Pesticide Depletion in Dairy Cows Following Long Term Exposure[1,2]

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Since chlorinated hydrocarbon insecticides are fat soluble, they are closely associated with an animal's lipid metabolism. Once ingested, these residues tend to persist in the body lipid compartment for varying periods of time. Persistence depends upon a number of factors including: type of compound; length, level and method of exposure; nutritional and physiological status and idiosyncratic variation among animals (1-10). Various reports have been made regarding the contamination of milk caused by adding an insecticide to the feed or by administrating it directly to the cow by various means. Dosages have varied from below 1 to as high as 500 ppm of the daily feed intake. Depletion rate following removal of contamination sources appears to be quite variable (1,5-7,9,11,12). While dosing by direct addition methods has given much valuable information, the feed-through and depletion rates observed in some of these trials may be different than in the case of long term intake of pesticide from feed sources which have been contaminated under natural field conditions.

Experimental

This study concerns a group of Holstein cows moved simultaneously from an environment of moderately high pesticide contamination to one of very low intake under conditions prevailing at the University of Arizona dairy herd. The animals were all from the same herd and at the time of transfer, nine were lactating, while six were in advanced stages of gestation. They had been continuously exposed to feed sources characterized by prolonged, uniform levels of moderately high contamination (13,14). By comparison, routine, detailed analysis indicated a very low level of contamination (>0.01 ppm) in feed used by the University of Arizona herd. The feed was continuously monitored during these observations.

In the case of the lactating animals, milk samples were taken immediately after transfer and then at the end of 1,2,3, 5 and 8 months. Three of the cows were also sampled at 10

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months. Those animals which parturated after arrival were sampled on the same basis except that the 10 month sample was omitted. Milk was taken from morning and evening milkings, composited, refrigerated, and analysed within 2 or 3 days for pesticide. Analysis for DDT and its metabolites was by electron capture gas chromatography and is reported as total pesticide (1).

Results and Discussion

The concentration of total pesticide in the milk fat of the lactating animals ranged from 0.93 to 3.30 ppm with a mean value of 1.79 ppm in the initial sample (Table 1).

TABLE 1
Total pesticide in milk fat of cows in lactation after being placed on low residue feed

	Sampling interval (mos.)						
Cow No.	Initial	1	2	3	5	8	10
	ppm						
1	0.93	0.86	[a]	[a]	0.36[b]	0.11	-
2	1.66	1.11	0.46	0.35[b]	0.17	[a]	0.17[b]
3	1.30	1.05	[a]	0.68[b]	0.45[b]	[a]	[a]
4	0.93	0.90	[a]	[a]	0.39[b]	0.13	-
5	1.22	0.99	0.61	0.32[c]	0.33	0.07	-
6	1.88	1.64	0.87	0.49	0.27	[a]	0.19[b]
7	2.13	2.01	1.27	0.58	0.28	[a]	[a]
8	2.34	2.37	0.89	0.73	[a]	0.38[b]	-
9	2.50	2.55	1.39	0.94	0.53	[a]	0.28[b]
10	3.30	2.87	1.22	0.96	[d]	[d]	[d]
Mean	1.79	1.64	0.96	0.63	0.35	0.17	0.21

[a] Dry period
[b] Subsequent lactation
[c] Subsequent lactation following a dry period of less than 1 month
[d] Died

It is apparent that the pesticide level (>0.01 ppm) in the diet after transfer was low enough to cause fairly rapid depletion. At the end of 8 or 10 months on low residue feed the pesticide concentration in the milk fat averaged from 0.17 to 0.21 ppm. The rate of decline in these ten animals was comparatively uniform and the $t_{\frac{1}{2}}$ averaged about 2 months during the observation period. This $t_{\frac{1}{2}}$ compares with ones reported by various authors ranging from 23 to 53 days for DDT and its metabolites following single up to 60 day exposures (1,7,9,11) and 47 to 60 days for dieldrin $t_{\frac{1}{2}}$ after 60 days intake (12).

The decline in pesticide concentration in milk fat from cows which began lactation after transfer portrays a slower rate (Table 2).

TABLE 2

Total pesticide in milk fat of cows which began lactation after being placed on low residue feed

Cow No.	Sampling interval (mos.)					
	Initial	1	2	3	5	8
	ppm					
11	1.26	0.88	0.70	0.61	0.36	-
12	0.41	0.47	0.42	0.31	0.25	0.13
13	1.47	1.02	1.48	1.04	0.77	0.57
14	1.57	0.95	0.79	0.70	0.49	0.25
15	0.70	0.64	0.67	0.57	0.30	0.25
Mean	1.08	0.79	0.81	0.64	0.46	0.31

The $t_{\frac{1}{2}}$ in this case is about 4 months. This trend is not as uniform, however, as that in the case of animals lactating at transfer were on low residue feed for varying periods of time prior to calving. This longer $t_{\frac{1}{2}}$ might possibly be related to the dilution of body stores pursuant to gain in weight and in fetal development. The dilution effect is further evidenced by the fact that a lower pesticide level is seen in milk fat following dry periods (Table 1). The only exception was a slight increase in the average values between the eighth and tenth months in the first group. This is considered insignificant as fewer observations are involved in these values.

When the initial and final pesticide levels in milk fat of cows is related to time on low residue feed the indiosyncratic variation is noted (Table 3). Seven of the ten animals had initial milk fat pesticide levels ranging from 0.93 to 2.50 ppm while two cows (Nos. 12 and 15) had levels of 0.41 and 0.70 ppm, respectively, and one (No. 10) a concentration of 3.30 ppm.

While the total pesticide in the milk fat at the final observation tended to be related to both the initial concentration and the time on low residue feed individual variation in the final level is also noted. Aside from the animal that died due to unknown causes (No. 10), abnormal physiological conditions could not account for these variations. Similarly, uniform feeding and management practices were used prior to and after transfer. As a result differences in nutritional status could not explain the variations noted.

TABLE 3

The initial and final pesticide concentration in milk fat of cows as related to time on low residue feed

Cow No.	Total pesticide Initial	Final
	ppm	
	3 months on low residue feed	
10	3.30	0.96[a]
	5 to 5.5 months on low residue feed	
3	1.30	0.67
7	2.00	0.28
11	1.25	0.36
Mean	1.85	0.44
	8 to 8.5 months on low residue feed	
1	0.93	0.63
4	0.93	0.42
5	1.22	0.31
8	2.34	0.28
13	1.47	0.57
14	1.57	0.25
Mean	1.41	0.41
	10 to 10.5 months on low residue feed	
2	1.66	0.17
6	1.88	0.19
9	2.50	0.28
12	0.41	0.13
15	0.70	0.12
Mean	1.43	0.18

[a]Died after 3 months

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