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RESIDUES OF LINDANE IN THE ADIPOSE TISSUE OF DIFFERENT ANIMAL SPECIES OVER A THREE YEAR PERIOD (1991–1993)

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Among possible meat contaminants, pesticides are considered to be of particular importance for its safety as a dietary ingredient. The group of organochlorine pesticides, which used to be the most frequently applied, is of specific interest. The persistence of organochlorine pesticides in the environment, chronic toxicity and concentration in biological systems brought about some restrictions and their substitution with less persistent pesticides. Despite legal restriction of the use of many chlorinated pesticides, lindane still has a wide application in agriculture as well as for the control of ectoparasites in livestock production. With the aim of monitoring the safety of meat, the presence of chlorinated pesticides in animal tissues has been the subject of systematic examination for many years.

In this paper we present the results obtained for lindane residues in the tissues of pigs, cattle, lambs and poultry originating from inside and outside this country. Data obtained over the three year period pointed to decreasing residue levels in the tissues of slaughtered animals. The lindane residues found were mainly below the tolerance level, with the exception of some particular cases. Namely, 4.4% of domestic lamb samples and 0.2% of imported beef samples exceeded the tolerance limit.

The quantities detected were rather high namely, up to 20,32 mg/kg in lambs, probably as a consequence of direct animal treatment. The data obtained point to the adequate application of lindane as an agriculture pesticide and unproper use as a veterinary pesticide in livestock production.

Key words: residues, lindane, adipose tissue, monitoring.

INTRODUCTION

The use of chlorinated hydrocarbon pesticides in crop and animal production had and still has great importance. Apart from the advantages of pesticide aplication, it eventually became obvious that their persistence, chronic toxicity

and ability to bioaccumulate can cause not only an environmental hazard but they can also enter the human food supply and pose problems in the assessment of its safety (Spindler, 1983). The persistence of organochlorine pesticides in the environment, concentration in the biological food chain and storage in human tissues led to doubts concerning their long-term application (Ware, 1980; Jensen, 1983). All these facts brought about the restricted use of many organochlorine pesticides and their substitution with less persistent pesticides.

Thus, after DDT's legal restriction for use lindane (hexachlorocyclohexane, γ -HCH) still has a wide application in agriculture as a very effective insecticide, acaricide and larvicide in many countries. The extensive use of lindane in crop protection, due to its poor biodegradability, led to its accumulation in the environment, which makes it a very persistent environmental pollutant. Pesticide residues from the environment enter the animal body through feedstuffs, where they deposit and accumulate in fatty tissue (Wottram et al., 1983).

Apart from its extensive use in crop protection, lindane has been approved as a veterinary pesticide in animal husbandry for destroying lice, fleas, ticks and mange mite in cattle, pigs, sheep and poultry. The direct use of lindane in the form of dusting powder, emulsions, a spray wash or dip to control ectoparasites in livestock production can leave high residue levels in the animal body. The fate of the pesticide in the body of food producing animals, i.e. its accumulation in the adipose tissue or its elimination through their products can induce unexpected high residue levels in the human food chain (Edwards, 1974; Kan, 1978; Schlatter, 1990).

Since pesticides, due to their persistence, solubility in fat and ability to bioaccumulate, can enter the human food supply, their presence in animal tissues has been the subject of a systematic examination we have conducted for several years.

MATERIALS AND METHODS

According to the established monitoring program, sample tissues for the examination of pesticide residues were collected from slaughter houses throughout the country. Fat tissues were taken randomly from animals of known origin, by the veterinary inspector at the slaughter line. Sampling of imported meat was in accordance with the official regulations.

Samples were analysed according to the USA Analytical Chemistry Laboratory Guidebook. Chlorinated hydrocarbons were extracted and separated by elution from fat in small glass columns filled with partially deactivated alumina. The eluate was evaporated to a workable volume and an aliquot was injected into a gas chromatograph for detection and quantification. The gas chromatograph was equipped with a capillary column and electron capture detector.

