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Concentration of PCBs, HCB, DDT, and HCH Isomers in the Ovaries, Mammary Gland, and Liver of Cows

E. Sitarska, W. Kluciński, R. Faúndez, A. M. Duszewska, A. Winnicka, K. Góralczyk

Department of Internal Diseases, Veterinary Faculty, Agricultural University of Warsaw, Grochowska 272 Street, 03-849 Warsaw, and National Institute of Hygiene, Department of Environmental Toxicology, Chocimska 24 Street, 00-971 Warsaw, Poland

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Persistent organic chlorine compounds such as DDT and its metabolites, hexachlorobenzene (HCB) and polychlorinated biphenyls (PCBs) play an important role in chronic poisoning and take part in a number of pathological processes (Lembowicz et al. 1991, Sitarska et al. 1991).

Fat solubility of those compounds is responsible for their varied concentrations in the tissues and their accumulation in the lipoproteins of the cell membranes thus changing their structure and permeability (Antunes-Madeira et al. 1993, Chowdhury et al. 1990).

A number of experimental research work in the recent years revealed a negative effect of that group of compounds on the male and female reproductive systems (Sircar et al. 1990, Martinez et al. 1991 and 1992). Observations from experiments with guinea pigs have clearly indicated a higher accumulation of HCH compounds in the mammary gland than in the liver (Sitarska et al. 1990). In our investigations in cows we also found a significantly higher level of HCH isomers, p,p'-DDE, p,p'-DDT and p,p'-DDD in the secretions before parturition compared with those in colostrum and milk (Sitarska et al. 1991). In our studies on the relationship between the composition and the concentration of the complex of organochlorine compounds we found that in concentrations observed in milk they reduce the phagocytic activity of cells isolated from milk (Sitarska et al. 1990). The aim of the present study was to estimate the degree of accumulation of those compounds in the liver, ovaries and mammary gland tissues of cows under natural environmental conditions.

MATERIALS AND METHODS

Tissue samples were collected from 18 cows just after slaughtering, always from the same parts of the studied organs. The extraction of organic chlorine pesticides including HCB and PCBs were carried out according to the generally accepted procedures. PCBs were separated from organic chlorine pesticides in the purified extracts by means of HPLC (Varian Model 1638 with a UV detector). The fractions containing PCBs and the remaining initially separated organic chlorine pesticides were analyzed by means of gas-liquid chromatography. Pye-Unicam

Correspondence to: E. Sitarska

gas chromatograph equipped with electron capture detector (Ni^{63}) and a glass column packed with 1.5 % OV-17 and 1.95 % OV-210 on Gas Chrome Q (80-100 mesh) were used for this purpose. All standards were obtained from Poly Science Co. USA and the Institute of Organic Industry in Warsaw, Poland. The whole procedure was checked in the international interlaboratory of the Analytical Quality Assurance Program for OC pesticides and PCBs organized by The National Food Administration in Sweden. The limit of detection (in mg/kg of fat) of about 0.05 for p,p'-DDT, 0.02 for p,p'-DDE and β-HCH , 0.01 for γ-HCH and HCB, 0.005 for α-HCH and 0.1 for PCBs are achievable using this analytical procedure. Results were expressed as the mean $\pm$ SEM in μg/kg wet mass. A two-tailed Student's t-test was used to evaluate the significance of the difference between means of different studied groups.
Furthermore the correlation between concentrations of the compounds in different organs was determined by calculating the correlation coefficient (r).

RESULTS AND DISCUSSION

The means $\pm$ SEM, and the highest values of the PCBs, HCB, DDT and HCH isomers in the ovaries, mammary gland, and the liver of cows are presented in Table 1.

Table 1. Concentrations of organochlorine compounds in the ovaries, milk gland and liver of cows (μg/kg of wet mass)

COMPOUND	ORGANS					
	OVARIES		MAMMARY GLAND		LIVER	
	Mean	±SEM	Mean	±SEM	Mean	±SEM
HCB	1.394	0.753	1.061	0.364	0.550	0.207
α - HCH	-*	-	0.055	0.055	-*	-
β - HCH	-*	-	0.277	0.277	0.522	0.522
γ - HCH	0.138	0.138	0.102	0.102	-*	-
p,p'-DDE	3.383	0.826	11.350	2.314	2.805	0.440
p,p'-DDD	2.251	1.569	2.433	1.320	7.188	2.565
p,p'-DDT	10.733	2.717	9.766	2.425	11.261	2.726
PCB	2.694	2.112	8.694	2.534	13.550	2.173

