EARLY DRAFT

OHIO AGRICULTURAL RESEARCH AND DEVELOPMENT CENTER

Wooster, Ohio

PROJECT NO. State 425
Revised

DEPARTMENT: Dairy Science

COOPERATION: Cooperative Extension Service (Entomology)
The Ohio State University, Columbus

TITLE: Elimination of Polychlorinated biphenyl Residues from Producing Dairy Cows and Their Feed Supply.

LOCATION: Ohio Agricultural Research and Development Center, Wooster

PERSONNEL: L. B. Willett, A. C. Waldron, H. R. Conrad, and D. L. Palmquist

PROBABLE DURATION: Three years

JUSTIFICATION:

Polychlorinated biphenyls (PCB's) are a family of chlorinated hydrocarbons of the same general structure as DDT. They are manufactured by Monsanto Chemical Company under the trade name Aroclor. They, as all synthetic chlorinated hydrocarbons, are illegal components of milk, even though preliminary studies suggest that Aroclor is nontoxic to humans (5). However, since PCB's have only recently been identified as an environmental pollutant, only limited toxicological studies have been conducted with mammals.

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Several silos in Ohio, which were treated against leakage and water erosion, are contaminated with PCB (designated as Arcolor 1254). While it is not a specific product produced for application to silos or other types of feed storage, as a plasticizer it has been used in some protective coatings for wood, metal, and concrete. It is suspected that 200 silos in the Ohio-Michigan area may be so contaminated. With seven herds in Ohio having already been confronted with the problem of PCB contamination of milk, and the possibility of this being a chronic problem over several years (because it is known in the case of one silo that the protective coating was applied 16 years ago), it seems justifiable than an effort should be made to develop a procedure that will abet decontamination of silos and cattle in order that large producing herds shall not be disqualified for producing milk for human food.

PREVIOUS WORK AND PRESENT OUTLOOK:

Polychlorinated biphenyls have been manufactured for over 40 years, however, were only discovered as a contaminant of our environment in 1966 (4). Since 1966 PCB's have been shown to: be toxic to some aquatic animals (1, 14, 15); interfere with normal egg formation (9) and reduce the ability to resist stress (2, 8) in birds; and interfere with liver, enzyme and hormonal function in small mammals (4, 7, 12, 13). The affects of PCB's on large animals and man are not yet known. However, since PCB's have been shown to disrupt enzyme systems and are thought to interfere with steroid metabolism in small animals, they may well reduce

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productivity and reproductive efficiency in large domestic animals as well.

The mechanism by which PCB's from Aroclor-containing coatings contaminate the silage, and in turn the cows, was originally thought to be only mechanical by flaking off of contaminated chips. It is not uncommon for these chips to contain 5000-10,000 ppm of Aroclor. However, recent work has shown that the Aroclor is soluble in silage juice (11). In the aforementioned study, silage contamination extended up to 48 inches from the silo wall, but most of the contaminating Aroclor was in the six inches adjacent to the silo walls.

Recent attempts to increase the clearance of PCB's from contaminated cows by feeding phenobarbital and activated carbon were not successful (3). Acceleration of DDT and dieldrin residue removal from contaminated cows was achieved by feeding high fat diets (10). This accelerated removal of the chlorinated hydrocarbons is probably the result of increased turnover of the body adipose tissue. Palmquist and Conrad (6) have shown that a high fat diet may reduce the turnover time of the body adipose tissue pool by 30%.

OBJECTIVES:

1. To study methods of and recommend a procedure for decontaminating polychlorinated biphenyl (PCB) contaminated silos.
2. To discover dietary and/or pharmacological agents abetting the removal of PCB from the endogenous lipid pools of dairy cows.

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3. To determine if steroid hormone levels are altered in animals that are highly contaminated with PCB. Also to determine any pathological or toxicological changes and PCB levels in the body tissues of PCB-contaminated animals that die or are killed.
4. To develop a feasible approach for selectively skimming milk from highly contaminated cows to reduce PCB contamination of the total milk supply below the actionable level.

