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Residues of Organochlorine Pesticides in Milk Gland Secretion of Cows in Perinatal Period

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Persistent organochlorine (OC) compounds such as DDT and its derivatives, isomers of hexachlorocyclohexane (HCH), hexachlorobenzene (HCB) and polychlorinated biphenyls (PCBs) may pose toxicological and ecological impact due to their persistency in some biological compartments.

Such chemicals as DDT, PCBs, HCH and HCB as well as some other inducers of drug metabolizing enzymes are also promoters in experimental hepatocarcinogenesis (Pitot et al. 1980). The relationship between shell thinning and the OC pesticide residues as a result of environmental contamination is another well known effect of the persistence of these chemicals in the environment (King et al. 1970).

Despite the fact that agriculture has discontinued the use of the majority of these pesticides in many countries, the considerable differences in their concentrations in samples of human and animal origin are evidence that biological magnification via the food - chain still exists in the case of OC compounds. This phenomenon may be illustrated by the close relationship between OC compound concentration in the fat of human and cow milk (Pawlicki et al. 1983).

Because of the concentration of OC compounds in fat their accumulation is particulary high in the milk gland and leads to elevated concentrations in the colostrum and milk produced shortly after parturition. These concentrated compounds are ultimately passed to both human and animal newborns and infants (Mitsuru et al. 1985).

The purpose of the present study was to determine the rate of excretion of the OC pesticide complex including their metabolites in the perinatal and post-natal period during various gland secretion phases.

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MATERIALS AND METHODS

The study was carried out in the winter 1988/1989. The material was obtained from 12 milk cows of the lowland black-and-white breed in a farm near Warsaw. The herd had a high frequency of mastitis and illnesses of calves. Milk gland secretion was taken from clinically healthy cows from 10 to 4 days before parturition, within 24 hours after parturition (colostrum period), 4 to 7 days after parturition, and again 10-14 days after parturition. The first portions of the secretions were taken for testing.

Organochlorine pesticides were extracted according to routine principles (Pawlicki et al. 1983). The pesticides were determined after the clean-up using gas chromatography with electron capture detector (Pye-Model 104, Detector EC/Ni 63). The reference standards were obtained from the Poly Science Co.,USA, and Institute of Organic Industry in Warsaw.

The results were expressed in μg/l of whole milk and μg/kg of fat (n=12) and Student's-t test was used for statistical analysis.

RESULTS AND DISCUSSION

The analysis of the concentrations of organochlorine compounds in the milk gland secretion prior to parturition, in the colostrum, and in the first two weeks after parturition demonstrated a significantly higher level of HCH isomers in the secretion before parturition as compared to milk and colostrum. Statistically significant differences were found between the isomers alpha, beta and gamma of HCH as well as their sum calculated per 1 kg of fat before and after parturition. The sum of DDE, DDT and DDD concentrations was also significantly higher in the secretion before parturition as compared to colostrum and milk.

No significant differences were observed in the concentration of these compounds in μg/l of milk in view of high quantitative differences in milk gland secretion in the perinatal period, and considerable individual range of results, which are presented in Tables 1, 3. However, an entirely different pattern of excretion can be observed when the results are expressed as concentrations in fat (table 2). In this case the real concentrations were always higher in the fat of "prenatal secretions" than in fat of milk, obtained two weeks post parturition. Also the concentrations of OC compounds in colostral fat were generally lower than in normal milk fat, although this difference was not significant.

Table 1. Residues of organochlorine pesticides in milk gland secretion of cows (μg/l of milk)

COMPOUNDS	LACTATION PERIODS before parturition	colostrum	4-7 days after parturition	10-14 days after parturition
DDE	1.13 ±1.40	2.00 ±2.30	1.21 ±1.35	1.09 ±1.12
DDT	0.90 ±1.56	0.39 ±0.92	0.45 ±0.78	0.40 ±0.73
DDD	0.08 ±0.19	0.34 ±0.64	0.36 ±0.69	-
α HCH	0.30 ±0.36	0.22 ±0.20	0.30 ±0.25	0.32 ±0.31
β HCH	2.12 ±1.40	2.44 ±1.20	2.32 ±1.21	2.47 ±1.09
γ HCH	1.31 ±2.42	0.52 ±0.42	0.57 ±0.41	0.66 ±0.32
HCB	0.13 ±0.14	0.21 ±0.28	0.11 ±0.15	0.07 ±0.12

Table 2. Residues of organochlorine pesticides in the fat of milk (μg/kg of fat)

COMPOUNDS	LACTATION PERIODS before parturition	colostrum	4-7 days after parturition	10-14 days after parturition
DDE	302.10 ±367.50	72.52 ± 87.79	116.54 ±164.23	105.60 ±117.29
DDT	138.30 ±240.80	17.83 ± 43.50	27.75 ± 63.76	19.12 ± 63.43
DDD	12.50 ± 27.80	31.64 ± 70.63	87.22 ±270.45	-
α HCH	32.00 ± 25.00	9.78 [a] ± 10.17	24.88 ± 28.69	26.33 ± 33.34
β HCH	549.20 ±512.10	151.88 [a] ±193.88	212.22 ±207.69	185.28 [a] ±161.32
γ HCH	173.96 ±144.43	35.68 [b] ± 24.36	50.53 [a] ± 38.60	53.21 [a] ± 43.52
HCB	43.00 ± 63.40	6.68 ± 10.30	6.58 ± 8.32	9.23 ± 26.31

Table 3. Total concentration of organochlorine pesticides in milk gland secretion in the perinatal period in cows

	DDE+DDT+DDD (μg/l of milk)	HCH (μg/l of milk)	DDE+DDT+DDD (μg/kg of fat)	HCH (μg/kg of fat)
Before parturition	2.11 ±2.85	3.71 ±3.05	452.86 ±495.70	859.10 ±601.40
			a	b
Colostrum	2.72 ±2.32	3.18 ±1.26	121.80 ±147.88	197.35 ±211.77
				b
4-7 days after parturition	2.09 ±2.47	3.18 ±1.37	163.16 ±195.55	294.48 ±243.15
			a	b
10-14 days after parturition	1.49 ±2.49	3.42 ±1.32	124.72 ±126.27	286.26 ±210.39

Table 2 and 3. Difference statistically significant at a $p<0.05$, b $p<0.01$

Ranking the determined compounds according to their concentration in milk the highest level was found of beta-HCH and gamma-HCH. Followed by DDE, HCH isomeres were found in all samples independently of the period of lactation (table 1). DDE was found in about 60% of samples in the range 8.5-0.5 μg/l of milk. DDE was not found in any of the samples of one cow. HCB was present in 50% of samples ranging from 0.87 to 0.05 μg/l.

The remaining compounds were demonstrated in single samples. Considerable differences in the concentrations and in the frequency of the individual compounds in the samples taken in various periods of lactation indicated individual determinants of metabolic processes and elimination of the tested compounds. These results were obtained from a limited number of animals on one farm and they reflected the exposure to organochlorine pesticides of this group of cows. The considerably increased concentration of fat-soluble pesticides in milk gland secretion before parturition has shown an adverse effect on the function of the gland.

As it results from the present investigations these compounds in the composition and concentration observed in the milk gland secretion prior to the parturition significantly decrease the phagocytic activity of bovine milk cells which may indicate that this group of compounds plays a role in the etiology of mastitis in cows (Sitarska et al. 1990).

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