The accuracy of the data obtained was estimated by recoveries of lindane from fortified samples. The results are evaluated on the basis of official regulations. Residues are expressed on a fat basis.

RESULTS AND DISCUSSION

The residues of lindane found in adipose tissue of different animal species after monitoring domestic meat samples over a three year period are presented in Table 1.

Table 1. Residues of lindane in the adipose tissue of different animal species after monitoring domestic meat samples

Animal species	Year	Number of sample	Number and percent of samples in the range (mg/kg)							
			0.00–0.01		0.01–0.05		0.05–0.10		> 0.10	
			No	%	No	%	No	%	No	%
Pork	1991	212	206	97.2	6	2.8	0		0	
	1992	207	168	81.2	32	15.4	7	3.4	0	
	1993	199	197	99.0	1	0.5	1	0.5	0	
	Total	618	571	92.4	39	6.3	8	1.3	0	
Beef	1991	154	145	94.2	8	5.2	1	0.6	0	
	1992	94	83	88.3	7	7.4	4	4.3	0	
	1993	85	83	97.6	1	1.2	1	1.2	0	
	Total	333	311	93.4	16	4.8	6	1.8	0	
Lamb	1991	124	109	87.9	7	5.7	2	1.6	6	4.8
	1992	57	50	87.7	6	10.5	1	1.8	0	
	1993	25	22	88.0	0		0		3	12.0
	Total	206	181	87.9	13	6.3	3	1.5	9	4.4
Poultry	1991	14	14	100	0		0		0	
	1992	16	11	68.8	1	6.2	4	25.0	0	
	1993	14	14	100	0		0		0	
	Total	44	39	88.6	1	2.3	4	9.1	0	

As can be seen from the data obtained (Table 1), in the case of porcine, bovine and poultry tissue, no sample exceeded the tolerance limit of 0.10 mg/kg. The lindane residues in more than 68% of the examined samples were below the LDL (lowest detectable limit) of the method, i.e. below 0.01 mg/kg.

In the case of lambs 4.8% of the examined samples in 1991 and 12.0% in 1993. exceeded the tolerance level. In this particular case the quantities found were from 0.13 up to 20.32 mg/kg in 1991. and from 2.27 to 3,08 mg/kg in 1993. The data we obtained for lambs pointed to the unproper use of lindane as a veterinary pesticide, probably as a sheep dip for destroying mange mite. The pesticide have entered through the skin into the animal body and then penetrated to the foetus through the placenta. Another possibility was that lindane found in the lambs was derived from pesticide contaminated milk (Harrison et al., 1970; Dagorn, 1990).

Data obtained over the last three years of the monitoring program (Table 1) are in accordance with our earlier presented results (Višacki et al., 1981; Spirić et al., 1993). Namely, the reduced application of organochlorine insec-

ticides in agriculture has been followed by a decrease of pesticide residue levels in animal feed and consequently in the tissues of slaughtered animals (Brooks, 1975; Spindler, 1983).

The data obtained for residues of lindane in imported meat of different animal species are presented in Table 2.

Table 2. Residues of lindane in the adipose tissue of different animal species after monitoring imported meat

Animal species	Year	Number of samples	Number and percent of samples in the range (mg/kg)							
			0.00–0.01		0.01–0.05		0.05–0.10		> 0.10	
			No	%	No	%	No	%	No	%
Pork	1991	317	290	91.5	23	7.3	4	1.2	0	
	1992	557	490	88.0	50	9.0	17	3.0	0	
	1993	309	297	96.1	10	3.2	2	0.7	0	
	Total	1183	1077	91.1	83	7.0	23	1.9	0	
Beef	1991	525	478	91.1	38	7.8	7	1.3	2	0.4
	1992	249	227	91.2	16	6.4	6	2.4	0	
	1993	50	49	98.0	1	2.0	0		0	
	Total	824	754	91.5	55	6.7	13	1.6	2	0.2
Lamb	1991	15	14	93.3	1	6.7	0		0	
	1992	16	13	81.2	2	12.5	1	6.3	0	
	1993	0	0		0		0		0	
	Total	31	27	87.1	3	9.7	1	3.2	—	
Poultry	1991	67	66	98.5	0		1	1.5	0	
	1992	82	75	91.5	6	7.3	1	1.2	0	
	1993	2	2	100	0		0		0	
	Total	151	143	94.7	6	4.0	2	1.3	0	

