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Insecticide Content of Diet and Body Fat of Alaskan Natives

Abstract. A study was made of the DDT and DDE content of the diet and body fat of native Alaskans who lived in isolated, primitive areas and had minimal contact with insecticides. No DDT or DDE was detected in any of the native Alaskan foods analyzed with the exception of two white owls, both of which contained low levels of DDE. Eskimos store considerably less DDT and DDE in their body fat than the general population in the United States. These low dietary levels and the resultant low levels in body fat are consistent with previously published data on the relationship between intake and storage of DDT.

Analysis of representative restaurant (*1*) and institutional (*2*) meals has indicated that the average person in the United States consumes 184 to 202 μg of DDT and even smaller amounts of DDE in his daily food. Most of the material is found in animal fats, and only small amounts in vegetables and other constituents of meals. The total dietary intake accounts for most if not all of the DDT and its metabolite DDE stored in people without occupational exposure to the insecticide.

Hayes and his co-workers (*3*) reported that analysis of fat from persons who died before 1942, and, therefore, before the use of DDT, revealed no trace of DDT-like material. By contrast, samples of body fat collected from the general population during 1954–56 contained DDT in an average concentration of 4.9 parts per million (ppm). The same authors found that meatless meals served in a cafeteria catering to meat abstainers contained only about one-fourth as much DDT as meals served in ordinary restaurants. Persons abstaining from meat deposited in their fat only about half as much DDT as people with an ordinary diet. Thus, for that study, the storage of the insecticide was not only proportional to dietary dosage but also proportional to the intake of meat. Although dosage was probably the important variable, the data offered no way of evaluating any contribution that animal fat may make to the absorption and eventual storage of DDT present in the food.

It is, of course, clear that occupational exposure to DDT may lead to storage far greater than that ever reported as the result of ordinary dietary intake. An average concentration of 17.1 ppm was found in the fat of agricultural workers who applied DDT (*3*). A concentration as high as 648 ppm was found in the fat of an asymptomatic worker in a formulating plant (*2*).

Further search has been made for groups of people with minimal occupational, environmental, and dietary contact with DDT. Native Alaskans who live in an isolated, primitive area where there is little or no use of insecticides and who eat food of local origin appeared to be a group that might have minimal DDT exposure and at the same time maximal intake of animal fat. The present paper describes a study of DDT and DDE content of the diet and body fat from these Alaskan natives.

The food samples were collected in the villages of Shungnak, Kotzebue, Gambell, Hooper Bay, and Point Hope. A total of 42 samples of food, representing 31 different items of the Eskimo diet, were analyzed. The foods studied included various fresh and dried fish; fat, oil, or meat from beaver, beluga, caribou, eider duck, moose, oogruk, polar bear, seal, walrus, whale, and white owl; and miscellaneous foods including cranberries, salmonberries, and wild rhubarb. These foods make up the major portion of the diet of the village Eskimos. There are also a limited number of imported food items, including cereals, sugar, bacon, lard, and hydrogenated fat, in the diet of these people.

All analyses for DDT and DDE in both food and body fat were carried out by the modifications of the Schechter-Haller spectrophotometric procedure cited by Hayes *et al.* (*3*).

No DDT or DDE was detected in any of the native foods analyzed, with the exception of two white owls from Point Hope, which contained 1.1 ppm DDE in the meat. The source of exposure of these birds to DDT is unknown. It may be accounted for by their migratory habits. It is also possible that some naturally occurring constituent of food stored by these birds may interfere in this analysis.

Samples of human body fat were obtained through the cooperation of the U.S. Public Health Service Hospital in Anchorage. Single samples from 20 patients were analyzed. The subjects chosen were residents of isolated villages. Fat samples were taken from patients who underwent surgery after a minimal period of hospitalization. Sample meals from this hospital for one day were analyzed and found to contain 184 μg of DDT and 26 μg of DDE. A dish of meatballs and spaghetti contained 111 μg of DDT and represented 60 percent of the daily total residue of this insecticide in the diet. These daily totals for DDT and DDE are similar to those found in representative restaurant and institutional meals in the 48 contiguous states (*1*, *2*).

The DDT and DDE content of the body fat of these native Alaskans is shown in Table 1, along with comparative values obtained for the general population and for meat abstainers by

Table 1. Storage of DDT and DDE in the fat of Alaskan natives (as found in this study) in comparison with the general population of the United States and with abstainers from meat (as found by Hayes *et al.*, *3*).

Value	DDT (ppm)		DDE (ppm)	
	Tissue	Extract*	Tissue	Extract*
	Alaskan natives (20 cases)			
Range	0 to 1.9	0.3 to 2.2	0 to 3.9	2.5 to 5.8
Mean ± S.E.	0.8 ± 0.10	1.4 ± 0.16†	2.0 ± 0.41	3.8 ± 0.31†
	General population (61 cases)			
Range	2 to 12	3 to 22	2 to 13	3 to 25
Mean ± S.E.	4.9 ± 0.35	6.8 ± 0.42	6.1 ± 0.42	8.6 ± 0.52
	Abstainers from meat (16 cases)			
Range	0 to 7	0 to 10	0 to 9	0 to 12
Mean ± S.E.	2.3 ± 0.44	3.5 ± 0.63	3.2 ± 0.63	4.9 ± 0.84

* Carbon tetrachloride extract. † Based on 11 samples only.

