Secretion of DDT in Milk by Fresh Cows[1,2]

by W. H. Brown,[3] J. M. Witt,[4] F. M. Whiting,[5] and J. W. Stull[3]

Environmental contamination of animal feed by pesticides applied onto nearby crops is considered to be the major source of pesticide residues found in milk. However, examination of the pesticide input from these sources frequently does not account for the level of pesticide residue found in the corresponding milk. Attempts to explain the discrepancy between the amount of pesticide residue found in milk and the amount which one can predict should be found based on many feeding studies (1, 2, 3, 4) has led many persons to suggest that there may be a relationship between these unexplainably high pesticide residues in milk and the stage of lactation in the cow, i.e. that cows which have just come fresh secrete more pesticide in their milk fat than during later stages of lactation. The rationale which

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[3] Department of Dairy Science, University of Arizona, Tucson

[4] Department of Entomology, University of Arizona, Tucson

[5] United Dairymen of Arizona, Tempe, Arizona

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prompted this suggestion is based on the fact that a cow loses considerable body weight, presumably stored body fat, during the first weeks following parturition. Since cows store insecticide in their body fat at a level near that secreted in the fat of milk (1, 2, 5, 6) it appeared reasonable that depletion of body fat would release the previously stored insecticide and make an unusually large amount of insecticide available for secretion in the milk. This theory has been sporadically tested by analysis of single samples of milk from fresh cows or groups of fresh cows and compared to samples from cows in later stages of lactation in the same herd which have received the same dietary exposure to insecticides. This type of testing has given conflicting results as to whether fresh cows excrete more insecticide in milk fat than those in later stages of lactation (Ariz. State Dept. Health., pers. comm.; Calif. State Dept. Agric. pers. comm.; unpublished data, this laboratory). Laben *et al*. (6) give data which show a decline in the level of DDT in the milk fat immediately after parturition for a period of 40 weeks in a sequence of samples taken from the same cows. However, all but the control group of cows were also declining from an exposure of DDT which had been terminated 30 days prior to parturition and this decline would mask any effect due to changes in fat mobilization. Their data presented for the control group of cows, which received only that DDT which unavoidably appeared in the hay ration (ca. 0.05 ppm), shows that there was little or no pattern of decline for 20 weeks following parturition, but that there was a decline from ca. 1.5 ppm to ca. 0.25 ppm from the 20th to the 30th post-partum weeks and this decline was followed by a rise to 0.4 ppm by the 40th week.

The supposition that fresh cows may contribute a disproportionate share of insecticide to the pooled herd milk has been primarily concerned with the possibility of a gross disproportion occurring in the first 2 or 3 post-partum weeks rather than for the first half of the milking period. It was the purpose of this study to examine the insecticide level in the milk in the very early stage of lactation by sampling with sufficient frequency to detect short term fluctuations that would be masked by weekly composites. This milk was sampled at every milking for 14 days and sampled six times per week and composited into two samples per week following this earliest lactation period.

Eight Holstein cows from the University of Arizona dairy herd were used as experimental animals. Six of the animals were in their 2nd lactation, one in her 3rd, and one in her 5th lactation. The cows were maintained on the same source of feed during the last stages of their lactation, the dry period, and the post-partum testing period, although the amounts of hay and grain were adjusted according to Morrison's standards. The cows received hay only during the dry period which extended for 43 to 87 days, with an average of 61 days. The animals did not receive any special dose of DDT prior to or during the experimental period. The only known insecticide intake was from the DDT which constituted an unavoidable contamination of the feed. The hay contained an average of 0.01 ppm of DDT and its degradation products and the grain contained 0.05 ppm. Milk samples were taken twice daily for the first 14 days following parturition and analyzed individually. The daily average is presented in table 1.

