An Epidemiological Study of Pesticide Contamination in Milk on an Operating Dairy Farm[1,2]

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Contamination of feeds by pesticides is considered to be the major source of these residues found in milk (1 - 5). A number of reports in the literature give information concerning the feed through ratio of pesticides found in milk fat in relation to that which is found in the feed. These have been summarized by Witt et al. (6). In addition Witt et al. (5, 6) have shown that it is possible for respiratory intake to give rise to contamination of pesticides in milk. The response to respiratory exposure, however, was shown to be minimal and could not

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account for sustained higher levels of pesticide in the range of three parts per million or more. In addition there has been the supposition that recently fresh cows may contribute a disproportionate high share of pesticides in pooled herd milk. Work by Brown et al. (7) however, has shown that fresh cows are not a source of unusually high pesticide secretion in milk fat.

The purpose of this study was to correlate pesticide levels in feed intake with observed milk contamination on an actual operating farm. The particular operation selected had attempted to minimize pesticide contamination by selecting the feed materials used. This selection and control was based on chemical analysis of all lots of feed prior to their use. Even though this precaution was taken, the level of pesticides in the pooled herd milk from this farm had run consistently higher than might be expected from the results of the feed analysis. It was hoped that this study would give a more accurate quanitative measure of the contribution of each feed source and determine whether or not their sum could account for the residue actually found in the milk under actual operating conditions.

Experimental Procedure

The dairy farm selected for this study was located in central Arizona. The milking herd consisted of approximately 500 grade Holstein cows. The feed being used consisted of locally grown high quality alfalfa hay, green chop or ensiled hegari and a grain concentrate mixture composed of barley, milo and cottonseed meal.

Feed and milk samples were taken at approximately 30-day intervals over a 17-month period. All samples were taken, handled and analyzed by the methods described by Witt, et al. (5).

Results and Discussion

The results of feed and milk analyses are given in Table 1. The results are expressed on the basis of the parts per million of total pesticide in the feed on a dry weight basis. The chief material found was DDT and its metabolites, DDD and DDE. The amount of residue in the feed was then expressed on the basis of the proportional contribution made by each feed in the diet. Using this method, a total contribution for all feeds was arrived at. By plotting the available information in the literature on feed through ratios (6) the dietary residue as calculated above was used to obtain a predicted value of residue in milk fat. This value was much lower than that actually determined in the milk fat.

An explanation for this discrepancy is difficult to make with the information obtained on the nature of this dairy farm operation. Some factors which were considered but which gave no adequate explanation included the following: a) An incomplete record of management practices may have occurred prior to the study. In this regard precise information indicates that the feeding practices used, prior to the iniation of this study were not significantly different than those used during the study. Prior build up of body stores, therefore, was not felt to be a factor in this discrepancy. b) Improper feed sampling could be responsible for incorrect residue values. Work by Witt et al. (5), however, indicates that the

TABLE I

Pesticide in feed, dietary components together with predicted and determined levels in milk fat.

	Feed					Milk Fat (ppm)	
Mo.	Hay	Silage	Green Chop	Grain	Total	Pre-Dicted	Deter-mined
1	0.70/58.2[a]	0.33/19.8	--	0.83/21.4	0.65[b]	0.35[c]	2.05
2	0.10/58.5	0.38/27.7	0.26/1.6	0.10/22.5	0.19	0.07	1.60
3	0.18/57.9	0.62/14.5	1.60/9.9	0.08/18.2	0.37	0.17	2.35
4	0.09/47.3	0.50/20.7	0.19/12.6	0.02/21.0	0.18	0.06	4.25
5	0.08/48.4	0.36/13.7	0.57/10.6	0.04/27.3	0.16	0.06	1.65
6	0.17/52.3	1.69/6.8	2.12/16.4	0.19/24.3	0.59	0.31	3.70
7	0.27/58.0	1.69/18.4	--	0.13/23.6	0.50	0.29	1.89
8	0.20/59.0	1.11/20.0	--	0.03/21.0	0.35	0.15	2.03
9	0.34/71.5	4.70/8.3	--	0.04/20.2	0.57	0.30	3.80
10	0.29/69.5	2.92/5.1	--	0.01/25.0	0.35	0.15	2.88
11	0.13/72.0	1.12/8.6	--	0.03/19.4	0.19	0.07	3.12
12	0.13/62.0	0.24/16.0	--	0.03/22.0	0.13	0.05	3.52
13	0.07/59.0	0.21/19.3	--	0.03/21.7	0.09	0.04	3.23
14	0.07/55.5	0.36/21.3	--	0.03/23.2	0.12	0.05	1.90
15	0.13/55.0	0.18/21.5	--	0.07/23.5	0.12	0.05	1.16
16	0.14/55.0	--/22.0	--	0.05/23.0	0.09	0.04	1.30
17	0.34/54.0	0.12/23.0	--	0.12/23.0	0.24	0.09	1.25

