

Letters to the Editor

Comments on “Concentration of selected metals in liver, kidney, and muscle of red deer (*Cervus elaphus*)”

Gasparik et al.^[1] determined concentrations of selected metals in the liver, kidney and muscle of red deer (*Cervus elaphus*). They found that the concentration of lead in muscle tissue ranged from 0.150 to 104.873 mg/kg with median value of 6.478 mg/kg, while the concentrations in liver and kidney tissues were much lower. It is very unlikely that lead concentration will increase to such a high level in muscle tissue. Lead in the liver or kidney in the concentration range

above 10 mg/kg will result in poisoning and even death of the animal.^[2,3] It is well known that a wild animal’s muscles, especially deer, usually contain a lead concentration in the range of 0.02–0.262 mg/kg, which is substantially lower than the values reported by Gasparik et al.^[1] while the liver and kidney contain some higher concentrations^[4–10] (see Tables 1–3). In my opinion, these higher lead concentrations in muscle tissue are the consequence of incorrect sampling procedures. It is very likely that the samples of muscle used in Gasparik et al.^[1] study contained parts of a bullet.

Table 1. Lead concentrations in muscle, liver and kidneys, found by different authors.

		Muscle (mg/kg)	Liver (mg/kg)	Kidney (mg/kg)
Niemi et al. ^[10]	x ± SD w/w	0.02 ± 0.03	0.05 ± 0.04	0.07 ± 0.04
Santiago et al. ^[5]	x ± SD w/w		0.57 ± 1.53	0.33 ± 0.32
Pokorny & Ribarič ^[6]	x ± SD w/w	0.05 ± 0.03	0.71 ± 0.65	0.03 ± 0.01
Falandyz et al. ^[7]	x ± SD w/w	0.22 ± 0.26	0.26 ± 0.21	0.31 ± 0.26
Reglero et al. ^[8] 4 different regions	x ± SD d/w		0.109–0.805 ± 0.081–0.210	
Kramarova et al. ^[11]	x ± SD w/w		1.904 ± 0.804	0.561 ± 0.112

Table 2. Lead concentrations in muscle, liver and kidneys of red deer from Croatia with respect to their age.^[9]

	<1.5 years (mg/kg)	1.5–3.0 years (mg/kg)	4–6 years (mg/kg)	> 6 years (mg/kg)
Muscle x ± SD w/w	0.262 ± 0.143	0.034 ± 0.011	0.201 ± 0.144	0.028 ± 0.006
Liver x ± SD w/w	0.132 ± 0.018	0.081 ± 0.016	0.075 ± 0.010	0.074 ± 0.021
Kidney x ± SD w/w	0.101 ± 0.016	0.099 ± 0.022	0.073 ± 0.006	0.123 ± 0.019

Table 3. Median lead levels in liver and kidneys (dry weight) of red deer from Netherlands with respect to their age.^[4]

	< 0.5 years (mg/kg)	0.5–1.5 years (mg/kg)	1.5–8 years (mg/kg)	> 8 years (mg/kg)
Liver median d/w	0.90	0.70	0.54	0.80
Kidney median d/w	1.75	1.11	0.89	0.45

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Emil Srebočan, DVM, Ph.D

Department of Pharmacology and Toxicology
Veterinary Faculty,
University of Zagreb, Croatia
E-mail: emil@vef.hr

Response to Comments on “Concentration of selected metals in liver, kidney, and muscle of red deer (*Cervus elaphus*)”

We thank Dr. Emil Srebočan for his interest in our study and critical comments, and to the Editor for providing the opportunity to respond.

Dr. Srebočan suggested that the reason of high lead concentration in muscle might be related to small bullet particles. However, during the procedure of material collection used in our study there was no evidence present of visible bullet particles in the samples and it is unlikely that they

remained hidden. We have reported actual concentrations of lead in muscle samples detected under the experimental conditions used in our study. It should be noted that such a high concentration was detected only in one sample (Fig. 1). In regard to the analyses of metal contents in animal tissues we would like to point out that we have followed the same procedure on a routine basis in our laboratory for many years.^[1–3] The reason for the abnormally high concentration of lead observed in one sample will remain a matter of conjecture until more information is available.