* below the limit of determination

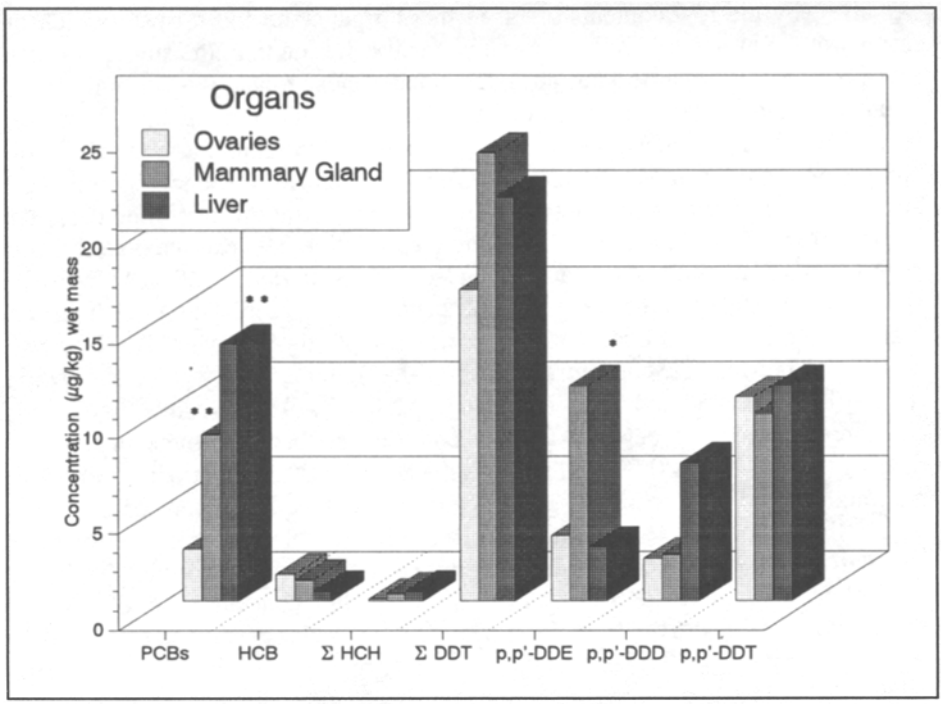

Figure 1. Concentration of PCBs, HCB and residues of organochlorine pesticides in ovaries, mammary gland and liver of cows. Σ HCH and Σ DDT - Σ of means (*$p \leq 0.01$, **$p \leq 0.001$).

After analyzing the frequency of appearance and concentration of DDT and its metabolites, HCH isomers, HCB and PCB in the samples of ovaries, mammary gland and liver, we have determined the presence of p,p'-DDE and PCBs in 83 %, p,p'-DDT in 55 %, HCB in 38 % and p,p'-DDD in 33 % of examined animals.

The three isomers of HCH were only found in one cow in a sample of mammary gland and γ-HCH in the ovaries and β-HCH in liver from single cows. Concentrations of HCH isomers in the greater part of analyzed samples were below the limit of determination for the used method. Polychlorinated biphenyl concentrations in liver and mammary gland were significantly higher than in ovaries ($p \leq 0.001$ and $p \leq 0.01$). On the other side p,p'-DDE concentrations were significantly higher in milk gland as compared with those found in ovaries and liver ($p \leq 0.01$). No significant differences were noted between examined organs regarding concentration of the remaining compounds. In the present study the concentrations of DDE in ovaries and liver were lower than DDT. this was unexpected because usually the concentrations of DDE are tenfold higher than DDT (Sitarska et al. 1991, Lembowicz et al., 1991, Ludwicki and Góralczyk, 1994). However, similar concentrations of these compounds were found in the mammary gland. Our results concerning the ovaries and liver in part may be

explained by the low contents of fat in these organs and the form in which our result were expressed, it is in μg/kg of wet mass. Beside this, the studied material was obtained from cattle kept at farms situated near towns with a high human population and so the exposition of animals to the studied compounds is steadily high. The relationship between concentrations and accumulation of the tested compounds in the studied organs is shown in the Figure 1. It seems interesting to analyse the correlation between the determined concentrations of compounds. This has established a highly significant positive correlation between the concentration of p,p' DDT in liver and mammary gland ($r= 0.969$, $p \leq 0.001$). Also a significant correlation between the concentration of p,p'-DDD in liver and mammary gland ($r=0.804$, $p \leq 0.001$) was observed. However There was no correlation between the concentration of p,p'-DDE in mammary gland and ovaries ($r=0.108$, $p \geq 0.05$) and liver ($r=0.368$, $p \geq 0.05$). At the same time a high correlation was found between the concentration of this compound in liver and ovaries ($r=0.711$, $p \leq 0.001$). These results confirm the clear predilection of the mammary gland tissues for the gathering of p,p'-DDE. PCB were present in 83 % of liver and 44 % mammary gland samples. However there were no correlation between the concentration of this compound in these organs ($r=0.040$, $p \geq 0.05$). At least a high correlation between the concentration of HCB in mammary gland and liver ($r=0.962$, $p \leq 0.001$) was observed. The same was for liver and ovaries ($r=0.635$, $p \leq 0.01$). Comparing our results, and those from others in the last two years, in samples obtained from animals, it was observed that a slow decrease of the concentration of organochlorine pesticides had occured. At the same time an increase in the concentration of PCBs and HCB was also observed. The concentration of Σ DDT and the highest values found in the studied samples were significantly lower than the maximum accepted concentration of 1 mg/kg for fat in meat export. Furthermore the mean concentration of HCB was twice lower than the tolerated value 0.20 mg/kg (Rodziewicz and Hajduk, 1989). On the other hand it is interesting that the concentration of HCB in the liver, in comparison with that determined in mammary gland and ovaries, seems to decrease. However, PCB in ovaries was determined only in single samples, meanwhile it was present in the greater part of the liver samples.

Accumulation of the studied compounds, even in relatively low concentrations in mammary gland and ovaries, may contribute to the appearance of pathological changes in the reproductive system in cattle. The variability of the composition and concentration of these compounds in different organs, create the constant necessity of monitoring and investigation of their effect on health and animal productivity. Results obtained in the present work will be used as a basic information for further investigations on the effect of those compounds on the early development of bovine embryos.

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