Koncentrácia kadmia v pečeni a obličkách niektorých voľne žijúcich zvierat

Concentration of cadmium in liver and kidney of some wild animals

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Abstract

Cadmium is an environmental pollutant that has serious toxic effect in animals and also humans. In this study we analyzed the accumulation of this metal in liver and kidneys of wild animals (wood mouse, yellow-necked mouse, red deer, brown hare). Samples were analyzed by the atomic absorption spectrophotometry (AAS). The highest levels of cadmium were found in the kidneys (0.213 – 2.387 mg. kg-1) of all animal species. The concentration of cadmium in liver was in range of 0.06 – 0.48 mg.kg-1.

Key words: farm animals, cadmium, liver, kidneys, wild animals.

Cadmium is an environmental pollutant that has serious toxicity in humans and animals and causes Itai-Itai disease (Mochizuki et al., 2002). Cadmium is known to be both extremely toxic and ubiquitous in natural environments. It occurs in almost all soils, surface waters and plants, and it is readily mobilised by human activities such as mining. As a result, cadmium has been recognized as a potential health threat to wildlife species; however, because it exists most commonly in the environment as a trace constituent, reported incidences of cadmium toxicity are rare. Cadmium toxicity may be more common among natural populations of vertebrates than has been appreciated to date and that cadmium toxicity may often go undetected or unrecognised (Larison et al., 2000; Soylak et al., 2002).

In long – term chronic occupational exposure to cadmium, the kidneys are usually the most critically affected organs, and in 1980 the World Health Organisation (World Health Organisation Study Group, 1980) recommended that the cadmium concentration in urine should not be allowed to reach 10 μg $Cd.g^{-1}$ creatinine, since above this concentration there is some risk of renal dysfunction (World Health Organisation Study Group, 1980). The kidney is well known to be a major target organ of cadmium in animals and humans. During chronic exposure the metal accumulates in renal cortex up to what appears to constitute a critical level at which the incidence of overt malfunction in a human population at risk begins to increase (Kjellstrom et al., 1984).

The accumulation of toxic substances in the tissue of game animals is studied almost world-wide. Studies concern not only the degree of contamination of the whole animal body or particular tissue but also the influence of accumulated elements on the condition, growth and reproduction of individuals. Some tissue, such as deer antlers, might be even used for biomonitoring of natural ecosystems (Samiullah, 1990). Also wild birds reflect the level of environmental contamination which should be monitored (Mochuňizuki et al., 2002).

Cadmium exposure leads to renal tubular dysfunction. This is primarily a re-absorption defect in the proximal tubules and the critical effect of cadmium. There are also various effects on reproduction, causing follicular atresia in ovary (Krasny, Holbrook, 1977),

degenerative alterations in testes (Massányi et al., 2002; Toman, Massányi, 2002) decreased spermatozoa motility (Lukáč et al., 2003; Massányi et al., 2004). Cadmium can be etiological factor in various pathological processes as higher blood pressure, arteriosclerosis, inhibition of growth, alterations in central nervous system, hepatic dysfunction, bronchitis and teratogenic effects (Friberg et al., 1986; Oishi et al., 2000).

The aim of this study was to estimate the amount of cadmium in liver and kidneys of wild and farm animals and comparison of the cadmium concentrations.

Material and Methods

In this study 9 animal species: yellow-necked mouse (*Apodemus flavicollis*; n=15); wood mouse (*Cleithrionomys glareolus*; n=8); brown hare (*Lepus europaeus*; n=74); fallow deer (*Dama dama*; n=10) and red deer (*Cervus elaphus*; n=22); were analyzed for the presence of cadmium in liver and kidney *(cortex renalis).*

After collection the tissue samples were kept at –18°C until analysis. In the laboratory the samples (liver, kidney cortex) were weighed and ashed with diluted nitric acid p.a. (HNO_3:H_2O=2:1) at 130°C for 2 h. Undissolved particles were filtered off and the solution diluted to 25 ml. The concentrations of cadmium were analyzed by AAS (Perkin Elmer 4100 ZL) in a graphite furnace. The flame conditions were those recommended by the instrument manufacturer for cadmium – wavelength 228.8 nm. Values of cadmium are presented on a wet weight basis in mg/kg (Massányi et al., 2003).

To compare results the analysis of variance (mean, minimum, maximum, standard deviation) as well as F-test (PC program Excel) were applied.

Results

The results of average concentration of cadmium in the liver and kidneys of animals as small rodents: yellow-necked mouse *(Apodemus flavicollis)*, wood mouse *(Cleithromyces glareolus)*, leporidae: brown hare (*Lepus europaeus)* and ruminants: fallow deer *(Dama dama* and red deer *(Cervus elaphus)* are summarized in Table 1.

In small rodents we found higher concentration in kidneys in comparison to liver. The concentration in kidneys of wood mouse was 0.52 ± 0.26 $mg.kg^{-1}$. Lower values were found in kidneys of yellow-necked mouse (0.213 ± 0.11 $mg.kg^{-1}$). The sequence of concentration of cadmium in liver was as follows: wood mouse (0.07 ± 0.02 $mg.kg^{-1}$) and yellow-necked mouse (0.03 ± 0.02 $mg.kg^{-1}$).

