holder system.
(f) The margins of safety in product sanitary control in H.T.S.T. pasteurization are so narrow that automatic control precision instruments are required in its operation.
(g) Pasteurization efficiency of high-thermoduric count raw milk is less than that when holder pasteurization is used; thus, unless close regulation and control are maintained over the raw milk supply, higher bacteria counts in the finished product may result.
(h) Unit fortification of milk by adding vitamins and minerals is difficult in the closed system.

REFERENCES

Anon. 1962. Flow diagram for strontium 90 removal by ion exchange resin. American Milk Review *24*, No. 2, 26–28.

Bateman, G. M., and Sharp, P. F. 1928. A study of the apparent viscosity of milk as influenced by some physical factors. J. Agr. Res. *36*, 647.

Bowen, J. T. 1930. Heat transfer in dairy machinery. Agr. Eng. *11*, 27–32, 71–74.

Clarke, R. J. 1957. Process Engineering in the Food Industries. Philosophical Press, New York.

Coulson, J. M., and Richardson, J. R. 1956. Chemical Engineering. Vol. I., McGraw-Hill Book Co., New York.

Dahlberg, A. C., and Hening, J. C. B. 1925. Viscosity, surface tension, and whipping properties of milk and cream. N. Y. S. Agr. Expt. Sta. Tech. Bull. *113*.

Fetterman, J. C. 1928. Electrical conductivity method of processing milk. Agr. Eng. *9*, 107–108.

Foote, G. E. 1956. The effect of elevated temperatures in processing dairy products. South. Dairy Prod. J. *60*, No. 6, 28–30, 110–111.

Fuchs, A. W. 1938. Contamination of pasteurized milk by improper relative pressures in regenerators. J. Milk Technol. *1*, No. 5, 9–16.

Getchell, B. E. 1935. Electric pasteurization of milk. Agr. Eng. *16*, 408–410.

Hall, C. W., and Trout, G. M. 1950. High temperature treatment of milk. Dairy Eng. *76*, 275–279.

Hammer, B. W., and Babel, F. J. 1957. Dairy Bacteriology. 4th Edition. John Wiley & Sons, New York.

Harrall, B. E. 1935. A study of the lecithin content of milk and its products. Ind. Agr. Expt. Sta. Bull. *401*.

Jordan, W. K., and March, R. P. 1953. Studies on overholding in high-temperature short-time pasteurizers operated on water. J. Dairy Sci. *36*, 614–619.

Kilbourne, C. H. 1916. The Pasteurization of Milk from the Practical Viewpoint. John Wiley & Sons, New York.

Lowry, F. J. 1939. Plate-type heat exchangers. Chem. Eng. *66*, Part 1, No. 13, 89–94.

Mallory, W. E. 1942. Process of treating liquids. U.S. Pat. 2,270,540. January 20.

McKillop, A. A., and Dunkley, W. L. 1960. (Plate heat exchangers) heat transfer. Ind. Eng. Chem. *52*, Part 2, No. 9, 740–744.

MONS 038803

Moses, B. D. 1938. Electric pasteurization of milk. Agr. Eng. *19*, 525–526.
Parker, M. E., Harvey, E. H., and Stateler, E. S. 1954. Elements of Food Engineering. Vol. II, Reinhold Publishing Co., New York.
Peeples, M. 1960. Forced convection heat transfer for milk. Thesis for Ph.D Ohio State University.
Rogers, L. A. 1935. Fundamentals of Dairy Science. 2nd Edition. Reinhold Publishing Corp., New York.
Roswell, C. N. 1957. Engineering principles "no-hold" pasteurization (ultra-high temperature, 200° to 300°F.). Proc. Natl. Dairy Eng. Conf. *5*, 2–9.
Soxhlet, F. 1959. Landow. Vers. Stat. *19*, 118–1876, from Principles of Dairy Chemistry. R. Jenness and S. Patton, Wiley and Sons, New York.
Tobias, J., Herreid, E. O., and Ordal, Z. J. 1953. A study of milk pasteurization at high temperatures. J. Dairy Sci. *36*, 356–362.
Tobias, J. Kaufmann, O. W., and Tracy, P. H. 1955. Pasteurization equivalents of high-temperature short-time heating with ice cream mix. J. Dairy Sci. *38*, 959–968.
Troupe, R. A., Morgan, J. C., and Prifti, J. 1960. The plate heater—versatile chemical engineering tool. Chem. Eng. Prog. *56*, No. 1, 124–128.
Trout, C. M., and Farrall, A. W. 1946. High temperature short-time pasteurization, Mich. Agr. Exp. Sta. Spec. Bull. 355.
U.S. Dept. of Health, Education and Welfare. 1956. Milk Ordinance and Code. 1953 Recommendation. Public Health Service Publication 299.
U.S. Dept. of Health, Education and Welfare. 1965. Grade A pasteurized milk ordinance. Public Health Service Pub. 299.
Watson, E. L., McKillop, A. A., Dunkley, W. L., and Perry, R. L. 1960. Plate heat exchanger flow characteristics. Ind. Eng. Chem. *52* Part 2, No. 9. 733–740.
Whitaker, J. R. 1947. Plate heat exchangers and their applications. Australian J. Dairy Technol. 2, No. 3, 110–118.
Whitaker, R., Sherman, J. M., and Sharp, P. F. 1927. Effect of temperature on the viscosity of skimmilk. J. Dairy Sci. *10*, 361–371.

MONS 038804

dioactive components (Anon. 1962). But before being passed through the ion exchanger, the milk must be reduced to a pH of about 5.3 by citric acid at a temperature below 80°F. (27°C.). The product is then passed through the ion exchanger. As it leaves the exchanger, the pH is again adjusted to 7.0 by the addition of potassium hydroxide. Following its neutralization, the product can be pasteurized, homogenized, and finally deodorized.

