

## **Lead and Cadmium in Meat and Organs of Game in Slovenia**

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Received: 28 March 1994/Accepted: 8 August 1994

Pollution of the environment and contamination of animals including game with Pb and Cd are serious problems in most countries. Our many-years results of Pb and Cd residues in meat and organs of game (*Veterinary directorate of the R Slovenia, Reports from 1983 to 1988*) show us, that the herbaceous game, which feed only with various herbs are more contaminated than other animals - cattle and pigs. They really seem to be a good environmental contamination indicator (Hecht et al. 1984).

The aim of our research was to establish contamination levels of game with Pb and Cd. Two different regions of Slovenia, an industrial region with a lead mine and smeltry in Koroška and an unindustrial one at Ilirska Bistrica were chosen to study contamination of game. Muscle tissues, heart muscles, kidneys and livers of roe-deer, chamois, red-deer and wild boars were analysed (Tomšič 1986, Osrajnik 1988). The correlation between the animals' age and cadmium content in kidney was researched and a positive correlation was established. We have found out to which extent the meat and organs of game correspond with our available tolerances (Uradni list SFRJ 1987) for each single residue and whether they are unfit for human consumption.

The results of investigations concerning Pb and Cd content in game analysed in Slovenia in the last four years were shown, too. Results were taken from the reports of the Residue monitoring and surveillance which is performed in the Republic Slovenia for more than ten years (*Veterinary directorate of the R Slovenia, Reports from 1989 to 1992*).

### **MATERIALS AND METHODS**

The samples of animals were taken from the hunters' families in the years from 1985 to 1988, all were shot with legal permission. After dissection tissues were packed separately and frozen. They were stored at -18°C and analysed as soon as possible. Each animal was provided with the following information: species of animal, sex, weight, estimation of age, time and place of shooting, place and altitude above sea level.

From Ilirska Bistrica heart muscle, kidneys and livers of 14 roe-deers, 8 red-deers and 16 wild boars were analysed. From the Koroška region 43 samples of meat, 70 samples of kidney and liver of roe-deers, and 22 samples of meat, 54 samples of kidney and liver of chamois were analysed.

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Digestion of samples was done with dry ashing. Homogenized 10g of each sample were put in quartz vessel, dried at 105°C and ashed at 450°C overnight. Ash was dissolved in dill. hydrochloric acid 1:2 and filtered into a 50-ml volumetric flask with double-distilled water. In order to concentrate the elements and eliminate the interferences liquid-liquid extraction was used. Pb and Cd were determined as a diethylammonium-N,N-diethyldithiocarbaminat complex (DDDC) extracted with methylisobutylketone (MIBK). The method with standard editions was used (lead Merck 9969, cadmium Merck 9960). Analyses were carried out by flame ionization atomic absorption spectrometry on the instrument Varian AA 175 (AOAC 1990, Snodin 1973). Air-acetylene flame was used and D<sub>2</sub>-hollow cathode lamp for background correction of nonspecific absorption. Pb was detected at wave-length 217 nm and Cd at 228.8 nm. The limit of lead determination was 0.05 mg/kg and of cadmium determination 0.003 mg/kg. Recovery for Pb was between 94 and 100% and for Cd between 96 and 105%, with coefficient of variation under 5% (certified reference material BCR No 184, 185 and 186).

## RESULTS AND DISCUSSION

The cadmium and lead concentrations in meat, heart muscle, liver and kidney of game are presented in Tables 1 and 2. Because element contents of particular tissues of various animal species did not largely differ the results are presented for all species together within the same region.

Table 1. Lead and cadmium in tissues of game from the Koroška region (mg/kg wet weight)

		Pb	cd
Meat	mean	0.31	0.029
	range	<0.05-7.76	<0.003-0.373
	% exc.sam.	29.2	3.1
n=65			
Kidney	mean	1.31	3.118
	range	<0.05-8.55	0.205-9.145
	% exc.sam.	45.0	78.3
n=60			
Liver	mean	0.96	1.275
	range	<0.05-7.85	0.027-7.198
	% exc.sam.	28.1	64.1
n=64			

% exc.sam. - percent of samples which exceed tolerances

With regard to the results in Tables 1 and 2 it may be concluded that the lead concentrations in liver from Koroška were higher than the Ilirska Bistrica ones. Considering the presence of a lead mine and smeltry in Žerjav near Mežica in Koroška the results were to be expected. Lead concentrations in kidney from Ilirska Bistrica were higher than from Koroška. In Koroška a much higher percent of kidneys and livers exceeded our official tolerance for Pb (Uradni list SFRJ 1987) than in Ilirska Bistrica, so it seems that the contamination of game with Pb in Koroška is higher. It is more obvious with concentrations of Cd in kidney and liver of game from Koroška (means and

