, for example, six ribosome ty nucleotides/ er; different, ser systems[9,7], ever inferring e number of e synthesis.

sparagus under e surrounding were removal e in a nutrient on a sucrose solvent, which a ribonuclease ium. Labelled d an estimated t to be nascent es which were s.

earch for poly- re. They dis- proline in the 0g for 108 min. 4 to treatment easing concen- cycloheximide. The collagen. In- d protein were cycloheximide r cent, and it leached to each nature of these ve shown that denatured col- en chains from aggregation of the number of nes cannot be fore the mole- formed cannot

wo gradients. gradients, up obtain hypro- 2 h at 40,000g. e five-sixths of r properties to Manner *et al.*— clease and col- of Martin and late the s value ry viscous and g/cm³ (ref. 12). e to tempera- trol accurately It is therefore material. Also, bottom of the e size distribu- he experiments ecomes, them- ay.

roblasts in the to synthesize ^{14}C-proline in a tion in a buffer her magnesium ey were able to e on 15–60 per the high con- te the range of ut, considering ate of s value lied polysomal

band on 15–60 per cent gradients can be compared with the narrow band of polysomes with β-galactosidase activity on 15–30 per cent gradients from *E. coli* homogenates[14]. The broad hypro-labelled polysome profile from fibroblasts seems inconsistent with a polysome with a specific number of ribosomes, and a definite length of mRNA, making a specific protein. It seems more likely again that it indicates aggregation between polysomes.

The conclusion must be that it is impossible to infer the size of the protein molecule being made from the evidence at present available about polyribosomal aggregates involved in collagen biosynthesis.

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[1] Proteins on Collagen, 1 (edit. by Ramachandran, G. N.) (Academic Press, London and New York, 1967).
[2] Watson, J. D., *Molecular Biology of the Gene*, 892 (Benjamin, New York, 1965).
[3] Martin, R. G., and Ames, B. N., *J. Biol. Chem.*, **236**, 1372 (1961).
[4] Sherbrits, T., Wettstein, F. O., Ours, E., and Noll, H., *Nature*, **202**, 894 (1964).
[5] Warner, J. R., Rich, A., and Hall, C. E., *Science*, **138**, 1399 (1962).
[6] Latham, H., and Darnell, J. E., *J. Mol. Biol.*, **14**, 1 (1965).
[7] Zimmermann, R. A., and Levintal, C., *J. Mol. Biol.*, **26**, 349 (1967).
[8] Nall, B. A., and Spearman, P. T., *Life Sciences*, **3**, 81 (1964).
[9] Maaser, H., Mayberger, E. H., Gould, N. B., and Rich, A., *Biochim. Biophys. Acta*, **134**, 411 (1967).
[10] Bois, G., and Engel, J., *Biochemistry*, **5**, 2746 (1966).
[11] Fernández-Madrid, F., *J. Cell. Biol.*, **30**, 27 (1967).
[12] de Duve, C., Berthet, J., and Beaufay, H., *Progress in Biophys. and Biophys. Chem.*, **9**, 325 (1959).
[13] Goldberg, B., and Green, H., *J. Mol. Biol.*, **28**, 1 (1967).
[14] Eiko, Y., and Rich, A., *Proc. US Nat. Acad. Sci.*, **54**, 1751 (1965).

Organochlorine Pesticides in Rainwater in the British Isles

Previous studies of the presence of the persistent organochlorine pesticides in the atmospheric environment of this country[1–3] have all indicated the need for more comprehensive surveys. The first of these studies by Wheatley and Hardman[1] was confined to rainwater collected in the rural area of Wellesbourne, in Warwickshire. Subsequent studies by the Laboratory of the Government Chemist were concerned with the examination of rainwater[2] and air[3] collected chiefly in the central London area. These three studies showed that, in the areas concerned, the atmospheric environment contained small amounts of BHC, dieldrin and DDT; rainwater collected in these areas contained concentrations of up to 400 parts/10^{12} of these compounds and their breakdown products. The higher levels for DDT found in London rainwater, compared with that from Wellesbourne, were attributed to London air having a higher content of particulate matter, chiefly carbon particles, for which DDT has an affinity. Dieldrin probably also shows this affinity but to a lesser extent.