The ion exchanger itself is regenerated by (a) one warm water rinse, (b) a washing with nonionic cleaning solution at 140°F. (60°C.), (c) sanitizing with hypochloride (50 p.p.m.), and (d) strontium removal from the column with a solution of salts of calcium, magnesium, and sodium. On a pilot model basis, the cost of strontium 90 removal is approximately 5 to 10¢ per quart of milk product.

REFERENCES

Anon. 1962. Flow diagram for strontium 90 removal by ion exchange resin. American Milk Review *24*, No. 2, 26–28.

Anon. 1963. Bactofugation. Food Processing *24*, No. 1, 127.

Ball, C., and Olson, F. C. W. 1957. Sterilization in Food Technology. McGraw-Hill Book Co., New York.

Barber, J. E. 1957. Deodorizing market milk. Taylor Technol. *9*, No. 3, 23–24.

Cooley, J. H. 1957. Different principles of valves used for filling bottles. Proc Natl. Dairy Eng. 47–57.

Dahlberg, A. C. 1932. The margin of safety between the thermal death point of the tubercle bacillus and the thermal cream layer volume impairment of pasteurizing milk at various temperatures. New York Agr. Expt. Sta. Tech. Bull. *203*.

Dashiell, W. N. 1958. Use of time-delay to control booster pump operation. J. Milk Food Technol. *21*, 184–186.

Fuchs, A. W. 1938. Contamination of pasteurized milk by improper relative pressures in regenerators. J. Milk Food Technol. *1*, No. 5, 9–16. Also Public Health Bept. *53*, No. 13, 496–505.

Hall, C. W. 1959. Symposium: latest developments in the heat and vacuum treatment of milk. Equipment for vacuum treatment of milk. J. Dairy Sci. *42*, Part 1, 557–560.

Hall, C. W., and Shiffermiller, W. E. 1954. Time requirements for the cleaning operations in a dairy plant. Mich. Agr. Expt. Sta. Quar. Bull. *36*, 305–309.

Hall, C. W., and Trout, G. M. 1959. High temperature treatment of milk. Dairy Eng. *76*, 275–279.

Hall, C. W., Trout, G. M., and Rippen, A. L. 1961. Survey of homogenized milk in Michigan, II. Functions, maintenance, and care of the homogenizer with suggested sequences of operation. Mich. Agr. Expt. Sta. Quar. Bull. *43*, 631–647.

Harvey, W. C., and Hill, H. 1951. Milk: Production and Control: 3rd Edition. H. K. Lewis & Son, London.

Hedrick, T. I., and Hall, C. W. 1961. Aseptic filling of cartons. Dairy Eng. *78*, 248–250.

Pflug, I. J., Hall, C. W., and Trout, G. M. 1959. Aseptic canning of dairy products. Dairy Eng. *76*, 328–331.

MONS 038805

Roberts, W. M. 1959. Symposium: latest developments in the heat and vacuum treatment of milk. Problems involved in flavor removal. J. Dairy Sci. *42*, Part 1, 560–563.

Scott, J. K. 1954. The steam stripping of taints from liquids. 1. An analysis of processing methods with particular reference to the vacreator. J. Dairy Res. *21*, 354–369.

Scott, J. K. 1957. Multi-stage counterflow operation of vacreators in New Zealand. Dairy Industries *22*, 482–487.

Trout, G. M. 1950. Homogenized Milk. Michigan State Univ. Press, East Lansing, Mich.

Trout, G. M., Hall, C. W., and Rippen, A. L. 1961. Survey of homogenized milk in Michigan. I. The extent, operating conditions, and utilization of returns. Mich. Agr. Expt. Sta. Quar. Bull. *43*, 616–633.

U.S. Dept. of Health, Education and Welfare. 1956. Milk ordinance and code 1953 - recommendations of the Public Health Service, U.S. Pub. Health Service Pub. *229*.

U.S. Dept. of Health, Education and Welfare. 1961. U.S. Public Health Service, Division of Environmental Engineering and Food Protection. Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. Milk Pasteurization Controls and Tests (95M) Course Manual (11 sections).

U.S. Dept. of Health, Education and Welfare. 1965. Grade "A" pasteurized milk ordinance. U.S. Pub. Health Service Pub. *229*.

Whitaker, J. R. 1947. Plate heat exchangers and their applications. Aust. J. Dairy Technol. *2*, 110–118.

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Agriculture Handbook No. 331

SUGGESTED GUIDE FOR THE USE OF INSECTICIDES TO CONTROL INSECTS AFFECTING CROPS, LIVESTOCK, HOUSEHOLDS, STORED PRODUCTS, FORESTS, AND FOREST PRODUCTS 1967

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Agricultural Research Service and Forest Service
U. S. DEPARTMENT OF AGRICULTURE

SUGGESTED GUIDE FOR THE USE OF INSECTICIDES TO CONTROL INSECTS AFFECTING CROPS, LIVESTOCK, HOUSEHOLDS, STORED PRODUCTS, FORESTS, AND FOREST PRODUCTS—1967

PREFACE

This handbook is intended to be a guide for entomologists and other research and extension workers rather than to provide information for individual users of insecticides. It was prepared by the Entomology Research and the Market Quality Research Divisions, Agricultural Research Service, and the Divisions of Forest Pest Control and Forest Protection Research, Forest Service, as of December 1, 1966.

This guide suggests uses of chemicals and such related treatments as application of pathogens, heat, and cold for the control of insects and related pests that affect crops, livestock, households, forests, forest products, and agricultural products in storage. The information was compiled in consultation with the Pesticides Regulation Division of Agricultural Research Service, the Federal Extension Service, and the Cooperative State Research Service. It is emphasized that these insecticide uses are those suggested by the U.S. Department of Agriculture. However, they are based on information obtained by various Federal, State, and other research organizations.

