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DISTRIBUTION OF TRACE ELEMENTS IN LIVER AND MUSCLE OF JAPANESE QUAILS

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ABSTRACT

The purpose of this study was to examine concentrations of trace elements in the selected tissues and organs of Japanese quails (*Coturnix coturnix japanica*). The samples of liver and muscle were analyzed for the presence of cadmium (Cd), chromium (Cr), zinc (Zn) and copper (Cu) on the atomic absorption spectrophotometer (Unicam Solar 939). The mean values of Cd, Cr, Zn and Cu found in leg muscle were 0.016; 0.361; 51.076 and 4.822 $mg.kg^{-1}$ respectively; and in liver the values were 0.026; 0.277; 50.607 and 9.346 $mg.kg^{-1}$, respectively. Tissue analysis showed an accumulation of Cd, Cr, Zn and Cu in the liver and muscle of Japanese quails and some significant relationship between liver and muscle metal concentrations.

Keywords: cadmium, chromium, zinc, copper, liver, muscle, Japanese quail

INTRODUCTION

Cadmium is an environmental contaminant unique among metals because of its diverse toxic effects, extremely protracted biological half life, low rate of excretion from the body and predominant storage in soft tissue (Beňová et al., 2006; Lukáč et al., 2007). Chromium and zinc are essential nutrients for animals. Chromium plays an important beneficial role in interaction with some toxic elements (Skalická et al., 2007). Zinc, frequently used as dietary ingredients do not always supply adequate Zn to meet animal requirements for this element (Kottferová et al., 2002). Copper is an essential but potentially toxic element. Deficient intake results in impairment of various biological functions but the metal is toxic when ingested in excess (Skalická et al., 2005). Element toxicity upon the biological systems of animals is affected by the route and form of ingestion as well as by the interaction between essential and toxic elements. The amount of an element, which accumulates in the organs, depends on the interval of exposure, the quantity of ingested element, as well as animal age and breed (Massányi et al., 2000).

Japanese quail (*Coturnix coturnix japanica*) is an interesting domestic economic species for commercial egg and meat production besides chicken. Quail is often used for investigation of physiological process in the birds, and is also a suitable experimental model for observation of relationship between essential elements and xenobiotics *in vivo* (Kottferová et al., 2005; Holovská et al., 2008)

The aim of this study was to examine the distribution of cadmium, chromium, zinc and copper in liver and leg muscle of Japanese quails.

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MATERIAL AND METHODS

Fifty Japanese quails were included in the experiment. During the 58 day of life quails were fed with standard diet (HYD–10). The used feed and water was provided *ad libitum*. Liver and leg muscle samples (n=96) were collected for analysis of trace elements. The analysis consisted of digestion (5 ml HNO_3 and 1 ml HCl per 1 g of sample) in the microwave oven Milestone and determination of cadmium by the method of Kocourek (1992). Samples were analysed for presence of Cd, Cr, Zn and Cu using an atomic absorption spectrophotometer (AAS) Unicam Solar 939. Concentrations of Cd and Cr were analyzed in a graphite furnace and concentrations of Zn and Cu by using a flame atomic absorption spectrophotometer. Metal concentrations are expressed on wet weight basis (Skalická et al. 2005).

The differences in Cd, Cr, Zn and Cu concentrations between muscle and liver were compared and statistically analyzed using Student's t–test (Microsoft Excel 7.0) setting significance levels at $p<0.05$, $p<0.01$ and $p<0.001$. The data are presented as means ± standard deviations. The statistical associations between concentrations of heavy metals in muscle and liver were also evaluated using correlation analysis.

RESULTS AND DISCUSSION

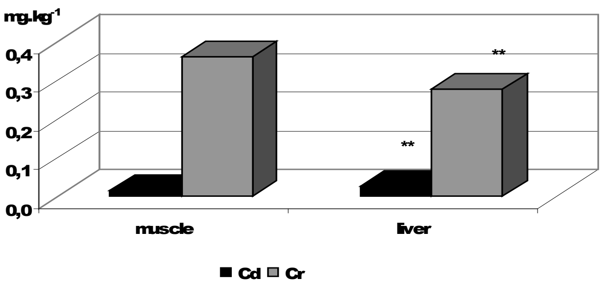
Mean concentrations of cadmium, chromium, zinc and copper in the liver and leg muscle are recorded in Table 1.