The results are similar to the data obtained from domestic samples with the exception of two particular cases. The lindane residues found in two beef samples were rather high – 1.32 and 1.64 mg/kg, probably as a consequence of direct animal treatment.

During the three year period the total number of examined meat samples indicated that, in the case of pork and beef, detection was ensured with a high probability. Namely, ensuring a 99% probability of detecting at least one violation when one percent of the sampled population is violative would require approximately 690 specimens. During the period examined no pork samples were violative and only 0.2% of the examined beff samples exceeded the tolerance limit. Concerning lambs and poultry, the total number of examined samples was low, 237 and 195 respectively, which enabled the detection of violative samples with the probability of only 90%. Even with this lower probability we detected violation in 4.4% of the examined lamb samples. That indicated a contamination problem in the case of lambs. No poultry samples were violative.

CONCLUSION

The overall data for lindane residues in the specimens examined indicated that the occurrence of residues in pork, beef and poultry meat has no great potential impact on public health. The lamb violative samples point to the unproper application of lindane as an ectoparasitic in livestock production. A more cautious approach needs to be followed concerning its application as a veterinary pesticide in animal husbandry.

Having in mind the toxicological properties of lindane, its residue occurrence and potential human exposure, a systematic pesticide residue monitoring of any ovine edible commodity should be undertaken with the aim of public health protection.

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REZIDUI LINDANA U MASNOM TKIVU RAZLIČITIH VRSTA ŽIVOTINJA U TOKU TROGODIŠNJEG PERIODA ISPITIVANJA (1991–1993)

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SADRŽAJ

Pesticidi se, kao kontaminenti mesa smatraju veoma značajnim za procenu njegove higijenske ispravnosti. Od posebnog interesa je grupa organohlornih pesticida, koji su do danas najviše primenjivani. Međutim, perzistentnost or-

ganohlornih pesticida u prirodi, njihova hronična toksičnost i akumulacija u biološkim sistemima uslovilo je ograničenje njihove upotrebe i supstituciju sa manje perzistentnim pesticidima. Iako je upotreba mnogih organohlornih pesticida ograničena, lindan je i dalje ostao u širokoj primeni, kako u poljoprivredi tako i za suzbijanje ektoparazita u uzgoju stoke. U cilju obezbeđivanja higijenske ispravnosti mesa, sistematsko ispitivanje prisustva organohlornih pesticida u tkivima životinja se sprovodi već niz godina.

U ovom radu su dati rezultati ispitivanja ostataka lindana u tkivima svinja, goveda, jagnjadi i živine u okviru domaćeg monitoringa i iz uvoza. Rezultati dobijeni tokom trogodišnjeg perioda ukazuju na smanjenje količina rezidua u tkivima zaklanih životinja. Dokazane količine lindana su, u većini slučajeva, bile ispod tolerantne vrednosti, sa izuzetkom nekoliko pojedinačnih slučajeva. Naime, u 4,4% uzoraka tkiva jagnjadi u okviru domaćeg monitoringa i 0,2% uzoraka tkiva junadi iz uvoza dokazane su količine lindana iznad tolerantne vrednosti.

U slučaju jagnjadi, dokazane količine lindana bile su veoma visoke, čak do 20,32 mg/kg, verovatno kao posledica direktnog tretiranja životinje. Dobijeni rezultati ukazuju na odgovarajuću primenu lindana kao pesticida u poljoprivredi i na njegovu nepravilnu upotrebu kao pesticida u stočarskoj proizvodnji.