This handbook is intended to supplement information and recommendations issued by State agencies. The chemical uses it suggests do not necessarily apply to all areas or parts of the country. There are other registered uses that meet the requirements of the Federal Insecticide, Fungicide, and Rodenticide Act and the provisions of the Pesticide Chemicals Amendment of 1954 and the Food Additives Amendment of 1958 to the Federal Food, Drug, and Cosmetic Act.

As new tolerances for insecticides are established or changes made, the Department will review these suggestions and modify them as needed to insure that residues do not exceed the new tolerances. Since new materials and new uses for older materials are registered throughout the year, we suggest that you keep in touch with your State agricultural experiment station, State extension service, the U.S. Department of Agriculture, or manufacturers of specific products, for up-to-date information.

Many of the suggestions in this handbook appear in other publications of the U.S. Department of Agriculture. The important publications are listed. However, some of the earlier suggestions have been modified and others are new and have not previously appeared in print. The insecticide uses suggested in this handbook take priority over those in other publications of the Department published before April 1, 1967.

This agriculture handbook supersedes Agriculture Handbook 313, "Suggested Guide for the Use of Insecticides to Control Insects Affecting Crops, Livestock, Households, Stored Products and Forest Products—1966."

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OTHER MEANS OF INSECT CONTROL

In addition to the use of insecticides, there are a number of other ways to control or to help control insect pests. Natural control factors, such as insect parasites, predators, and diseases, and adverse weather conditions are continually at work in the field. In many instances, they reduce pest populations and keep them at noneconomic levels. Good sanitation and housekeeping practices are essential for effective control of house flies, stable flies, cockroaches, fleas, and similar pests, even when supplemented by the use of chemicals. Cultural and mechanical practices aid materially in the control of certain plant pests, including the pink bollworm, boll weevil, tobacco hornworm, white pine weevil, and some bark beetles. Crop varieties resistant to insect pests have been developed and are available to avoid or reduce damage by such insects as the Hessian fly, wheat stem sawfly, spotted alfalfa aphid, and the European corn borer.

Subjecting harvested products to heat or extreme cold in storage often destroys or inhibits the development of insect infestations. Insect-free commodities can be protected by insect-resistant packaging and sanitation in storage and in marketing channels.

More satisfactory control of insect pests may frequently be obtained by carefully integrating the use of insecticides or fumigants with the beneficial effects of biological control agents or other nonchemical measures. It may be necessary to use insecticides only as a supplement to other control methods.

In the case of any insect infestation, all means of control must be considered, in order to capitalize on the value of all control factors and coordinate these factors to the greatest advantage, with the least harmful effect to the environment and to living organisms within it. Various State and Federal publications suggest this approach to pest control. Consult these publications and your State agricultural experiment station for the latest information. Do not use insecticides or fumigants unless they are needed.

APPLICATION OF INSECTICIDES

The key to effective use of insecticides without injury to the treated plants or animals is to follow directions on the label and not use any insecticide preparation for any purpose for which it is not specified. Most oil sprays prepared for application to walls of buildings will injure living plants or animals. Insecticide concentrates prepared for application to plants may injure or kill treated animals and result in illegal residues in animal tissues or byproducts.

Only general information can be given here on the effective application of insecticides, since much depends on the habits of the insect pest, the kind of damage that it causes, the nature and condition of the infested plants, animals, or commodities to be treated, weather conditions, and application equipment, as well as the type and formulation of the insecticide to be applied. For information to meet special needs, consult your State agricultural experiment station.

Weather Conditions

Wind, rain, and sun play an important part in the control you get from outdoor use of insecticides. Keep an eye on the weather. Local weather reports may be of help in planning insecticide applications. Before you start to treat, watch the tops of trees or use other means of determining the direction and amount of wind. Some air movement is helpful. Winds, however, can cause an insecticide dust or spray to be unevenly distributed on the plants and to drift away from target areas.

Usually the best time for airplane spraying is in the early morning or late evening. Treating at these times minimizes the harm to bees and other pollinating insects.

If rain is predicted, it is best to postpone treatment, if possible. Rain falling soon after you treat may reduce the effectiveness of an insecticide deposit. Cold weather may have the same effect. Some insecticides must be applied at temperatures above 50° F. to be of value.

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Extremes in weather during or following the spraying of fruit trees may lead to fruit or foliage injury. Injury such as russeting of fruit may be increased by pesticide sprays if they are applied at night or during cool, rainy, or humid weather. Emulsifiable materials are more likely to cause injury than wettable powders.

Condition of Host Plant or Animal

The type and density of plant foliage, as well as the extent of coverage needed, may influence the choice of formulation that is applied. In some instances a coarse spray will be the most effective; in others, a fine spray, mist, or fog will give better pest control. Plants with smooth leaves are apt to have a quicker runoff of spray material than those with rough surfaces. However, stickers that are included in the formulation, or that may be added, help the material adhere to the plants.

Sick, emaciated, or stressed animals may react unfavorably to some treatments that normally are harmless. Thick hair on livestock may keep the insecticide from penetrating. Consider all such circumstances in selecting an insecticide, type of formulation, or type of equipment that will provide the best and safest control of the target pest.

Diluting and Mixing Sprays

Most spray materials are formulated with enough wetting and sticking agents to correct for water hardness and to improve their other physical properties.

Before mixing two or more pesticides or adding wetting or sticking agents, read the labels and consult the manufacturer, a spray compatibility chart, or a spray bulletin regarding possible injury to plants.

Calibration of Equipment for Applying Insecticides [1]

At the start of each growing season, thoroughly inspect and calibrate all equipment you will use to apply insecticides. Repeat thereafter whenever you use a different rate of application. It is most essential that you apply the correct dosage, not only to obtain effective control of the insect pest but also to avoid plant injury and to be certain that any residue remaining at the time of harvest or feeding does not exceed the tolerance established for that particular chemical on the crop you treat.