Table 1: Concentrations of Cd, Cr, Zn and Cu in liver and leg muscle of Japanese quails (mg.kg $^{-1}$)

Trace elements		muscle	liver
Cd	x	**0.016**	**0.026**
	sd	0.003	0.008
	x max	0.020	0.040
Cr	x	**0.361**	**0.277**
	sd	0.020	0.055
	x max	0.387	0.320
Zn	x	**51.076**	**50.607**
	sd	4.212	11.087
	x max	58.440	61.200
Cu	x	**4.822**	**9.346**
	sd	0.304	2.318
	x max	5.218	12.340

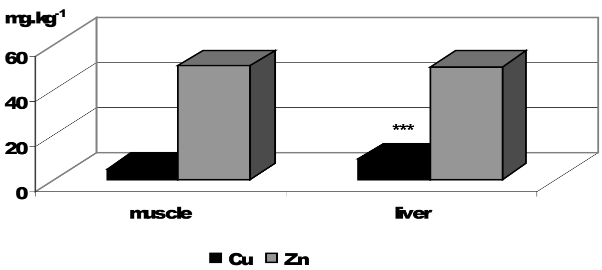
Liver mean concentration of Cd was higher (0.026 mg.kg^{-1}) than mean concentration of Cd in muscle (0.016 mg.kg^{-1}). Similarly, the mean concentration of Cu in liver was higher (9.346 mg.kg^{-1}) in comparison to mean value of Cu in muscle (4.822 mg.kg^{-1}). On the other hand, the mean level of Cr and Zn in liver was lower (0.227 and 50.607 mg.kg^{-1}, respectively) than in muscle (0.361 and 51.076 mg.kg^{-1}, respectively). In the present study a Zn – Cu antagonism was observed: deposition of Cu in the leg muscle and liver of Japanese quails decreased against Zn. Magali et al. (2008) studied the concentration of trace elements in three domestic ducks. In muscle the concentrations of Zn ranged from 67.5 to 77.3 mg.kg^{-1}, in liver from 24.6 to 48.7 mg.kg^{-1}, Cu in muscle from 5.9 to 7.4 mg.kg^{-1}, Cu in liver from 17.9 to 36.9 mg.kg^{-1}; Cd in muscle from 0.004 to 0.005 mg.kg^{-1} and in liver from 0.028 to 0.173 mg.kg^{-1}, respectively. These concentrations of Zn and Cd were higher in comparison to our results of Japanese quails. In turkeys, Aderson et al. (1989) observed higher mean concentrations of Cr in muscle and liver.

Mean level of Cd in liver was higher than mean Cd level in muscle of Japanese quails. This difference was statistically significant ($p\leq0.01$). Mean concentration of Cu in liver was significantly higher ($p\leq 0.001$) than mean concentration of Cu found in muscle. On the other hand, significantly lower ($p\leq0.01$) mean Cr level was observed in liver compared with muscle, but the difference in Zn concentration was not significant (Fig.1; Fig. 2).



** Statistically significant at $p\leq 0.01$

Fig. 1: Concentrations of cadmium and chromium in leg muscle and liver of Japanese quails



*** Statistically significant at $p\leq0.001$

Fig. 2: Concentrations of zinc and copper in leg muscle and liver of Japanese quails

Table 2: Correlation between the concentrations of Cd, Cr, Zn and Cu in Japanese quails

	CdM	CrM	CuM	ZnM	CdL	CrL	CuL	ZnL
CdM	1							
CrM	-0.947	1						
CuM	-0.192	0.215	1					
ZnM	0.780	-0.630	-0.270	1				
CdL	0.769	-0.693	-0.588	0.706	1			
CrL	0.088	-0.277	-0.072	0.135	0.229	1		
CuL	-0.885	0.899	-0.076	-0.724	-0.596	-0.442	1	
ZnL	0.503	-0.361	-0.423	0.268	0.742	-0.335	-0.148	1

CdM – cadmium in muscle; CrM – chromium in muscle; CuM – copper in muscle; ZnM – zinc in muscle; CdL – cadmium in liver; CrL – chromium in liver; CuL – copper in liver; ZnL – zinc in liver.

As shown in Table 2, correlation analysis detected some relationships between liver and leg muscle metal concentrations. A significant correlation was found between Cd in muscle and Cr in muscle (r=–0.947), Cu in liver and Cr in muscle (r=0.899) and Cu in liver and Cd in muscle (r=–0.885).

Several authors have shown that Cd, Cr, Zn and Cu primarily accumulate in inner organs (Magali et al., 2008; Skrivan et al., 2005; Jevsnik and Doganoc, 2003). Falandysz et al. (1994) determined the concentrations of Cu, Zn, and Cd in muscle and in liver of poultry from the northern part of Poland. The mean values obtained related to wet weight for muscle meat and livers of animals were: 0.52 – 7.3 $mg.kg^{-1}$ for Cu; 5.7 – 40 and 20 – 45 $mg.kg^{-1}$ for Zn and less than 5 – 140 and 250 – 5100 $\mu g.kg^{-1}$ for Cd, respectively.

