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COMPARISON OF CADMIUM, LEAD AND NICKEL ACCUMULATION IN LIVER, BREAST AND LEG MUSCLES OF PHEASANTS

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ABSTRACT

In this study, the heavy metal contents - cadmium, lead and nickel were detected in pheasants (*Phasianus colchicus)*. The samples of liver, breast and leg muscles were collected from pheasants (n=13) and analysed using atomic absorption spectrometry method (AAS) and expressed on a wet weight. The pheasants (n=7) were shot by hunters (using lead shots) in the defined area in Eastern Slovakia or killed (n=6) without shooting. The highest mean levels of cadmium (Cd) were detected in liver (0.037 mg.kg^{-1}). Mean lead (Pb) (0.849 mg.kg^{-1}) and nickel (Ni) (0.548 mg.kg^{-1}) concentration were the highest in breast muscle of shot pheasants. On the other hand, the killed pheasants had highest mean concentrations of heavy metals in liver. The analysis of investigated biological material confirmed higher mean concentrations of Pb and Ni in shot than killed pheasants. Minimum differences were observed between mean levels of Cd in shot and killed pheasants. Remarkable increase of Pb and Ni in breast muscle of shot pheasants may be due to used shots.

Key words: pheasant, cadmium, lead, nickel

INTRODUCTION

Game birds are those birds that have traditionally been wild or hunted but have been raised commercially for their meat, for egg production or for release in hunting reserves (Almášiová et al., 2008). *Phasianus colchicus* is the most popular species of hunting (0.10 – 0.13 millions pheasants/year with total weight of about 100 – 130 tons) in Slovakia (Slamečka et al., 2003).

Industrial uses of heavy metals led to widespread dispersion of these metals at trace levels into the natural environment (Kimáková, 2000). However, there is little information about content of Cd, Pb and Ni in pheasants.

Cadmium contamination in wild birds is an indicator of environmental pollution (Mochizuki et al., 2002). It can be an etiological factor in various pathological processes such as hepatic, renal tubular dysfunctions and alterations in the reproductive organs (Massányi et al., 2008; Srebočan, 2006). Lead is a naturally occurring basic element and environmental contaminant. Pb pollution primarily comes from lead smelters, metal processing plants and incinerators. Pb in the body can damage internal organs, the brain and nervous system and cause reproductive disorders and osteoporosis (Kolesárová et al., 2008). Nickel has toxic effect on living organisms and is often considered as contaminant and a weak carcinogen (Stawarz et al., 2003). Animal studies report depressed growth, reduced reproductive rates and alteration of serum lipids and glucose (Arpášová et al., 2007). The aim of this study was to determine Cd, Pb and Ni bioaccumulation in tissues of "hunted" and "killed" pheasants.

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MATERIALS AND METHODS

Samples (n=39) of breast and leg muscles and livers were collected from pheasants (n=13) from defined locality in Eastern Slovakia. This area is burden with pollution of metallurgical industry, for that reason, may deserve special attention with regard to possible heavy metal contamination. The pheasants (n=7) were shot by hunters (using lead shots) or killed without shooting (n=6). Samples of muscles and liver of pheasants were immediately transported to the laboratory. They were frozen and stored at –20° C until analysed. Samples were digested in a microwave oven MLS 1,200 MEGA (Milestone) using a mixture of 5 ml HNO_3 and 1 ml HCl per gram of sample. Metals were determined using an atomic absorption spectrometry (Unicam Solar, Model 394) by the method of Kocourek (1992). The reproducibility of the method was tested by analysing reference materials (MBH Anal. Ltd., England). The graphite furnace was optimised for maximum absorbency and linear response while aspirating known standards. The standards were prepared from the individual 1000 $mg.kg^{-1}$ standard (Merck, Germany); 100 ml of five combined standards were prepared in 0.1 N HNO_3. The lamp current was 75%. The signal type was transient. Measurement time was 3 seconds. The recovery of the methods was 96 to 98% and reproducibility was better than 1%. The metal concentrations were expressed on a wet weight basis (Skalická et al. 2005). The results were statistically analysed using Student's t-test (Microsoft Excel 7.0) setting significance level at $p<0.05$. The data are presented as means and standard deviations.