The work reported here details the results of a more comprehensive study. Rainwater was collected continuously during 12 months at seven widely distributed sites in the British Isles (Fig. 1). These sites were chosen so as to present a variety of conditions and locations and were as follows: Camborne: a rural area outside the town of Camborne, about 40 km from Land's End in Cornwall; Eskdalemuir: a remote mountain area in southern Scotland about 80 km south of Edinburgh; Lerwick: a small town in the Shetland Islands north of Scotland; London: rainwater was collected on the roof of a building approximately 53 m high in central London; Maidstone: a large town in Kent in south-east England; Sheffield: rainwater was collected in the centre of Sheffield, a large industrial town in the Midlands; Wellesbourne: a small rural town in Warwickshire in the Midlands.

Camborne, Maidstone and Wellesbourne are in agricultural country; there is also a large fruit growing industry in the Maidstone area. Eskdalemuir and Lerwick are both remote, sparsely populated areas with some sheep farming as a local activity.

At these sites, rainwater was usually collected in all-glass apparatus with amber coloured receiving vessels to reduce photochemical degradation of the pesticides. In January, February and March, however, the glass receiving bottles were replaced by opaque hard polythene bottles to prevent loss of sample by fracture of the vessels caused by freezing of the contents.

The total precipitation collected in each 3 month period of a year at the seven sampling stations was analysed. The samples were extracted with hexane in the collecting vessels which were subsequently washed out with the same solvent to ensure that no pesticides were retained in the vessels. The combined hexane solutions were dried over anhydrous sodium sulphate and passed through a column of prepared alumina (alumina heated at 400° C for 5 h, cooled and partially de-activated by the addition of 10 per cent of water). The eluates were then subjected to thin-layer chromatography on silica gel plates using hexane as developing solvent[3]. Areas of the developed chromatoplate corresponding to areas of concurrently developed standard pesticide solutions, were removed from the plates and eluted. These final eluates were then examined by gas-liquid chromatography using columns of silicone *GE SE 52* and 'Apiezon *L*' (rel. 4) and electron-capture detection. The identity of the more important of the compounds detected was confirmed by chemical and gas chromatographic techniques. The fractions containing pp'-DDT and pp'-TDE were hydrolysed to pp'-DDE and 1-chloro-2,2-di-(4-chlorophenyl)ethylene, respectively, and these products were estimated gas chromatographically. Dieldrin was converted to its brominated derivative and these identified on the gas chromatograph[3]. Because of the low concentrations of

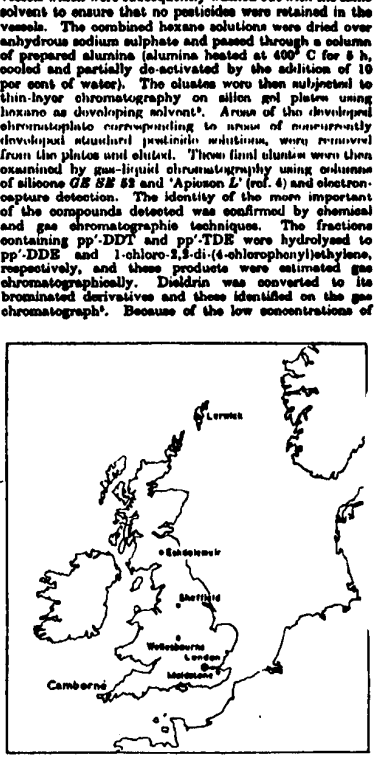


Fig. 1. Distribution of rainwater collecting sites in the British Isles.

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these pesticide compounds in rainwater, extreme care had to be taken to avoid adventitious contamination at all stages of the analysis. Blank determinations were carried out but yielded no detectable residues. At two of the stations, London and Wellesbourne, duplicate collections were made for the first 6 months, at sites about 2 m apart. These duplicate samples were examined separately but yielded results which differed only within the range of the experimental error of the determinations. The limits of detection were about 2 parts/10^{12} for pp'-DDT and its breakdown products pp'-DDE and pp'-TDE but about 1 part/10^{12} for the other pesticide residues.

The results, expressed in parts/10^{12} of the rainwater collected, are set out in Table 1. They show the pesticide residues collected in each quarter and the mean value for the whole year for the individual sites. In addition, small amounts of beta-BHC and heptachlor epoxide were sometimes detected but these in no case exceeded 18 parts/10^{12}. No other organochlorine pesticides were detected but aldrin, chlordane, endosulfan, endrin and heptachlor would have been detected if present above their levels of detection, which are similar to those of the other pesticides. Small amounts of polychlorobiphenyl compounds were present in all samples but were not estimated.