Power Sprayers.—Before you start to spray, check or calibrate the sprayer to determine whether it will deliver at the desired rate.

Note: Since viscosity of spray material can affect the discharge rate, it is preferable to calibrate the sprayer with the mixture you plan to use. It is also preferable to make your calibration in an area as similar as possible to the one you plan to treat.

One method of calibrating a sprayer for field use is as follows. (1) Set two stakes in the ground 40 rods apart (660 feet). (2) With the sprayer on level ground, fill the tank with the liquid. Then operate the sprayer long enough that all nozzles are discharging smoothly. Cut off sprayer and refill tank. Then mark the height of the spray material on a measuring stick that you have calibrated in gallons for your particular tank. (3) Drive the spray rig one round trip between the stakes at the speed and pressure suggested by the nozzle manufacturer, with the sprayer in full operation. *Spray only between the stakes.* (4) With the sprayer again on level ground, place the measuring stick in the tank and determine the gallons of spray used for the round trip. (5) Multiply the number of gallons used by 33 and divide by the number of feet of width sprayed. The result of this calculation will be the number of gallons applied per acre.

EXAMPLE.—Suppose the boom on your sprayer is 20 feet long, and it took 5 gallons of spray material to refill the tank after spraying the round trip during the calibration. Five times 33 divided by 20 equals 8.2 gallons per acre.

If the calibration shows that the application rate is too low, increase the rate by reducing the speed of travel or increasing the pressure. You may decrease the rate by doing the opposite in each case.

[1] Information furnished by the Agricultural Engineering Research Division, Agricultural Research Service.

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Power dusters.—Before starting a dusting operation, check the application rate of the duster unit. Dust mixtures vary in density, and the application rate can vary at a given setting of the feed regulator.

A procedure that can be used to calibrate a duster is as follows. (1) Measure off an area of at least one-half acre (21,780 square feet). (2) Fill the dust hopper and set the feed regulator for the desired application rate. (3) Dust the measured area. Drive at a constant speed, because rate of speed affects the application rate. Use of a tractor speedometer is recommended. (4) Refill the hopper from a weighed amount of dust. Subtract the weight of the dust left over from the weight of the original amount. This gives the amount required to fill the hopper and, therefore, the amount applied to the measured half acre.

Applicators for Granules.—Many equipment manufacturers and some producers of granular insecticides can provide tables showing the proper settings of the feed mechanism for selected flow rates of specific materials. It is usually necessary, however, to calibrate the applicator for each new batch used because of the allowable range of sizes in a formulation and because of differences in density.

You may find it convenient to affix paper bags at the dispersing points of the applicator, run a measured course at a measured speed, and then weigh the granules collected. Calculations can then be made to show how many pounds of granules are being dispersed per acre.

Or you may calibrate your applicator in the field. Set the applicator to distribute less than the manufacturer recommends. Then measure out 1 pound of granules at a time and mark the level in 1-pound increments on the inside of each hopper. The marks tell you how fast the granules feed down, and the applicator can then be gradually opened up to get the desired rate.

Aircraft Equipment.—For information on aircraft calibration, consult U.S.D.A. Agriculture Handbook No. 287, "Aerial Application of Agricultural Chemicals." [2]

[2] For sale only by Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. 20 cents.

PRECAUTIONS

The following safeguards are for the protection of handlers of insecticides and treated plants, of consumers of treated crops and animals, of honey bees, fish, and wildlife, and of our basic natural resources—water, soil, and air.

Insecticides used improperly can cause injury to man and animals. Use them only when needed and handle them with care. Follow the directions and heed all precautions on the container label. Do not exceed the maximum dosage suggested. Always apply the least amount of an insecticide required. Insecticides should be kept in closed, well-labeled containers, in a dry place where they will not contaminate food or feed, and where children and animals cannot reach them.

Some States have special restrictions on the use of certain insecticides. Before applying insecticides, check State and local regulations.

Protection of Persons Using Insecticides

In handling any insecticide, avoid repeated or prolonged contact with skin and prolonged inhalation of dusts, mists, and vapors. Wear clean, dry clothing, and wash hands and face before eating or smoking. Launder clothing daily.

The handling and application of most concentrates and the handling and application of oil solutions applied as coarse sprays require special precautions. When handling or mixing a concentrate or oil solution of any insecticide, avoid spilling it on the skin and keep it out of the eyes, nose, and mouth. If any is spilled, wash it off the skin immediately with soap and water. If you spill it on your clothing, remove clothing immediately and wash the contaminated skin thoroughly. Launder clothing before wearing it again. If the insecticide gets in the eyes, flush with plenty of water for 5 minutes and get medical attention.

The following insecticides can be used without special protective clothing or devices, provided they are in dusts, water sprays, oil mist sprays, granules, or baits that have been diluted to the strengths suggested in this handbook. Concentrates of these insec-

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ticide should be handled in accordance with the precautions for such materials as described above. In all cases, follow the label precautions.

