THE EFFECTS OF PROCESSING AND STORAGE OF DAIRY PRODUCTS ON CHLORINATED INSECTICIDE RESIDUES

II. ENDRIN, DIELDRIN, AND HEPTACHLOR[1, 2]

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Summary

The effects of processing and storage of butter, ice cream, Swiss-type cheese, condensed milk, and dry whole milk powder manufactured from milk containing dieldrin, endrin, heptachlor, and dieldrin and heptachlor in combination were studied. There was loss of heptachlor epoxide and dieldrin during condensing and loss of all insecticides studied during spray and drum drying. Butter and cheese in most cases contained less insecticide than the raw milk on a fat basis, because some insecticide separated into the skimmilk and whey. The rest of the finished products contained essentially the same amount of residue as the raw milk when expressed on a fat basis.

In a previous paper *(1)*, the authors reported on the effects that processing and storage had on DDT and lindane and how these residues were partitioned during the manufacture of butter, ice cream, Swiss-type cheese, condensed and dry whole milk powder.

As a continuation of this study, the effects of processing and storage of dairy products manufactured from milk containing endrin, dieldrin, heptachlor and dieldrin and heptachlor in combination were also studied.

The results obtained during this study are presented in this paper.

Method

Milk with the desired concentration of insecticide residue for the manufacture of dairy products was obtained as follows:

1. Insecticides were added directly to milk. The desired insecticide was dissolved in 75 ml ethanol and then added to 10 gal of milk. The milk was heated to 90 F and agitated for 15 min. Both 0.1 and 1.0 ppm concentration of insecticides were added to milk in this way.

2. Insecticides were incorporated into milk by feeding to Holstein cows. Capsules containing the desired insecticide were fed to the cows daily. Two different Holstein cows were used for each insecticide.

a. Heptachlor – technical grade (72%) was fed at the rate of 1,000 mg per animal per day.

Table 1. Distribution of Endrin and Dieldrin During the Manufacture and Storage of Butter

	% Milk fat		ppm (wt. basis) Dieldrin		ppm (fat basis) Dieldrin	
	(1)	(2)	(1)	Endrin (2)	(1)	Endrin (2)
Raw milk	3.5	3.7	0.92	0.17	26.14	4.68
Pasteurized milk	3.5	3.7	0.94	0.18	26.80	4.81
Cream	31.5	46.5	8.21	1.69	26.03	3.63
Butter	83.1	84.8	10.20	4.50	12.24	5.26
Buttermilk	1.4	8.0	0.50	0.30	35.72	3.70
Butter after storage	83.0	84.8	10.72	–	12.86	–

1 = Milk which had dieldrin added.

2 = Milk from cows fed endrin.

b. Dieldrin–technical grade (95%) was fed at the rate of 500 mg per animal per day.

c. Endrin–technical grade was fed to two animals at the rate of 475 mg per day for the whole experiment while two other Holsteins were fed 1,000 mg per animal per day for six days and 750 mg per animal per day for the rest of the experiment.

d. Dieldrin and heptachlor–the same amount of each insecticide was fed when used in combination as fed alone.

The milk was processed when the residue reached concentrations of 0.6 to 0.8 ppm.

The methods and procedures described in the first paper in this series *(1)* were used for the manufacture and storage of the dairy products.

All samples were analyzed by the method of Langlois, et al., *(2)*.

Results and Discussion

A portion of the heptachlor was converted to heptachlor epoxide by the cow. Approximately 50% of the heptachlor present in the milk was epoxide. This change in structure was greater than found for DDT *(1)* where DDE accounted for approximately 25% of the residue. No significant conversion was observed for the other insecticides which were fed.

Typical results for the various dairy products manufactured and analyzed are presented in Tables 1, 2, 3, and 4. All results are expressed on a fat basis for easier comparison.

The amount of insecticide present in the buttermilk was greater than that which would be found

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TABLE 2. DISTRIBUTION OF DIELDRIN AND HEPTACHLOR DURING THE MANUFACTURE OF CONDENSED MILK AND WHOLE MILK POWDER

	Percent milk fat[a]	ppm (wt. basis)			ppm (fat basis)		
		Heptachlor	Heptachlor epoxide	Dieldrin	Heptachlor	Heptachlor epoxide	Dieldrin
Raw milk	4.60	0.17	0.97	0.89	3.72	21.15	19.26
Condensed milk	9.40	0.37	1.03	1.07	3.96	10.96	11.38
Sterilized milk	9.40	0.36	1.18	1.05	3.79	12.56	11.19
Spray dried	27.46	0.05	2.11	2.33	0.18	7.39	8.48
Drum dried	25.09	0.01	2.03	2.28	0.21	8.09	9.10
Sterilized milk storage	9.40	0.28	1.23	1.09	2.96	13.09	11.60

[a]Milk from cows fed heptachlor and dieldrin.