At all the sampling sites, considerable variation was often shown in the pesticide concentrations for the different periods. This might be attributable, in part at least, to the seasonal variations in total rainfall in these areas. Nevertheless, the overall picture clearly indicates that at all the sites, throughout the year, rainwater contained alpha-BHC, gamma-BHC, dieldrin, pp'-DDT and its two primary toxic metabolites pp'-DDE and pp'-TDE; the concentrations of the individual compounds were of the order of parts/10^{12} or parts/10^{10}.

Comparison with the earlier reports[1,2] indicates that the general concentrations at Wellesbourne and in London are now lower than they were. The fall in the dieldrin content may in part be a consequence of the abandonment of the large scale uses of aldrin and dieldrin that were previously approved in Britain. The effect of the substantial reduction in the amount of these two insecticides used in this country has already been noted in other contexts. For example, a reduction has taken place in the dieldrin content of human fat in the United Kingdom[3]; lower residues of dieldrin have also been found in home-produced foodstuffs[4].

Another factor which may have influenced the concentration of DDT compounds in London's atmosphere is the progressive reduction in the atmospheric pollution of the metropolis that has been taking place in recent years. The Warren Spring Laboratory[5] has shown the smoke content of London air to be declining at a steady rate under the influence of the Clean Air Act. Because DDT in the London atmosphere has been shown to be associated with the particulate content[5], a reduction of this form of pollution could lead to a corresponding reduction in DDT content.

Several studies, however, have indicated that the organochlorine pesticides are often transported long distances by winds and ocean currents. For example, although it was noted more than a century ago that dust seemed to be transported hundreds of miles out to sea from Africa[6], it has now been shown that dust and pesticides in trade winds reaching the Barbados had their origin in the African-European continent some 5,000 km away[7,11]. The blubber of penguins in the Antarctic has been found to contain a range of these pesticides derived from their principal food, the krill in the surrounding waters[12]. It is possible, as we have suggested, that usage and conditions in individual countries have some influence on the concentrations of these compounds in local atmospheric environments. It would, for example, be interesting to know whether endrin can be detected in the rainfall of those countries which use this compound extensively. These local variations, however, could not be expected to make large differences on a world-wide scale because of the ability of winds and ocean currents to distribute these compounds, eventually, over wide areas.

It seems logical to assume that these organochlorine pesticides now have a world-wide distribution. Certainly the present study gives credence to this view by demonstrating that they are present throughout the year in the atmospheric environment over the whole of the United Kingdom.

Table 1. ORGANOCHLORINE PESTICIDE RESIDUES IN RAINWATER COLLECTED BETWEEN AUGUST 1966 AND JULY 1967 (Parts/10^{12})

Collecting site	Period of collection	Alpha-BHC	Gamma-BHC	Dieldrin	pp'-DDE	pp'-TDE	pp'-DDT
Camborne (Cornwall)	Aug.–Oct.	18	20	4	29	15	29
	Nov.–Jan.	—	25	18	50	60	130
	Feb.–Apr.	—	40	2	60	12	28
	May–July	5	85	—	40	55	38
	(Mean 5)		(43)	(6)	(50)	(34)	(100)
Kaddaimair	Aug.–Oct.	10	17	9	18	12	15
	Nov.–Jan.	—	10	1	10	8	15
	Feb.–Apr.	14	12	4	10	4	20
	May–July	80	85	—	40	12	70
	(Mean 149)		(32)	(4)	<20	(24)	<70
Lerwick, Shetland Islands)	Aug.–Oct.	14	23	3	10	10	10
	Nov.–Jan.	30	230	40	35	10	70
	Feb.–Apr.	12	180	—	15	—	25
	May–July	40	100	—	20	—	20
	(Mean 24)		(121)	(11)	(20)	(7)	(16)
London, W11	Aug.–Oct.	18, 21	28, 32	3, 4	32, 36	4, 5	50, 60
	Nov.–Jan.	23, 23	30, 30	10, 6	17, 10	6, 4	51, 46
	Feb.–Apr.	10	15	15	10	—	17
	May–July	60	100	35	25	20	120
	(Mean 29)		(50)	(16)	(25)	(7)	(61)
Maidstone (Kent)	Aug.–Oct.	18	10	1	8	7	20
	Nov.–Jan.	17	50	—	11	16	20
	Feb.–Apr.	13	65	6	4	5	100
	May–July	90	140	—	30	50	35
	(Mean 38)		(66)	(3)	(11)	(20)	(66)
Sheffield (Yorkshire)	Aug.–Oct.	30	40	12	15	11	60
	Nov.–Jan.	14	20	7	45	10	30
	Feb.–Apr.	10	40	6	5	—	27
	May–July	80	110	—	25	30	40
	(Mean 34)		(56)	(6)	(23)	(12)	(40)
Wellesbourne (Warwickshire)	Aug.–Oct.	16, 16	12, 18	4, 4	9, 8	8, 8	9, 40*
	Nov.–Jan.	18, 12	40, 40	1, 3	6, 5	5, 5	14, 10
	Feb.–Apr.	8	45	12	9	6	10
	May–July	50	70	13	10	6	35
	(Mean 22)		(44)	(6)	(7)	(6)	(18)
	Limit of detection	1	1	1	8	8	8