Abate	Morestan
allethrin	naphthalene
Aramite	ovex
Bacillus thuringiensis	paradichlorobenzene
calcium arsenate	paris green
carbaryl (Sevin)	Perthane
chlorobenzilate	piperonyl butoxide
cryolite	pyrethrins
DDT	pyrethrum
dicofol (Kelthane)	ronnel
Dilan	rotenone
diphenylamine	ryania
fenson	sabadilla
Genite 923	Strobane
Kepone	sulfur
lead arsenate	Sulphenone
Lethane 384	TDE
lime sulfur	tetradifon (Tedion)
malathion	Thanite
metaldehyde	trichlorofon
methoxychlor	zineb
mirex	

The following insecticides can be absorbed directly through the skin in harmful quantities. When working with these insecticides in any form, take the same precautions as with concentrates.

aldrin	dinitrocyclohexylphenol
benzene hexachloride	dioxathion (Delnav)
binapacryl	endosulfan (Thiodan)
chlordane	ethion
Ciodrin	fenthion (Baytex)
coumaphos (Co-Ral)	heptachlor
diazinon	lindane
dichlorvos (DDVP)	naled (Dibrom)
dieldrin	Nemacide (V–C 13)
dimethoate	Ruelene
dinitrobutylphenol	toxaphene
dinitrocresol	Zectran

The following chemicals are highly toxic and may be fatal if swallowed, inhaled, or absorbed through the skin. These highly toxic materials should be applied only by a person who is thoroughly familiar with their hazards and who will assume full responsibility for proper use and comply with all the precautions on the labels.

azinphosmethyl (Guthion)	famphur (Warbex)
Azodrin	Matacil
Bidrin	methyl parathion
carbophenothion (Trithion)	Methyl Trithion
Compound 4072	mevinphos (Phosdrin)
demeton	nicotine sulfate
dichloropropane-dichloropropene mixture	parathion
disulfoton (Di-Syston)	phorate (Thimet)
DN–111	phosphamidon
endrin	Telone
EPN	tepp

The following insecticides are used in closed spaces as fumigants and, because of their volatility and toxicity, are considered to be hazardous by inhalation. Fumigation in closed spaces should be done only by a licensed pest control operator or by a qualified individual who is thoroughly familiar with their hazards, who will assume full responsibility for their proper use, and who knows he must comply with all precautions on the labels. The value given in parentheses after each material is the maximum average atmospheric concentration (threshold limit) of the insecticide by volume, to which workers may be exposed for an 8-hour day without injury to health. These threshold limit values were adopted at the 28th Annual Meeting of the American Conference of Governmental Industrial Hygienists, April 1966.

acrylonitrile (20 p.p.m)	ethylene dibromide (25 p.p.m.)
aluminum phosphide (as phosphine 0.3 p.p.m.)	ethylene dichloride (50 p.p.m.)
	ethylene oxide (50 p.p.m.)
calcium cyanide (5 mg. dust per cubic meter)[1]	hydrogen cyanide (10 p.p.m.)
	methyl bromide (20 p.p.m.)
carbon disulfide (20 p.p.m.)	methyl formate (100 p.p.m.)
carbon tetrachloride (10 p.p.m.)	propylene dichloride (75 p.p.m.)
chloroform (50 p.p.m.)	propylene oxide (100 p.p.m.)
chloropicrin (0.1 p.p.m.)	tetrachloroethylene (100 p.p.m.)
ethyl formate (100 p.p.m.)	trichloroethylene (100 p.p.m.)

[1] Not from list of threshold limit values.

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COMMODITY, STORAGE, AND INSECT	INSECTICIDE OR TREATMENT	TOLERANCE (p. p. m.)	FORMULATION	DOSAGE (active ingredient per 1,000 cu. ft. unless otherwise stated)	HOW, WHERE, AND WHEN TO APPLY	SAFETY RESTRICTIONS
ANIMAL FEED--Citrus pulp In bags Beetles and moths	Malathion (premium grade)	50	WP	0.125 lb. in 1 gal. water/1,000 sq. ft.	Apply spray to all exposed surfaces of stack. Begin soon as stack is completed; repeat in 2 weeks and monthly thereafter. Discontinue when commodity temperature is below 60° F.	Repellent treatment not to be used on bags of less than 50-lb. size. Do not use malathion on medicated blocks. Fumigants should be applied only by a trained operator. Manufacturer of aluminum phosphide insists his representative train all first users. Aerate products 48 hours before offering to consumer. Do not fumigate prepared mixes.
	Pyrethrins + piperonyl butoxide + insect-tight bags.	1 + 10	WP	5 ± 1 mg. pyrethrins + 50 ± 10 mg. piperonyl butoxide /sq. ft. of bag surface.	The insect-repellent treatment is to be applied on the paper used as the outer ply of multiwall bags having insect-tight construction as in specifications available from ARS.	
ANIMAL FEED--Concentrate blocks In bags Beetles and moths	Malathion (premium grade)	10	Oil soln.	100 mg./sq. ft. of bag surface.	On packaging line, just before feed block enters bag. Spray nozzle deposits malathion on all interior surfaces of bag.	
ANIMAL FEED--Cottonseed cake In bags Beetles and moths	Aluminum phosphide	0.1	F		In tarpaulin fumigation place tablets or pellets in trays at each corner of stack.	
				45 tablets	Fumigate for 5 days at 54° - 59° F; 4 days at 60° - 68° F, or 3 days at 69° or above.	
				165 pellets	Fumigate for 4 days at 54° - 59° F; 3 days at 60° - 68° F, or 2 days at 69° or above.	