The results of this study demonstrate antagonism among selected trace elements. The decreased mean concentrations of cadmium, copper may lead to zinc excess in tissue.

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REFERENCES

ANDERSON, R A. – BRYDEN, N.A. – POLANSKY, M.M. – RICHARDS, M. P. 1989. Chromium supplementation of turkeys: Effects on tissue chromium. In: *J. Agric. Food Chem.*, vol. 37, 1989, p.131–134.

BEŇOVÁ, K. – DVOŘÁK, P. – FÁLIS, M. – SKLENÁŘ, Z. 2007. Interaction of low doses of ionising radiation potassium dichromate and cadmium chloride in *Artemia franciscama*, In: *Acta Vet. Brno*, vol. 76, 2007, p. 35–40.

FALANDYSZ, J. – KOTECKA, W. – KURUNTHACHALAM, K. 1994. Hg, Pb, Cd, Mn, Cu, Fe and Zn concentrations in poultry, rabbit and sheep from the northern part of Poland. In: *Sci. Total Environ*., vol. 141, 1994, p. 51–57.

HOLOVSKÁ, K. – ALMÁŠIOVÁ, V. – CIGÁNKOVÁ, V. 2008. Ultrastructure of skeletal muscle of Japanese quails during simulated microgravidity. 7[th] Internatational Scientific Conference Ecology and Veterinary Medicine VII, 2008, p.164-167.

JEVSNIK, M. – DOGANOC, D.Z. 2003. Trace elements in Slovenia poultry tissues. In: *J. Food Prot*., vol. 66, 2003, p. 686-690.

KOCOUREK, V.1992. Metódy analýzy cudzorodých látok v potravinách, Praha, 1992, 55 p.

LUKÁČ, N. – MASSÁNYI, P. – KOVÁČIK, J. – TOMAN, R. – KROČKOVÁ, J. –TRANDŽÍK, J. – CIGANKOVÁ, V. – KOLESÁROVÁ, A. – CAPCAROVÁ, M. 2007. Environmental contaminants in animal and testicular structure. In: WANG, Y. et al. (Eds): Progress in environmental science and technology. Vol. I. (Proceedings of the 2007 International Symposium on Environmental Science and Technology). Science Press, Beijing, China, p. 160-164.

KOTTFEROVÁ, J – KORÉNEKOVÁ, B. – SKALICKÁ, M. 2002. Zinc levels in poultry meat. In: *Trace Elements and Electrolytes*, vol. 19, 2002, p. 91–93.

KOTTFEROVÁ, J. – SASÁKOVÁ, N. 2005. Veterinárna klinická etológia ako aplikovaná forma etológie. Etologická konferencia 32, Nečtiny, Česká republika, 2005, p. 54.

MAGALI, L. – ANDRE, J.M. – BERNADET, M.D. – GONTIER, K. – GERARD, G. – DAVAIL, S. 2008. Concentrations of metals (Zn, Cu, Cd, Hg) in three domestic ducks in France: Pekin, Muscovy and Mule ducks. In: *J. Agric. Food Chem*., vol. 56, 2008, p. 281–288.

MASSÁNYI, P. – TRANDŽÍK, J. – LUKÁČ, N. – STRAPÁK, P. – KOVÁČIK, J. – TOMAN, R. 2000. The contamination of bovine semen with Cd, Pb, Cu and Zn and its relation to the quality of spermatozoa used for insemination. In: *Folia Veterinaria,* vol. 44, 2000, p. 150–153.

SKALICKÁ, M. – KORÉNEKOVÁ, B. – NAĎ, P. 2005. Copper in livestock from polluted area. In: *Bull. Environ. Contam. Toxicol*., vol. 74, 2005, p. 740–744 .

SKALICKÁ, M. – NAĎ, P. – DEMETEROVÁ, M. – KORÉNEKOVÁ, B. 2007. Influence of Cr and Cd on quality of Japanese quails eggs. 7[th] International Scientific Conference Risk Factors of Food Chain, 2007, Nitra, p. 197–199.

SKRIVAN, M. – SKRIVANOVA, V. – MAROUNEK, M. 2005. Effect of dietary zinc, iron and copper in layer feed on distribution of these elements in eggs, liver, excreta, soil and herbage. In: *Poultry Sci.*, vol. 84, 2005, p. 1570–1575.

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