* Sample contained two insects.

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1 Whatley, G. A., and Hardman, J. A., *Nature*, **207**, 466 (1965).
2 Abbott, D. C., Harrison, R. B., Tatton, J. O'G., and Thomson, J., *Nature*, **206**, 1317 (1965).
3 Abbott, D. C., Harrison, R. B., Tatton, J. O'G., and Thomson, J., *Nature*, **211**, 590 (1966).
4 Neumann, J. R., and Tatton, J. O'G., *J. Chromatog.*, **27**, 384 (1967).
5 Hammer, J. R., Hall, P. G., and Caverly, D. J., *Analyst*, **90**, 649 (1965).
6 Abbott, D. C., Goulding, R., and Tatton, J. O'G., *Brit. Med. J.*, **2**, 146 (1966).
7 *Ann. Rep. Government Chemist* (HMSO, London, 1965–1967).
8 *Investigation of Atmospheric Pollution 1955–1965*, Thirty-second Rep., Warren Spring Laboratory (HMSO, London, 1967).
9 Davis, C., *Quart. J. Geol. Soc.*, **2**, 99 (1846).
10 Blackburn, R. W., Nugent, R. J., Griffin, J. J., and Goldberg, E. D., *Science*, **156**, 1234 (1967).
11 Delany, A. C., Delany, A. C., Parkin, D. W., Griffin, J. J., Goldberg, E. D., and Reimann, B. E. F., *Tellus*, **15**, 65 (1967).
12 Tatton, J. O'G., and Ruzicka, J. H. A., *Nature*, **215**, 346 (1967).

Sugar Cane Products as Energy Sources for Pigs

THE advantages of exploiting sugar cane as a source of feed for livestock in tropical countries have been outlined by Preston and Hagelberg[1]. Encouraging results have already been reported[2–4] for up to 30 per cent of molasses in cattle diets and up to 50 per cent of sugar for broilers. Here we present data on the use of sugar cane products in pig feeding.

The subject is not new, for in 1933 Henke[5] reported that fattening pigs could efficiently use diets in which molasses replaced 30 per cent of the cereal. Subsequent work showed little advance, however, because it was invariably found that more than 30 per cent of molasses led to poor gains and feed conversion, and to diarrhoea[6–8]. Our first experiments with normal cane molasses were also disappointing, but subsequent developments have been more encouraging. In particular we found that when high-test molasses rather than normal cane molasses was used the cereal could be replaced completely without significant reduction in performance. There was no diarrhoea; in fact the dry matter of the faeces was 35–40 per cent, which is higher than is usually obtained with conventional cereal diets. High-test molasses is a heavy cane syrup from which none of the sugar has been extracted, but rather partially inverted to prevent crystallization. It thus differs from normal cane molasses in having a much lower ash content and approximately two-thirds of the total sugars in the form of monosaccharides (see Table 1).

It seemed to us that the disappointing results obtained with high levels of normal cane molasses were probably due more to the mineral content than to the inability of the pigs to use efficiently large quantities of sucrose, as was found in very young pigs by Dollar, Mitchell and Porter[9]. The following experiment was set up to test this hypothesis.