TABLE 3. DISTRIBUTION OF ENDRIN AND HEPTACHLOR DURING MANUFACTURE OF A SWISS-TYPE CHEESE

	Percent milk fat		ppm (wt. basis)		ppm (fat basis)	
	Endrin	Heptachlor	Endrin	Heptachlor	Endrin	Heptachlor
	(1)	(2)	(1)	(2)	(1)	(2)
Milk	3.5	4.7	0.70	0.84	19.91	17.82
Milk after setting	3.5	4.7	0.68	0.74	18.17	15.67
Whey after cutting	—	—	—	0.17	—	—
Whey after dilution	—	—	0.06	0.07	—	—
Whey after cooking	—	—	0.06	0.12	—	—
Curd	31.0	34.0	5.48	3.77	17.53	11.78
Cheese	31.0	34.0	5.89	3.74	19.02	11.69
Cheese after curing	—	34.0	—	3.36	—	10.50

1 = Milk which had endrin added.

2 = Milk which had heptachlor added.

TABLE 4. DISTRIBUTION OF ENDRIN AND DIELDRIN DURING THE MANUFACTURE OF ICE CREAM

	Percent milk fat		ppm (wt. basis)		ppm (fat basis)	
			Dieldrin	Endrin	Dieldrin	Endrin
	(1)	(2)	(1)	(2)	(1)	(2)
Raw mix	11.43	9.8	0.20	0.48	1.75	4.89
Pasteurized mix	11.43	9.8	0.13	0.34	1.12	3.42
Mix, 1 day old	11.43	9.8	0.14	0.38	1.23	3.87
Ice cream	11.49	9.8	0.14	0.40	1.23	4.03

1 = Milk which had dieldrin added.

2 = Milk from cows fed endrin.

under commercial buttermaking conditions. This was due mainly to the method used to remove the buttermilk from the churn and the inefficient churning action of the butter churn.

Heptachlor and heptachlor epoxide were the only insecticides detected in skimmilk after separation of wholemilk, whereas endrin and dieldrin were found only in the cream. If some insecticides were in the skimmilk, the amounts were too small to be detected. Since heptachlor and heptachlor epoxide were present in both the cream and skimmilk, this would suggest that heptachlor and heptachlor epoxide are

not associated with the fat as strongly as the other chlorinated insecticides studied.

There was loss of both heptachlor epoxide and dieldrin during condensing. This loss represented about one-half of the insecticide present in the raw milk when expressed on a fat basis. Heptachlor and endrin were not affected by condensing. There was some loss of heptachlor, heptachlor epoxide, dieldrin, and endrin during spray and drum drying. Heptachlor showed the largest loss during the drying operations.

Except for heptachlor, there were no detectable changes in the amount or structure of the other insecticides during the manufacture of ice cream. Some of our results seemed to indicate that some heptachlor was being converted to heptachlor epoxide when the mix was frozen into ice cream.

Detectable amounts of all insecticides were present in whey during the manufacturing of Swiss-type cheese. The amount of insecticide in the whey increased during cooking of the curd. More heptachlor was found in the whey than the other insecticides studied.

No significant changes were observed in the structure or amount of insecticide during storage of butter, cheese, ice cream, and sterilized milk.

In general, except for some loss of insecticide during condensing and drying, the results indicate that the insecticides studied are essentially stable under the conditions used during the study. The amount of insecticide in butter and cheese is less than that in the raw milk when expressed on a fat basis. This is due to loss of some of the insecticide in skimmilk and whey.

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INFANT FORMULA PLANT SANITATION[1]

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It is estimated that during 1963, over 600,000 infants will be fed formulas prepared by commercial formula services. Although this service was originally established in San Francisco 16 years ago, it is only within the past few years that it has become an important factor in the feeding of infants. There are now 13 such plants in operation in New York City, Miami, Florida, Philadelphia, Allentown and Lancaster, Pennsylvania, Baltimore, Maryland, Chicago and Peoria, Illinois, Kansas City, Missouri, Phoenix, Arizona, Los Angeles and San Francisco, California, and Seattle Washington. Two additional plants one in Cincinnati, Ohio, and one in Detroit, Michigan, are in process of completion. It is estimated that at least five more plants will be completed within the near future.

Their growth has been spurred by many hospital factors, including problems of contamination, limitation of variety, lack of consistency, and staff problems. In commercial formula preparation, the ever-present danger of outbreaks, due to contamination by pathogenic organisms or by careless use of toxic chemicals, can be completely eliminated. The many types of infant formulas available widen the scope of infant feeding. An accuracy and consistency in methods of preparation that cannot be equalled in hospital formula rooms is in itself a tremendous advantage. Hospitals no longer will be required to maintain and staff the qualified personnel so important to the growth of the newborn.

The inconsistencies and public health dangers involved in home preparation of infant formulas have been described in detail by an American Public Health Association Committee *(1)*.

To public health administrators, this can mean the assurance of safe formulas every day of the year *(2)*. In some cases, it reduces the necessity of policing 100 hospitals to control of one establishment under supervision of the public health authority. Although hospitals have had standard equipment available for the autoclaving of formula, the safety of this equipment varies with the personnel and other hospital activities. As an example, although autoclaves are

[1]Presented at 50th Annual Meeting of the International Association of Milk and Food Sanitarians, Inc., Toronto, Ontario, Canada, on October 24, 1963.