Continued

MDNS 038814

COMMODITY, STORAGE, AND INSECT	INSECTICIDE OR TREATMENT	TOLERANCE (p. p. m.)	FORMULATION	DOSAGE (active ingredient per 1,000 cu. ft. unless otherwise stated)	HOW, WHERE, AND WHEN TO APPLY	SAFETY RESTRICTIONS
ANIMAL FEED—Cottonseed cake						Repellent treatment not to be used on bags of less than 50-lb. size. Fumigants should be applied only by a trained operator. Do not release aerosol near an open flame. Aerosols may be used against exposed insects only.
In bags Beetles and moths (con.)	Pyrethrins + piperonyl butoxide + insect-tight bags.	1 + 10	WP	5 ± 1 mg. pyrethrins + 50 ± 13 mg. piperonyl butoxide /sq. ft. of bag surface.	The insect-repellent treatment is to be applied on the paper used as the outer ply of multiwall bags having insect-tight construction as in specifications available from ARS.	
ANIMAL FEED—Dog Food						
In packages Beetles and moths	Methyl bromide	400 (inorganic bromide)	F	1 - 2 lb. for 12 to 24 lb.		
ANIMAL FEED—Milled fractions*						
In bulk or in packages Beetles and moths	Methyl bromide	125** (inorganic bromide)	F	1.5 lb.	24 hr. at 60° F. or above.	
ANIMAL FEED—Mixed grain						
In bags Beetles and moths	Pyrethrins + piperonyl butoxide	1 + 10	Oil soln. % by wt. Pyrethrins 0.2 + piperonyl butoxide 2.0 + tetrachloroethylene 50.0 + deodorized kerosene 47.8	0.006 + 0.06 lb./ 10,000 cu. ft. of airspace over the load.	Apply with thermal aerosol generator.	
			Pyrethrins 0.5 + piperonyl butoxide 5.0 + tetrachloroethylene 50.0 + deodorized kerosene 44.5	0.006 + 0.06 lb./ 10,000 cu. ft. of airspace over the load.	Apply with mechanical aerosol generator or as a mist spray.	

Continued

* Barley, corn, grain sorghum (milo), oats, rice, rye, wheat.

** Same residue from carryover and concentration of residues from fumigation of the grains with methyl bromide or ethylene dibromide.

MONS 038815

COMMODITY, STORAGE, AND INSECT	INSECTICIDE OR TREATMENT	TOLERANCE (p. p. m.)	FORMULATION	DOSAGE (active ingredient per 1,000 cu. ft. unless otherwise stated)	HOW, WHERE, AND WHEN TO APPLY	SAFETY RESTRICTIONS
ANIMAL FEED—Mixed grain						
In bags Beetles and moths (con.)	Pyrethrins + piperonyl butoxide + insect-tight bags.	1 + 10	WP	5 + 1 mg. pyrethrins + 50 + 10 mg. piperonyl butoxide /sq. ft. of bag surface.	The insect-repellent treatment is to be applied on the paper used as the outer ply of multiwall bags having insect-tight construction as in specifications available from ARS.	Repellent treatment not to be used on bags of less than 50-lb. size.
BEANS AND PEAS, DRY						
In 100-lb. bags Weevils	Hydrogen cyanide	25	F	2 lb.	12 to 24 hr. at 60° F. or above in atmospheric chamber.	Do not fumigate with hydrogen cyanide (HCN) at temperatures below 60° F. Aerate for 24 hours after treatment. Fumigants should be applied only by a trained operator.
				2 lb.	12 to 24 hr. at 60° F. or above under tarpaulin.	
				2 lb.	24 hr. at 60° F. or above in warehouse.	
				2 lb.	12 hr. at 60° F. or above in warehouse.	
	Methyl bromide	50 (inorganic bromide)	F	1.5 lb.	24 hr. at 60° F. or above in atmospheric chamber.	
				3 lb.	24 hr. at 40° - 60° F. in atmospheric chamber.	
				2 lb.	24 hr. at 60° F. or above under tarpaulin.	
				3 lb.	24 hr. at 40° - 60° F. under tarpaulin.	
				3 lb.	24 hr. at 60° F. or above in freight car.	
				3.5 lb.	24 hr. at 40° - 60° F. in freight car.	
				2 lb.	24 hr. at 60° F. or above in warehouse.	
Continued				3 lb.	24 hr. at 40° - 60° F. in warehouse.	

MONS 038816

LIVESTOCK INSECTS

Precautions: In applying insecticides to livestock or around barns, do not contaminate feed or feed and water troughs, or allow runoff into streams. Avoid spraying or dusting animals in cold, stormy weather. Avoid treating stressed, overheated, or sick animals. Observe all other precautions specified in this handbook.

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (p. p. m. in fat unless otherwise indicated)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
CATTLE, DAIRY							
Cattle grubs (Hypoderma spp.)	Rotenone	--	--	5% WP (7½ lb. per 100 gal. water)	2 - 4 qt.	On back of animal with power sprayer 1 - 3 times every 30 days.	See page 167.
				5% WP (12 oz. per gal. water)	1 pt.	Sponge or brush on back.	
				1.5% D	4 - 5 oz.	Rub thoroughly on back.	
Face fly (Musca autumnalis)	Dichlorvos	--	--	0.5% B	3 - 5 ml.	Brush on forehead in morning; daily if needed.	
				EC or oil 1% S	1 - 1.5 fl. oz.	As mist spray daily with hand or automatic sprayer; do not soak skin.	
	Pyrethrins + Synergist*	--	--	Oil soln. or EC 0.075% + 0.75% S	1 - 2 fl. oz.	As mist spray daily to head and neck, with hand or automatic sprayer.	
	Ciodrin	--	--	EC or oil 2% S	1 - 2 fl. oz.	As mist spray daily to all parts of body.	
				EC, 0.5 - 1% S	1 - 2 pt.	Spray thoroughly. Repeat once a week if necessary.	
				EC, 0.15 - 0.3% S	1 - 4 qt.		
				EC, 0.5% S	1 - 2 qt.	Pen or corral spraying with high pressure equipment.	
	Coumaphos	1 meat and fat 0 milk	--	1% oil	1 gal./20 ft. cable	Saturate back rubbers. Construct to permit animal to rub its face.	
Horn fly (Haematobia irritans)	Malathion	4 meat 0 milk	--	4% D	2 oz.	Sprinkle on back, neck, and flanks every 10 to 14 days, if needed.	
				5% D	1.5 oz.		

Continued

*Piperonyl butoxide or sulfoxide. Such supplemental synergists as MGK 264, n-propyl isome, or sesame oil may be used as a partial replacement for piperonyl butoxide. Additives such as MGK R-11, MGK R-326, Crag, and Tabatrex may also be included and used according to manufacturer's directions.