Table 2. Lead and cadmium in tissues of game from the Ilirska Bistrica region (mg/kg wet weight)

		Pb	Cd
Heart muscle n=38	mean	0.66	0.008
	range	<0.05-16.46	<0.003-0.084
	% exc.sam.	7.9	0
Kidney n=38	mean	1.62	2.429
	range	0.06-31.12	0.359-9.114
	% exc.sam.	23.7	68.4
Liver n=38	mean	0.44	0.232
	range	<0.05-3.28	0.033-0.854
	% exc.sam.	13.2	10.5

% exc.sam. - percent of samples which exceed tolerances

maximum values in Tables 1 and 2). The percentage of samples which exceed tolerance for Cd from Koroška was also much higher than from Ilirska Bistrica. More than 70% of kidney and more than 60% of liver from Koroška exceeded our official tolerances which are 1.0 mg/kg for kidney and 0.5 mg/kg for liver (Uradni list SFRJ 1987). Both tissues of game from Koroška were considered as unfit for human consumption.

Concentrations of Pb in meat of game from Koroška (Table 1) show us that meat is a special problem. The maximum values were very high and the percent of exceeding samples was about 30. High content of Pb in meat of game is not only a consequence of environment contamination, it is a consequence of lead shots, too.

Table 3. Correlation between animals' age and Cd content in kidney of game from Ilirska Bistrica

Age (years)	Number of animals	Number of kidney with Cd content:		Percent of samples exceeding tolerance
		<1.0mg/kg	>1.0mg/kg	
<1	9	6	3	33.3
1-2	7	2	5	71.0
2-3	11	2	9	81.8

The correlation between the animals' age and Cd content in kidney in Ilirska Bistrica was researched. From Koroška we have not got enough animals of the same age. The positive correlation between the concentration of Cd in kidney of game from Ilirska Bistrica and the age was evident (Table 3). The number of samples with Cd content higher than 1.0 mg/kg increases with the increasing animals' age.

In Tables 4 and 5 the results of our Residues monitoring and surveillance programme for Pb and Cd content in tissues of game from different places of Slovenia in the period from 1989 to 1992 are shown.

Table 4. Lead content in tissues of game \* (mg/kg wet weight) - results of the Residues monitoring programme in Slovenia for the period from 1989 to 1992

Year	Tissue	Number of samples	Range		Mean	Percent of samples exceeding tolerance
1989	Meat	40	0.05	7.67 <sup>a</sup>	1.01	35%
	Kidney	18	0.05	1.81 <sup>b</sup>	0.33	5.5%
	Liver	25	0.05	0.91	0.16	
1990	Meat	24	<0.05	4.66 <sup>c</sup>	0.96	12.5%
	Kidney	13	<0.05	0.22	0.09	
1991	Meat	11	<0.05	3.41 <sup>d</sup>	0.38	9.1%
1992	Meat	11	<0.05	0.32	0.08	
	Kidney	1	<0.05	<0.05	<0.05	

\* - roes, deer, wild ducks, chamois, hares, pheasants

a - roe-deer, b,c, and d - wild duck

Table 5. Cadmium content in tissues of game \* (mg/kg wet weight) - results of the Residues monitoring programme in Slovenia for the period from 1989 to 1992

Year	Tissue	Number of samples	Range		Mean	Percent of samples exceeding tolerance
1989	Meat	34	0.003	1.009 <sup>a</sup>	0.043	29%
	Kidney	12	0.005	8.215 <sup>b</sup>	1.058	55.5%
	Liver	9	0.004	2.110 <sup>c</sup>	0.400	33.3%
1990	Meat	8	<0.003	<0.003	<0.003	
	Kidney	9	<0.003	1.556 <sup>d</sup>	0.682	33.3%
1991	Meat	11	<0.003	0.010	0.004	
1992	Meat	11	<0.003	0.011	0.065	
	Kidney	1	1.342	1.342 <sup>e</sup>	1.342	100%

\* - as in Table 4

a - roe-deer, b and c - wild duck, d and e - roe-deer

The problem of lead residues in meat of game is obvious in all four years (samples of meat exceeded the official tolerances as seen from Table 4). Residues of cadmium in liver and specially in kidney of game are still a problem. (Table 5). The Ministry of agriculture, forestry and food in Slovenia ordered in January 1990 that kidneys of all species of game have to be judged as unfit for human consumption, irrespective of age and place.

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