RESULTS AND DISCUSSION

Mean concentrations of Cd, Pb and Ni in the liver, breast and leg muscle are recorded in Table1. The highest mean levels of Cd were noticed in liver of shot pheasants ($0.037\ mg.kg^{-1}$). The minimum differences were observed between mean levels of Cd in leg muscles of shot and killed pheasants. The obtained results were compared with the maximum permissible levels for Cd in game meat ($0.1\ mg.kg^{-1}$) according to Codex Alimentarius of Slovak Republic (2006). Our results are in accordance with study of Toman et al. (2005). They observed slightly higher mean concentration of Cd in liver ($0.04\ mg.kg^{-1}$) of pheasants. According to Grosicky and Kowalski (2002), the liver and muscle accumulate substantial amounts of administered Cd. In the experiment with pheasant low Cd content was noted in the muscle. Cadmium accumulated mainly in the kidney and liver of adult Cd–exposed pheasants.

Table 1: Concentration of Cd, Pb, Ni (mg/kg wet weight) in liver, breast and leg muscles of shot and killed pheasants (Phasianus colchicus)

Analysed parameter	Liver	Breast muscle	Leg muscle	Liver	Breast muscle	Leg muscle
Cadmium		shot pheasants			killed pheasants	
n	7	7	7	6	6	6
$\bar{x}$	0.037	0.008	0.019	0.036	0.024	0.016
Sd	0.024	0.004	0.034	0.017	0.025	0.017
x max	0.066	0.014	0.097	0.061	0.070	0.050
Lead		shot pheasants			killed pheasants	
n	7	7	7	6	6	6
$\bar{x}$	0.153	0.849*	0.115	0.144	0.065	0.042
Sd	0.074	2.092	0.057	0.086	0.025	0.016
x max	0.273	5.591	0.223	0.278	0.099	0.067
Nickel		shot pheasants			killed pheasants	
n	7	7	7	6	6	6
$\bar{x}$	0.189	0.548*	0.286	0.179	0.208	0.203
Sd	0.168	0.507	0.204	0.278	0.214	0.266
x max	0.406	1.408	0.659	0.745	0.589	0.724

n - number of samples analyzed; $\bar{x}$ - arithmetic mean; Sd - standard deviation; x max - maximal values, statistically significant differences at * $p<0.05$

Tissues analysis showed the statistically higher ($p<0.05$) mean levels of Pb (0.849 $mg.kg^{-1}$) in breast muscle of shot pheasants than in the ordinarily killed pheasants (0.065 $mg.kg^{-1}$). Similarly, slightly higher concentrations were observed in leg muscle of shot pheasants. The minimum differences were recorded between mean concentrations of Pb in liver of shot and killed pheasants. The results indicated that the cause of Pb bioaccumulation in muscles was probably the way of pheasant killing. The used shots (shells) contain pellets with high quality of lead. They are often plated with Cu or Ni, which give better patterns and penetration for clean kills. However, metal–plated lead shot has not been approved to be a nontoxic shot type. The thin layer of metal is easily eroded by a bird digestive system and resulting in negative effect.

The higher mean concentrations of Ni were found in shot pheasants than killed birds in all observed tissues. The mean content of Ni in breast muscle (0.548 $mg.kg^{-1}$) of shot pheasants was statistically higher ($p<0.05$) than in the killed pheasants (0.208 $mg.kg^{-1}$). Our results were compared with the study of Kalinska et al. (2004), who recorded also the highest Ni contents in muscles. The liver and kidneys showed slightly lower levels, ranged from 0.014 to 0.100 mg/g wet weight.

These results showed higher levels of Pb and Ni in "shot" than "killed" pheasants. These results indicate that shooting has a great impact only in case of Pb and Ni content. However, there were no significant association between levels of Cd in shot and killed pheasants. The character of Cd accumulation appeared to be related to local environmental pollution.

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