MONS 038817

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (p. p. m. in fat unless otherwise indicated)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
CATTLE, DAIRY							
Horn fly (Haematobia irritans) (con.)	Coumaphos	1 meat and fat 0 milk	--	1% oil	1 gal./20 ft. cable	Saturate back rubbers.	See page 167.
	Dichlorvos	--	--	1% oil S	1 - 2 fl. oz.	As mist spray daily to back, flanks, and legs.	
	Methoxychlor	3 0 milk	--	50% WP	1 tbsp.	Sprinkle on back, neck, and flanks every 3 weeks.	
	Clodrin	--	--	3% D	1 - 2 heaping tbsp.	On poll, back, and upper portions of sides every 14 days, if needed.	
				EC, 1%	1 qt.	Pour along backline.	
				EC or oil, 2% S	1 - 2 fl. oz.	As mist spray daily to all parts of body.	
				EC, 0.5 - 1% S EC, 0.15 - 0.3% S	1 - 2 pt. 1 - 4 qt.	Spray thoroughly once a week if necessary.	
				EC, 0.5% S	1 - 2 qt.	Pen or corral spraying with high pressure equipment.	
				1% oil	1 gal./20 ft. cable	Saturate back rubbers.	
	Pyrethrins + Synergist*	--	--	EC, 0.05% + 0.5% S	1 - 2 qt.	As wet spray every 5 - 7 days.	
				Oil soln. or EC 0.05 - 0.1% + 0.5 - 1% S	1 - 2 fl. oz.	As mist spray daily with hand or automatic sprayer.	
	Lethane 384**	--	--	Oil soln., 3% S	1 - 2 fl. oz.	As mist spray.	

Continued

*Piperonyl butoxide or sulfoxide. Such supplemental synergists as MGK 264, n-propyl isome, or sesame oil may be used as a partial replacement for piperonyl butoxide. Additives such as MGK R-11, MGK R-326, Crag, and Tabatrex may also be included and used according to manufacturer's directions.

**Used in conjunction with other materials.

MONS 038818

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (p. p. m. in fat unless otherwise indicated)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
CATTLE, DAIRY							
Horn fly (Haematobia irritans) (con.)	Thanite*	--	--	Oil soln., 5% S	1-2 fl. oz.	As mist spray.	See page 167.
Horse flies, stable fly (Stomoxys calcitrans), and mosquitoes	Dichlorvos**	--	--	1% oil S	1-2 fl. oz.	As mist spray, once or twice daily.	
	Clodrin**	Same as for Face fly.					
	Pyrethrins + Synergist***	--	--	EC, 0.1% + 1% S	1-2 qt.	As wet spray every 2-3 days.	
				Oil soln., or EC, 0.1% + 1% S	1-2 fl. oz.	As mist spray daily, with hand or automatic sprayer.	
	Lethane 384*, **	--	--	Oil soln., 3% S	1-2 fl. oz.	As mist spray.	
	Thanite*, **	--	--	Oil soln., 5% S	1-2 fl. oz.		
Lice	Clodrin	--	--	EC, 0.15-0.3% S	1-4 qt.	Spray thoroughly; repeat after 1 week, if needed.	
				EC, 0.5% S	1-2 qt.	Pen or corral spraying with high pressure equipment.	
				EC, 0.1-0.25% S	1-2 gal. (1 gal. 0.25%)	Apply second application 14 days later.	
	Pyrethrins + Synergist***	--	--	EC, 0.025% + 0.25% S	Depending on size of animals and amount of hair.	Spray or dust thoroughly; repeat after 2-3 weeks.	
	Rotenone	--	--	5% WP (1-2 lb. per 100 gal. water)			
				0.5-1% D			

*Used in conjunction with other materials.
**Not registered for control of horse flies.
***Piperonyl butoxide or sulfoxide. Such supplemental synergists as MGK 264, n-propyl isome, or sesame oil may be used as a partial replacement for piperonyl butoxide. Additives such as MGK R-11, MGK R-326, Crag, and Talmirex may also be included and used according to manufacturer's directions.

MONS 038019

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (*p. p. m. in fat unless otherwise indicated*)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
CATTLE, DAIRY							
Screw-worm (Cochliomyia hominivorax)	Diphenylamine	0 meat 0 milk	--	35% (Smear 62)	--	Brush or smear on wound and surrounding area, twice first week and then weekly until healed.	See below.
	Lindane	7	--	3% (EQ 335)	Minimum needed, not more than 3 tsp.		
Ear tick (Otobius megnini)	Lindane	7	--	0.75% in xylene-pine oil	½ oz.	Inside ear with spring-bottom oiler.	
Ticks	Ciodrin	Same as for Lice					
	Pyrethrins + Synergist*	--	--	EC, 0.1% + 1% S	Depending on size of animals and amount of hair.	Spray animals thoroughly as needed.	
	Rotenone	--	--	5% WP (2-4 oz. per gal. water)			

*Piperonyl butoxide or sulfoxide.

SAFETY RESTRICTIONS

Do not apply more than 2 fluid ounces per day per animal when using mist sprays containing Ciodrin, Lethane 384, or Thanite, or more than 1.5 fluid ounces per day when using mist sprays containing dichlorvos. Do not wet the hide with the spray.

Do not apply coumaphos in conjunction with oral drenches or other internal medications, such as phenothiazine, or with other organic phosphates. Do not use with synergized pyrethrins, allethrin, or synergist. Suspend back rubber at a height that will prevent straddling. For other than back rubber use, see Safety Restrictions for Beef Cattle, page 173.

Do not apply Ciodrin to cattle more often than once a week except as a mist spray. Do not apply Ciodrin dust more often than every 14 days.