Table 1. COMPOSITION OF THE HIGH-TEST AND NORMAL MOLASSES USED IN THE EXPERIMENT

Item	High-test molasses	Normal cane molasses
Phosphorus (percentage)	0·05	0·08
Calcium (percentage)	0·52	0·71
Potassium (percentage)	0·66	2·60
Sodium (percentage)	0·16	0·08
Ash (percentage)	2·05	5·81
Nitrogen (percentage)	0·17	0·55
Moisture (percentage)	23·5	23·1
Monosaccharides (percentage)	45·0	17·0
Sucrose (percentage)	34·0	31·0
pH	5·4	5·4

Duroc and Large White pigs initially weighing approximately 20 kg were allocated to four treatments in random blocks according to sex and breed. Up to 50 kg live weight, the diets contained 21·6–25·7 per cent fish meal, 2·30–2·68 per cent saccharomyces yeast, 0·83–0·97 per cent minerals, and 0·45–0·52 per cent vitamin pre-mix and either (*A*) 74·7 per cent high-test molasses, (*B*) 57·2 per cent normal cane molasses and 17·5 per cent raw sugar, (*C*) 30 per cent normal cane molasses and 36·5 per cent sugar, or (*D*) 12·9 per cent normal cane molasses and 57·2 per cent sugar. (The mixture of minerals contained 50 per cent $Ca(H_2PO_4)_2$, 40 per cent NaCl, 3 per cent $ZnCO_3$, 2·7 per cent $FeSO_4 \cdot 5H_2O$, 2·3 per cent $MnSO_4H_2O$, 1·0 per cent $CuSO_4 \cdot 5H_2O$, 0·01 per cent $CoSO_4 \cdot 7H_2O$, 0·01 per cent KI and 1·28 per cent maize meal. The vitamin pre-mix contained 1·2 million IU of vitamin A and 300,000 IU of vitamin D/kg.) The protein content was 18 per cent in the dry matter (DM). Above 50 kg live weight, the protein content was reduced to 15 per cent of DM by omitting some of the fish meal. The rations were prepared daily by mixing the prescribed amounts of supplements, molasses and sugar and diluting with water to approximately 40 per cent dry matter. Feeding was restricted in the first 3 weeks. The pigs were slaughtered at approximately 90 kg live weight.

Live weight gain, feed conversion and composition of the carcass for the first five replicates completing the trial (twenty pigs) are given in Table 2.

Table 2. MEAN VALUES FOR WEIGHT GAIN, FEED CONVERSION AND CARCASS COMPOSITION OF FATTENING PIGS GIVEN HIGH-TEST MOLASSES OR NORMAL CANE MOLASSES WITH DIFFERENT LEVELS OF SUGAR

Item	High-test molasses *A*	Normal cane molasses plus: High sugar *B*	Medium sugar *C*	Low sugar *D*	S.E. of differences
Initial weight in kg	21·8	20·8	22·1	20·6	
Final weight in kg	88·6	89·8	90·6	89·8	
Daily gain in kg	0·56	0·56	0·64	0·62	±0·05
Feed conversion, kg feed of 90 per cent D.M./kg gain	3·68	4·00	4·25	4·05	±0·26
Composition of carcass* (percentage)					
Muscle plus intermuscular fat	56·2	56·4	54·8	56·2	±1·07
Subcutaneous fat and skin	26·9	26·8	29·1	29·4	±1·61
Bone	16·5	16·4	16·2	14·3	±0·77
Average of five backfat measurements in cm	2·20	2·60	2·92	2·87	±0·16

* Analysis of half carcass less hair, head and feet. Comparable carcass data for pigs fed cereal concentrates were 58·7 per cent, 24·6 per cent, 11 per cent and 5·15 per cent, respectively.

All the pigs remained in excellent health and there was no serious diarrhoea on any of the treatments, although the faeces were slightly wetter on the normal molasses diet with the least amount of sugar, particularly in the early stages. There were no significant differences between treatments for any of the measures analysed, although feed conversion appeared to be slightly better on high-test molasses. The carcasses on this treatment tended to be fatter, which is surprising because feed efficiency and carcass fatness are usually negatively related. The implication is that digestive efficiency is high on the high-test molasses diet and this is, in fact, borne out by results of a concurrent metabolism trial in which the average digestibility of dry matter for eight pigs on the high-test molasses diet was 93·5 ± 1·4. This observation strongly supports the hypothesis that the disadvantage for pigs of normal cane molasses lies in its high mineral content. Diluting cane molasses with highly digestible non-mineral-containing ingredients, such as sugar, effectively overcomes this limitation and allows both a greater usage of molasses and also a more efficient feed utilization than does the

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