POSTER PRESENTATIONS

BIOACCUMULATION AND DISTRIBUTION OF LEAD AND CADMIUM IN HEN'S ORGANISM

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ABSTRACT

Investigation was conducted with 80 hens of ISA Brown's breed divided in 4 groups in 36 weeks age. The animal ration includes different amount of lead and cadmium: group 1-the amount of tow toxic elements is under the MRL. The amount of tow toxic elements in group 2, 3 and 4 is 10, 100, 1000 times bigger than MRL respectively (Pb=0.2, Cd=0.1 mg/kg).

Distribution of elements was studded with criteria: Klark of distribution (Kd) which is the ratio between the concentration of chemical element in mg/kg product and middle Klark (in wet weight). Criteria "Klark of distribution" allow to assessment of the bioaccumulation and distribution of the lead and cadmium in different organ and tissue.

Keywords: bioaccumulation, distribution, cadmium, lead, hens

INTRODUCTION

Heavy metals derive form industrial sources, natural erosion and geochemical cycles. Pollutants such as lead and cadmium enter the food chain through air and water. In estuaries, industrial and other anthropogenic sources often provide the primary source of heavy metals (Burger et al 2001 Dong-Ha et al 2002). There have been numerous studies of bioaccumulation in variety of organisms including mammals and birds. These studies usually examine levels of lead and cadmium in variety organs and tissues (Wayland et al 2001, Medvedev et al 1999, Erdogan et al 2005, Gotal et al 2992).

The amount of lead and cadmium which distributes in the organs and tissues of the animals depends on the interval of exposure, the quantity ingested; the production and reproduction phase of the animals, as well as their age and breed (Baykov et al 1996).

The dates in literatures have not criteria for assessment distribution of lead and cadmium in the organs and tissues of the animals.

The objective of our study was to determine cadmium and lead concentration in selected organs and tissues of the hens, and to estimate of the distribution dynamics of the lead and cadmium in the organism through criteria (suggested by us) that is Klark of distribution (Kd).

MATERIALS AND METHODS

Investigation was conducted with 80 hens of ISA-Brown's breed divided in 4 groups in 36 weeks age. The four groups are equalized by origin, sex and biomass. The birds ration includes different amount of lead and cadmium:

1. Group I-the amount of the tow toxic elements is under the MRL (Maximum Residues Limit).
2. Group II-the amount of the tow toxic elements is 10 times bigger than MRL.
3. Group III-the amount of the tow toxic elements is 100 times bigger than MRL.
4. Group IV-the amount of the tow toxic elements is 1000 times bigger than MRL

Before analysis the samples were kept at –18°C. in the laboratory the samples were weighted (2 g) 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 digested samples were analyzed for the presence of cadmium and lead by using an atomic absorption spectrophotometer (AAS). The sensitivity for cadmium and lead was 0.0001 and 0.0005 mg/l respectively.

The dynamics of distribution was studied using criteria: Klark of distribution (Kd), which is the ratio between the concentration of chemical element in mg/kg product and medium concentration of the same chemical element in the organism.

For statistical analysis Origin® 7.0 SR0, V 7.0220 (B220) and Excel were used. The following variations of the analysis of variance (ANOVA) test were used for analysis of data. The criterion for significance was $P < 0.05$

RESULTS AND DISCUSSION

Data is presented in Table 1 and 2 for the content of the lead and cadmium in the organs and tissues of the hens. Metal concentrations were reported as mg/kg wet weight. Mean lead concentration were highest in bone in experimental group with dose 100 (1.097 mg/kg) and 1000 (16.415 mg/kg) fold bigger MRL ($P < 0.05$), but the lower concentration is in the muscles and the heart. Feathers in comparison include high concentration of the lead. The concentration of Cd in the all organs and tissues differed significantly ($P<0.05$). The higher content of Cd in the kidney was established (1.567, 3.787, 13.983 and 102.660 mg/kg respectively in the four groups) (table 2) (Doganoc et al 1996, Grue et al 1984, Jeng et al 1997).

The Cd concentration in the lever of hens increase significantly ($P<0.05$) from 0.825 for control group to 47.750 mg/kg wet weight for IV-group (table 2). The higher content of the Cd in the feathers is 2.107 mg/kg in the IV group. The concentration of Cd in the muscles exceed MRL (0.05) in the experimental groups, which are with 100 and 1000 fold bigger MRL while in the II group is under MRL. The lower concentration of the Cd were in the muscles, where is 0.029, 0.038, 0.068 and 0.826 mg/kg wet weight respectively for the four groups. Same results were established in the rabbits, roe deer and mousse (Bilal et al 2003, Fenley et al 1979, Korenekova et al 2002, Lisunova et al 2003).