Hayes *et al.* (*3*). It is apparent that these Eskimos stored considerably less DDT and DDE than persons in the general population of the United States and somewhat less than meat abstainers. The DDE constituted from 10 to 90 percent and averaged about 73 percent of the total DDT-derived material for the Eskimo. For the general population this percentage was 56 and for meat abstainers, 59. These figures support a view that individuals with a lower degree of exposure to DDT are able to convert DDT to DDE more efficiently. The low storage level is consistent with the low level of the insecticide and its metabolite found in the Eskimo diet in spite of the very high meat content of that diet. The small amount of DDT and DDE that was found in the fat of the native Alaskans is probably accounted for by their limited consumption of imported foods and by their brief intake of hospital food prior to surgery.

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Drug Resistance due to Inbreeding

Abstract. Inbred mice susceptible to audiogenic seizures were found to develop resistance to the protective effects of chlorpromazine and its analogs. It is proposed that the use of such inbred mice provides a unique new tool for studying drug mechanism and drug resistance.

In several earlier reports I have shown that various phenothiazine ataractics exert protection against sound-induced convulsions in mice [audiogenic seizures (*1–3*)]. There are, however, conflicting reports about the degree of protection exerted by these agents (*4*). More recently it was reported that chlorpromazine was totally inactive against convulsions in an inbred strain of Swiss mice (*3*). The present report is an extension of that preliminary report.

The test chamber and sound source were described in an earlier paper (*1*). Essentially, the procedure consists of placing groups of five mice in the test chamber and exposing them to auditory stimulation for 1 minute. The criterion used to measure protection in this study was the occurrence or nonoccurrence of convulsions (clonic and tonic).

The diametrically opposed data obtained with chlorpromazine in noninbred and in inbred albino Swiss mice raise the interesting possibility that development of drug resistance may be incidental to inbreeding (*3*). To investigate this point, careful separation of the various generations of inbred Swiss mice was made, and a systematic bioassay of the effects of chlorpromazine and other agents on each individual generation of inbred Swiss mice was conducted.

The first agent studied under these conditions was chlorpromazine, which had been shown earlier to be a potent antagonist of seizures in noninbred Swiss mice. A constant dose known to be effective in noninbred mice was tested in each separate generation. A summary of the findings is shown in Table 1. The degree of protection exerted by chlorpromazine diminishes from the parental generation to each succeeding generation.

About 91 percent of the P_1 group was protected against convulsions by 10 mg of chlorpromazine. In the F_1 generation, a sharp reduction in protection against convulsions was seen. Only 33.3 percent of the animals were protected. Succeeding generations (F_2, F_3, F_4, and F_5) had protection rates of only 16.3, 7.1, 3.3, and 8.3 percent, respectively. Studies with higher doses (up to 80 mg/kg) did not show any discernible protection.

Control studies of generations F_1, F_2, F_3, F_4, and F_5 showed that these generations exhibited convulsions at a frequency of 90 percent.

Prior to auditory stimulation, all mice used in this research typically exhibited all of the symptoms of chlorpromazine medication: ptosis, heavy sedation, and ataxia. However, auditory stimulation of the "nonprotected" generations resulted in immediate arousal followed by wild running that culminated in convulsions. No mice receiving medication were used for inbreeding purposes.

Table 1. Protective effect of chlorpromazine on various generations of inbred Swiss mice.

Generation	Number convulsed / number tested	Protection (%)
P_1	3/34	91.1
F_1	10/15	33.3
F_2	41/49	16.3
F_3	26/28	7.1
F_4	29/30	3.3
F_5	11/12	8.3
F_{12}	10/10	0.0
F_{13}	10/10	0.0

The response of the mice of generations F_1 to F_5 to the auditory stimulus appeared to be a potentiation of a "fright" response, manifested by frenzied running. On the other hand, the proportion of homozygosity to heterozygosity may influence the "strength" of phenotypic expression and drug effect. In addition, the genes may be linked. These are questions to be settled through future research.

Preliminary studies of chlorpromazine analogs (promazine, perphenazine, prochlorperazine, and trifluoperazine) suggest a similar trend. All of these agents have been reported to be effective antagonists of audiogenic seizures in noninbred Swiss mice. However, as shown in Table 2, inbred mice (generations F_2 to F_5) are not significantly protected by these same agents. Thus, a maximal protection against convulsions of only 20 to 30 percent was obtained with promazine, perphenazine, prochlorperazine, and trifluoperazine in the inbred generations. In contrast to the phenothiazine ataractics, the barbiturate sodium phenobarbital uniformly gave complete protection against convulsions in all inbred generations tested.

Table 2. Protective effect of phenothiazine ataractics and phenobarbital on various generations of inbred Swiss mice.

Number convulsed /number tested			
F_2	F_3	F_4	F_5
	Promazine		
5/5	7/10		
	Perphenazine		
5/5	5/5	5/5	
	Compazine		
	8/10	8/10	
	Stelazine		
4/5	4/5	4/5	5/5
	Phenobarbital		
0/10	0/10	0/10	0/10