Concentration ($mg.kg^{-1}$) of cadmium in liver and kidney of some wild animals

Table 1

Animal	organ	n	mean	s	min	max
Apodemus flavicolis	liver kidney	15	0,03 0,21	0,02 0,11	0,01 0,07	0,06 0,42
Cleithromyces glareolus	liver kidney	8	0,07 0,52	0,02 0,26	0,03 0,15	0,09 0,97
Brown hare	liver kidney	74	0,16 1,57	0,14 1,10	0,00 0,00	1,00 4,72
Fallow deer	liver kidney	10	0,06 0,35	0,03 0,05	0,01 0,15	0,17 0,77
Red deer	liver kidney	22	0,26 2,39	0,10 0,91	0,07 0,32	0,87 5,76

The mean concentration of cadmium in internal organs of *Leporidae* was significantly higher in kidneys than in liver.

In comparison to concentration of cadmium in liver and kidneys in ruminants we found the similar results as in previous cases. It means that the kidneys were organ of higher accumulation of cadmium. In kidneys of red deer it was the highest amount (2.39 ± 0.91 $mg.kg^{-1}$), in fallow deer (0.35 ± 0.05 $mg.kg^{-1}$). The highest concentration of cadmium was, analogously, in red deer (0.26 ± 0.10 $mg.kg^{-1}$). In liver of fallow deer was lower content of cadmium (0.06 ± 0.03 $mg.kg^{-1}$).

Discussion

It is generally known that cadmium is mainly accumulated in kidneys and liver of animals (Massányi et al., 1995; Massányi, Uhrín., 1996; Tataruch, 1994; Toman, Massányi 1996; Toman, Massányi, 2005). Many authors present that organ of higher accumulation of cadmium is kidney as a detoxifying organ (Linde et al., 2004, Massányi et al., 2003; Tataruch, 1994; Yalin et al., 2005) what correspond also with our results. We found higher concentration of cadmium in kidneys of wild animals in comparison to the liver. Similar results are also presented in other animals as foxes (Dip et al., 2001), sheep (Bíreš et al., 1991), red deer (Kramárová et al., 2005; Wolkers et al., 1994), pheasants (Toman et al., 2005), wild boar (Wolkers et al., 1994) and rats (Yalin et al., 2005).

From group of small rodents the highest concentration was in kidneys of wood mouse. Lower concentration was found in kidneys of yellow-necked mouse. Small rodent species, in relation to their food chain, may serve as a bioindicator to detect certain toxic hazards as heavy metals in the game (Jančová et al., 2002). From the second group of *Leporidae* the highest accumulation of cadmium took place in kidneys of brown hare. Similar results are given also by (Massányi et al., 2003), where the median concentration of cadmium in adult hares was 0.154 in liver mg/kg and 1.521 mg/kg in kidney. The high accumulation of cadmium in kidneys of brown hare was published also by other authors (Kramárová et al., 2005: Lutzt, Slamečka, 1997; Massányi et al., 1995). From the third group – ruminants the high level of cadmium concentration was found in kidneys of red deer (2.39 mg/kg) followed by fallow deer (0.35 mg/kg). As was published by (Falandysz et al., 2005), for cadmium the concentrations in decreased in the order kidney>liver>muscle tissue of red deer, with overall means of 2.2, 0.10 and 0.26 mg/kg wet weight, respectively. In comparison with our experiment in the red deer the concentration of cadmium in liver was 0.26 mg/kg and in kidney 2.39 mg/kg. Wild ruminants consume more cadmium than domesticated ruminants, which do not consume parts of perennial plants. The rumen contents of all wild ruminants contained, with 0.20 to 0.25 mg/kg dry matter more cadmium than could be expected from the content of the grazing. In the cadmium contaminated areas the amount of cadmium in the rumen contents showed the cadmium-load. The cadmium concentration ascertained in the organs of the wild ruminants was compared with that of sheep and cattle. On average, the higher cadmium-load of the wild ruminants was confirmed. The kidneys of wild ruminants older than five years should, as a general principle, not be eaten and neither should the livers of animals from cadmium-contaminated biotopes (Anke et al., 1979)

Ingestion of even trace quantities of cadmium can influence not only the physiology and health of individual organisms, but also the demographics and the distribution of species (Larison et al., 2000). The pathological effects of cadmium to organs and tissues, and the long-life in humans and animals, from 30 to 10 years, respectively, strongly indicate the need for control of the amount of cadmium in foodstuffs. For people cadmium is a carcinogenic and mutagenic element (Andac et al., 2004). There is no specific treatment available for acute or chronic metal poisoning. Besides supportive therapy and haemodialysis, metal poisoning is

often treated with commercially available chelating agents including EDTA and dimercaprol. However, there is histopathological evidence for increased toxicity in animals when these agents utilized.

Acknowledgments:
This study was supported by State program Food Quality and Safety (18b/02-Biological Aspects of Increasing Quality of Animal Origin Foodstuff) and VEGA Scientific Grant 1/2417/05 from the Ministry of Education of Slovak Republic.

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