PROCEDURES:

Three approaches will be used in the procedures for decontaminating dairy systems of PCB. 1) The study of the silo structure itself will be carried out in order to determine materials that may be used for covering PCB contamination permanently, or the development of methods for removal of PCB. 2) A metabolic study will be done with dairy cows in order to study the procedures that may be used in decontaminating the fat pools of dairy animals at a more rapid rate. The main effects will be instituted through dietary regimes. 3) An effort will be made to institute a system of management procedures for skimming milk centrifically in order to remove the fat portion of the milk and the PCB contaminants from the total herd milk supply.

Decontamination of silos. Two lines of investigation will be used in the study of silo decontamination. The east silo at the Forage Research Farm, which is known to contain a substantial

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quantity of PCB in its protective coating near the base, will be used as the major structure for these studies. The silo will be sectioned into test blocks which will be mechanically coated with solvent- and water-based materials that are considered impervious to the Aroclor in the silo walls. Four months after the silo is filled the effectiveness of the cover coatings will be determined by analyzing the silage for Aroclor.

In other studies concrete silo blocks will be painted with an Aroclor-containing coating. Then the blocks will be recoated with the materials designed to prevent Aroclor migration. These blocks will be placed in 55 gallon drums of silage for four months, then the silage will be analyzed for Aroclor contamination.

Decontamination of cows. A series of experiments will be conducted to determine the biological half-life of PCB in cows fed various dietary regimes. Initially, the study will involve a comparison of the rate of PCB excretion in the milk, urine and feces of cows fed high-fat and high-grain diets versus those fed normal diets. It is known that the turnover of fat in cows occurs at a more rapid rate when high-fat is fed compared with the turnover of fat in animals receiving normal amounts of roughages. Conversely, high-grain diets reduce the turnover rate of adipose tissue.

A second approach will be to secure, if available, radioactively labeled PCB for studies of the rate of removal of PCB from the cow using more drastic treatments in the dietary regime and with systemically administered substances. This may be done by utilizing very high calcium diets with and without

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detergents in an effort to disrupt body lipid and Aroclor pools and increase the lipid and Aroclor excretion in the feces.

In all of these experiments changes in the blood lipid pattern and excretion of PCB in the milk, urine and feces will be determined.

Physiological evaluations. Blood samples will be collected from animals that have been contaminated with PCB and analyzed for steroid hormones by the competitive-protein-binding radioassay. These steroid values will be compared to those from control (non-PCB) animals of similar physiological state (i.e. pregnancy, estrous, maturity, etc.).

PCB-contaminated animals that die or are killed will be necropsyed. Studies will be conducted to investigate the accumulation of PCB's and their metabolites in organs and tissues, with histological examinations to detect abnormalities. In vivo and in vitro studies will be conducted to determine the effects of PCB's on specific hormonal and enzyme systems which are known to be important for production and reproduction in dairy cattle.

Removal of fat from contaminated milk. In this study a contaminated herd would be assayed individually for levels of PCB in milk. Milk from those cows having a PCB level higher than the actionable level would be subjected to centrifical separation of the milk fat, and thus removing the contaminant from the milk supply. While this procedure will allow for shipping of the milk, the milk fat percent of the total milk shipment obviously would be drastically reduced. This would seemingly be a preferred effort to complete cessation of milk

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sales. To test the feasibility of certain equipment to make this management approach, certain cows in the herd at O.A.R.D.C. might easily be used for this purpose, particularly those that are already contaminated with radioactivity in their milk.

Chemical procedures. The chemical procedures for measuring of blood lipids, milk fat, and fecal fat have already been developed and are in use in the O.A.R.D.C. laboratories of the Department of Dairy Science. Assays for PCB will be carried using the procedures developed previously by Waldron for analysis of PCB residues in milk.

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PCB-ARCH0744211