Do not apply malathion dust on dairy cattle during or less than 5 hours before milking. Do not use methoxychlor or malathion in sprays or dips on dairy cattle.

Certain of the insecticides suggested for Beef Cattle on pages 168-173 may also be used with limitations on dry dairy animals. See Safety Restrictions under Beef Cattle, page 173.

MONS 038820

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (p. p. m. in fat unless otherwise indicated)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
CATTLE, BEEF*							
Cattle grubs (Hypoderma spp.)	Ronnel** (Purified grade only)	0 meat	60	0.6% in feed	0.3 lb./100 lb. body weight	Daily for 7 days.***	See page 173.
			28	0.26% in feed	0.3 lb./100 lb. body weight	Daily for 14 days.***	
			21	5.5% in block or granules	0.25 lb./100 lb. body weight/month	Continuously for not less than 75 days.	
	Coumaphos	1 meat and fat	--	WP, 0.375 - 0.5% S or 0.25% dip EC, 0.375% S	Depending on size of animals and amount of hair	Wet entire body to skin.*** Higher concentration needed in northern areas or for late fall application when long hair coats make thorough wetting of the skin difficult.	
				WP, 0.25% S	Depending on size of animals and amount of hair	Make 2 applications not more than 90 days apart. Apply second spray soon after heel fly activity has stopped.	
				Soln, 4%	½ fl. oz./100 lb. body weight; maximum 4 fl. oz. per animal	Pour on evenly along animal's backline.***	
	Ruelene	--	28	EC, 0.375% S	Depending on size of animals and amount of hair but no more than 1 gal./animal.	Wet entire body to skin.***	
			28	EC, 8.3% in water Soln.; 9.4%	1 fl. oz./100 lb. body weight up to 800 lb. animal, but no more than 8 fl. oz./animal	Pour on evenly along animal's backline.***	

Continued

*Insecticides suggested for use on dairy animals may also be used on beef animals subject to the same restrictions.
**Aids in control of lice, horn flies.
***Use at end of adult heel fly season, but not later than November 1.

MONS 038821

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (p. p. m. in fat unless otherwise indicated)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
CATTLE, BEEF							
Cattle grubs (Hypoderma spp.) (con.)	Trichlorfon	--	14	Soluble powder 1% S	Depending on size of animal and amount of hair	Wet entire body to skin.*	See page 173.
			21	Soln., 8%	½ fl. oz./100 lb. body weight; no more than 4 fl. oz. per animal	Pour on evenly along animal's backline.*	
Face fly (Musca autumnalis)	Coumaphos	1 meat and fat	--	1% oil	1 gal./20 ft. cable	Saturate back rubbers; construct back rubbers to permit animal to rub its face.	
	Ronnel	0 meat	14	1% oil			
Horn fly** (Haematobia irritans)	Carbaryl	--	7	WP, 0.5% S	1 qt.	Spray thoroughly. Repeat as needed.	
				5% D	2 oz.	Dust back and neck only.	
	Dioxathion	1	--	1.5% oil	1 gal./20 ft. cable	Saturate back rubbers.***	
				EC, 0.6% in water	1 qt.	Pour on evenly along animal's backline.	
				EC, 0.15% S	1 - 2 qt.	To backs every 3 weeks or as needed.	
	Methoxychlor	3	--	EC or WP, 0.5% S	2 qt.		
				5% oil	1 gal./20 ft. cable	Saturate back rubbers.***	
	DDT	7	30	5% oil			
Continued	Toxaphene	7	28	5% oil			

*Use at end of adult heel fly season, but not later than November 1.
**Dips used to control lice will also control horn flies.
***Use of back rubbers will aid in louse control.

MONS 038822

ANIMAL AND INSECT	INSECTICIDE	TOLERANCE (*p. p. m. in fat unless otherwise indicated*)	MIN. DAYS FROM LAST APPLICATION TO SLAUGHTER	FORMULATION AND STRENGTH	AMOUNT OF FORMULATION PER ANIMAL UNLESS OTHERWISE INDICATED	WHERE AND WHEN TO APPLY	SAFETY RESTRICTIONS
CATTLE, BEEF							
Horn fly* (Haematobia irritans)(con.)	Toxaphene	7	28	EC or WP, 0.5% S	2 qt.	To backs every 3 weeks as needed.	See page 173.
				5% D	1 tbsp.		
	Ronnel	0 meat	56	EC, 0.5% S or 0.25% dip	1-2 qt.		
			14	1% oil	1 gal./20 ft. cable	Saturate back rubbers.**	
	Coumaphos	1 meat and fat	--	EC, 0.06% S WP, 0.06% S or dip	1-2 qt.	To backs every 3 weeks or as needed.	
				1% oil	1 gal./20 ft. cable	Saturate back rubbers.**	
	Malathion	4 meat	--	EC or WP, 0.5% S	2 qt.	To backs every 3 weeks or as needed.	
				2% oil	1 gal./20 ft. cable	Saturate back rubbers.**	
	Ruelene	--	28	EC, 0.375% S	Depending on size of animals and amount of hair but no more than 1 gal./animal	Spray thoroughly.	
				EC, 8.3% in water Soln., 9.4%	1 fl. oz./100 lb. body weight up to 800 lb. animal, but no more than 8 fl. oz./animal	Pour on evenly along animal's backline; in hot and humid weather, use soln. only.	
Lice	Coumaphos	1 meat and fat	--	EC, 0.06% S WP, 0.06% S or dip	Depending on size of animals and amount of hair	Immerse or spray thoroughly. Repeat all treatments after 2-3 weeks if needed.	
	Dioxathion	1	--	EC, 0.15% dip or S			

Continued

*Dips used to control lice will also control horn flies.
**Use of back rubbers will aid in louse control.

MONS 038823