In general, higher lead concentrations are detected in the liver and kidney. However, it should be noted that the highest lead concentration found in the muscle of the wild rabbit (3.81 ± 6.92 ; 0.06 – $20.42 \mu\text{g/g}$ wet weight) in comparison with the kidney (0.06 ± 0.03 ; 0.03 – $0.13 \mu\text{g/g}$) and liver (0.16 ± 0.21 ; 0.04 – $0.78 \mu\text{g/g}$) has been reported.^[4] Authors for this study also conclude that 40% of the lead concentration values obtained for the rabbit muscle were over the maximum limit. It is possible that the relatively high values of lead in the muscle of some rabbits may have resulted from the individual samples, which had already suffered gunshot injuries prior to their death.^[4] Also in gun-shot pheasants, significantly higher (5.5–times) lead concentrations were detected in the muscle in comparison with the liver.^[5] Slightly higher concentrations for some samples have been reported in the mountain hare^[6] as well as for cattle samples.^[7]

Bullet-derived game food products are an important source of lead contamination in humans. To assess bullet-derived lead contamination of soft game tissues, muscle tissue samples were collected from 10 wild boars and 10 red deer immediately after they had been shot.^[8] The individuals examined differed in the lead contents in their tissues surrounding the entry and exit wounds and at different sites along the bullet pathway. One of the animals showed as much as 1,095.9 mg/kg wet weight of lead in the tissue surrounding the bullet track near the entry wound and 736.0 mg/kg being recorded around the exit wound, indicating a seven-fold increase of the maximum concentration reported in our study.^[1] Also between 1988 – 2000 nationally representative samples of muscle, liver and kidney from wild animals were collected and analyzed for lead and other toxic metals. High lead levels in muscles appear to be the most notable discovery of this survey.^[9] The average lead content in the muscles of wild pigs was 4.342 mg/kg and in roe 4.193 mg/kg whereas in the liver and kidney the sample was 0.143 – 0.914 mg/kg.^[9]

Other researchers have reported the frequency of elevated lead concentrations in pectoral muscle tissues of hunter-killed game birds (mostly waterfowl), occasionally the cause of observed high lead values. Of the 827 right pectoral muscle pools, 92 had lead concentrations greater than $0.5 \mu\text{g/g}$ wet weight (0.5 mg/kg w.w.).^[10] The average lead concentration for those 92 pools was $12 \pm 38 \mu\text{g/g}$ wet weight. The average concentration of lead in right pectoral muscle tissue of individual birds from high

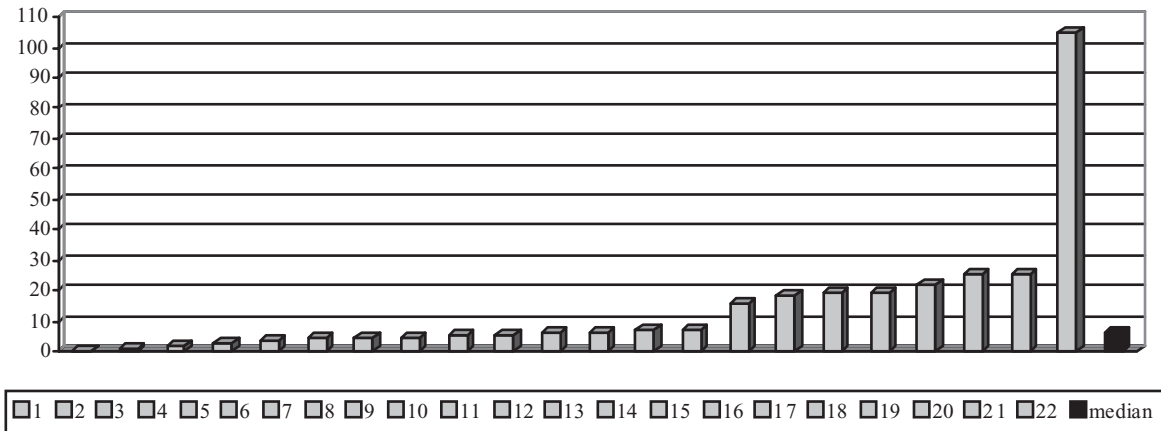


Fig. 1. Individual concentrations of lead in muscle (n = 22).

lead pools with elevated muscle–lead content was $211 \pm 634 \mu\text{g/g}$ and ranged from 5.5 to $3910 \mu\text{g/g}$. Radiography confirmed the presence of numerous small (<1 mm diameter) metallic fragments in the pectoral muscle samples from these birds.^[10] As we have not realized such an analysis we suspect that in our study this might be the reason for the high lead concentration detected in some samples. However, in view of the fact that higher concentration was also detected in liver, the reason for this observation appears to be a co–action of altered environment at this location.

References

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Peter Massanyi, DVM, PhD
 Department of Animal Physiology
 Faculty of Biotechnology and Food Science
 Slovak University of Agriculture
 Slovak Republic
 E-mail: massanyi@yahoo.com