[a]Total pesticides in ppm with percent of the diet supplied by the feed each on a dry weight basis.

[b]Dietary pesticide in ppm corrected for proportion contributed on a 90% dry weight basis.

[c]Predicted values from data of Witt _et al_. (6)

sampling techniques used in the study give reliable information concerning residue levels in the feed as it was handled in this operation. c) The possibility of high residue values in pooled herd milk arising from bringing replacement animals into the herd which have been receiving feed of high residue levels was investigated. This operator raised all herd replacements and did not import animals onto the premises. d) Additional sources of contamination such as respiratory exposure were being investigated concurrently with this study. Two aspects of this work would tend to eliminate this source as a possible explanation for the discrepancy. First, direct respiratory exposure of experimental animals by intra-tracheal infusion was shown to give a minimum response to the pesticide found in the milk fat produced by the exposed animals (5). Second, an air sampling and scrubbing device was installed on the premises of this farm. The air was sampled continuously for 7-days using two 4-hour sampling periods each day. The amount of pesticide recovery in the air sampling device could in no way explain a respiratory contamination high enough to account for the discrepancy found. e) Miscellaneous environmental sources were considered. These included manure, and bedding material from the corrals, soil or dust in the corral area, and drinking water. Analysis of all these materials failed to reveal pesticide residues at a level which could account for any significant contamination from these sources. f) The possibility that the feed analysis method might not account for all the pesticide present was considered. An exhaustive comparison of the extant and some new methods was made on a replicated basis using a single lot of feed containing a comparativity low level of pesticide (8). The results of this work have shown that differences in the exhaustiveness of these methods could not account for the discrepancy between the predicted and determined values.

One possible explanation for the discrepancy between the predicted values and those actually found in the milk fat may lie in the fact that the data used to plot the feed through data (6) includes mainly feed contamination values of one half part per million or higher fed usually on rather short term exposure. It was necessary then to extrapolate in order to obtain the predicted values for milk pesticide from the relatively low levels of feed contamination found in this operation. Work is currently under way to more adequately measure the effect of long-term, carefully controlled feeding of low levels of pesticides in feed e.g. from puberty through one or more lactations at levels of 0.1 to 0.5 p.p.m.

References

1. N. N. ALLEN, H. A. LARDY, and H. F. WILSON, J. Dairy Sci. 29,530 (1946)
2. R. E. ELY, L. A. MOORE, R. H. CARTER, H. D. MANN, and R. W. POOS, J. Dairy Sci. 35,266 (1952)
3. R. C. LABEN, T. E. ARCHER, D. G. CROSBY, and S. A. PEOPLES , J. Dairy Sci. 48,701 (1965)
4. G. ZWEIG, L. M. SMITH, S. A. PEOPLES, and R. COX, J. Agr. Food Chem. 9, 481 (1961)
5. J. M. WITT, F. M. WHITING, W. H. BROWN, and J. W. STULL, J. Dairy Sci. 49, 370 (1966)
6. J. M. WITT, F. M. WHITING, and W. H. BROWN, Adv. Chem. Ser. 60, 99 (1966)
7. W. H. BROWN, J. M. WITT, F. M. WHITING, and J. W. STULL, Bull. Environ. Contam. and Toxicol. 1,21 (1966)
8. F. M. WHITING, J. W. STULL, W. H. BROWN, MARY MILBRATH, and G. W. WARE, unpublished data (1967)