TABLE 1

Secretion of Pesticides and Milkfat in the Milk of Fresh Cows

Time after Part. (days)	DDT	DDE	DDD	Total	Fat (%)	Milk (kg/day)	Fat (kg/day)
	PPM in Milkfat						
0	0.13	0.49	0.01	0.73	3.4	10.1	0.34
1	0.12	0.56	0.01	0.69	4.2	15.6	0.66
2	0.14	0.54	0.02	0.70	3.3	20.4	0.67
3	0.08	0.62	0.01	0.71	4.3	18.2	0.78
4	0.09	0.55	0.02	0.66	4.5	20.2	0.91
5	0.09	0.63	0.01	0.73	5.0	19.8	0.99
6	0.11	0.50	0.00	0.61	4.6	19.8	0.91
7	0.10	0.54	0.01	0.65	5.5	21.8	1.20
8	0.11	0.51	0.02	0.64	5.6	18.0	1.01
9	0.12	0.45	0.01	0.58	4.8	22.0	1.06
10	0.11	0.57	0.02	0.70	4.0	21.6	0.86
11	0.10	0.47	0.01	0.58	4.0	23.8	0.95
12	0.11	0.56	0.01	0.68	4.1	23.2	0.95
13	0.13	0.54	0.02	0.69	3.5	26.4	0.92
14	0.09	0.54	0.02	0.65	3.4	23.8	0.81
15-17	0.11	0.58	0.01	0.70	3.3	25.8	0.85
18-21	0.11	0.62	0.02	0.75	3.5	26.4	0.92
22-24	0.12	0.56	0.01	0.69	3.4	27.4	0.93
25-28	0.10	0.56	0.01	0.67	3.3	25.0	0.83
29-31	0.10	0.61	0.01	0.72	3.3	25.0	0.83
32-35	0.13	0.64	0.02	0.79	3.1	26.2	0.81
36-38	0.13	0.61	0.02	0.76	3.1	27.4	0.85
39-42	0.10	0.50	0.01	0.61	3.3	25.0	0.83
43-45	0.10	0.58	0.01	0.69	3.3	25.2	0.83
46-49	0.12	0.58	0.02	0.72	3.0	26.4	0.79
50-52	0.14	0.53	0.02	0.69	3.0	25.0	0.75
53-56	0.10	0.49	0.01	0.60	3.0	25.2	0.76
57-59	0.11	0.51	0.01	0.63	3.0	25.1	0.75

From 14 to 59 days the milk was sampled once a day and composited for analysis semi-weekly. The analysis was carried out by electron capture gas chromatography and DDT, DDE, and DDD were measured separately (7).

The data are presented in table 1 as the average response from the eight cows studied. It can be seen by simple inspection that, although the level of DDT and its degradation products in the milk fat range from 0.58 to 0.79 ppm, there is no consistent trend either up or down of the level of DDT and its products over the 59 day period studied. The daily production of milk fat followed a slight upward trend until the 7th post-partum day and then decreased slightly but not significantly. The mean values and standard deviations for the 59 day experimental period are presented in table 2.

TABLE 2

Average Secretion of Pesticides and Milk Fat in the Milk of Fresh Cows

	Number of Observations	Average	Standard Deviation
DDT (ppm in milk fat)	165	0.119	0.145
DDE (ppm in milk fat)	165	0.549	0.123
DDD (ppm in milk fat)	164	0.018	0.022
Total pesticide (ppm in milk fat)	162	0.680	0.174
Percent fat in milk	210	3.65	1.306
Daily milk production (kg)	210	23.66	0.641
Daily fat production (kg)	210	0.86	0.129

The data were analyzed by methods described by Snedecor (8) to determine the standard deviation and the significance of any trends.

The standard deviations express the variation encountered between cows and the analytical error. The coefficients of variance of the chemical analyses were DDE, 26.2%; DDD, 93.5%; and DDT, 46.0%. The level of detection of DDT (0.1 ppm in the fat;

0.040 ppm in whole milk) and DDD (0.02 ppm in the fat; 0.001 ppm in whole milk) was so close to the level of the reagent blank when expressed in equivalent terms (0.03 to 0.05 ppm of milk fat), that a high standard deviation and coefficient of variance are to be expected. The variations of pesticide level and fat production found between cows and within cows with regard to time showed no consistent trend and were not of sufficient magnitude to be significant. Although many persons have rationalized that the fresh cow could uniquely contribute to the level of pesticide in the herd milk not only because of the release of pesticide stored in the body fat, but also because of a much higher level of production of milk fat during the early stage of lactation, this suggested higher level of fat production was not substantiated by this data nor has this concept been substantiated by any previous work (9) despite the continued belief that this phenomenon occurs. There is an approximate 30 percent decrease in the amount of fat produced at the end of the entire lactation period as compared to the early stages, but this is a gradual decline over the entire period.

Although the absence of trends was noted for the averaged response of the eight cows, there was an increase in the volume of milk production for the first ten days of lactation for three of the eight cows, and there was considerable variation (but no consistent trends) in percent milk fat for all of the individual cows for the first three or four days, but not in the weight of milk fat produced or in the level of pesticide residue in the milk fat. It was also shown that the cows in this study lost an average of only 37 lbs. body weight in the first month after calving. In the second month there actually was an average gain of 12 lbs. per cow.

It is interesting to note that although the feed for the cows on this test had a contamination of DDT (and its degradation products) which averaged out at 0.023 ppm, the milk fat had a residue of 0.68 ppm which is 30 times the residue level which would be predicted from the level in the diet (1, 2, 3, 4). Although the ratio of the level of pesticide in the dose to the level of pesticide in the milk was near to unity in the work of Laben _et al_. (6), their control group of animals also showed the same 30:1 disparity detected here (0.05 ppm in feed; 1.5 to 0.35 ppm in milk fat). This disparity poses a difficult problem in the management of herds producing milk carrying a level of pesticide residue near 2.0 ppm in the milk fat but which have been consuming feed carrying a pesticide residue level near or below 0.1 ppm. It is shown by the data presented here that this problem is not caused by a unique release of stored pesticides by cows just coming fresh.

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