The analysis of the data in the literatures show only establishment of the contents of the lead and cadmium in the vary animal's organs and tissues (Erdogan et al 2005, Gotal et al 1992, Wayland et al 2001, Medvedev et al 1999), but no information for the real distribution dynamics of lead and cadmium in the animal's organism, for that reason we suggest application new criteria Klark of distribution, which is show distribution dynamics of the lead and cadmium, which enter

in the organism through fodder and water in the vary organs and tissues of animals or birds, which are object of the our study.

Data for Klark of distribution of lead and cadmium are presented in table 3 and 4 respectively. Medium Klark of the lead in the four groups increase with increase it level in the fodder. The analysis of results in the table 3 show tows directions, decrease and increase of the values of Kd with increase of the dose. Kd in the lever, kidney increases gradually. The Kd of lead in lever of hens for control group is 0.291 and increase to 0.333, 0.316 and 0.385 respectively for experimental groups. Data for kidney is 0.236, 0.727, 0.662 and 0.418 respectively for I, II, III and IV.

The Klark of distribution of lead in the lungs, heart, gizzard muscles, bones and the feathers decrease according with increase of the dose in fodder proportionally (table 3).

Medium Klark of the cadmium in the organs and tissues increase according with increase of the dose in the fodder. Data for distribution of the cadmium is presented in table 4. The values of Kd of cadmium in lever begin with 8.777 for control group and increase to 11.815 in II group, afterwards decrease to 10.457 and 10.789 in III and IV group comparison with II group. The Kd of Cd in the muscles, feathers, lungs and the bones decrease proportionally for all groups (table 4). In remaining organs and tissues (heart and skin) the values of the Kd are increased with several characteristics for every organ and tissue.

The Kd of Cd in the heart of hens from control group is 0.223 and increase to 0.175, 0.218 and 0.219 respectively for II, III and IV experimental groups. For the skin, Kd in the control group is 0.255 and increase to 0.260 in II group, but this value decrease to 0.246 in III group and increase to 0.350 in IV group.

CONCLUSIONS

1. The concentration of lead and cadmium increase in the organs and tissues of the hens according with increase of the dose in fodder.
2. Criteria “Klark of distribution” allow to assessment of the bioaccumulation and distribution of the lead and cadmium in different organ and tissue.
3. The differences of steppe of the distribution of lead and cadmium give new explanations for bioaccumulation of tow toxic elements, respectively for importance in its accumulation in the studded organs and tissues, which connected with the mechanism of effect on kidney and bones (Itai Itai disease) and unfavorably effect on the function of heart.

REFERENCES

1. Baykov, B, M. Stayanov and M. Gugova. 1996 b. Cadmium and Lead bioaccumulation in male chickens for high food concentrations. Toxicoligicl and Environmental Chemistry. Vol. 54. pp. 155–159.
2. Bilal. T, E. Ercag. 2003. Retention of cadmium in the tissues of broiler chicks by dietary supplemental microbial phytase. Vet. Med.-Czech, 48(7), 199–205.
3. Burger. J, T. Shukla, C. Dixon, S. Shukla, M. Mcmahon, R. Ramos and M. 2001. Gochfeld. Metals in feathers of sooty tern, white tern, gray-backed tern and brown noddy from Islands in the North Pacific. Environmental Monitoring and Assessment, vol.71: 71–89.
4. Doganoc. D. Z. 1996. Distribution of lead, cadmium and zinc in tissues of hens and chickens from Slovenia. Bul. Environ. Contam. Toxicol. Vol. 57, pp. 932–937.

5. Dong-Ha N., Doo-Pyo Lee and Tae-Hoe Koo. 2002. Comparison of heavy metal concentration and reproduction of Feral Pigeons (Columba livia) between Urban and Industrial complex areas from Koria. Korean J. Ecol. Sci., 1(3): 159–164.
6. Erdogan Z, S. Erdogan, T. Aksu, E. Baytok and H. Turkey. 2005. The effect of dietary lead exposure and ascorbic acid on performance, lipid peroxidation satus and biochemical parameters of broilers. Turk. J. Vet Anim. Sci. vol 29, pp 1053–1059.
7. Finley. M and M. Dieter. 1976. Sublethal effect of chronic Lead ingestion in Mallard ducks. Journal of toxicology and environmental health, vol.1: 929–937.
8. Gotal. J and A. Crnic. Cadmium in tissues of roe deer (*Capreolus capreolus*) in Croatia. Veterinarski Archiv, vol.76 (6), 303–310. 2002.
9. Grue. C, T. Oshea and D. Hoffman 1984. Lead concentrations and reproduction in Highway-nesting barn Swallows. The Condor, vol. 86, pp. 383–389.
10. Jeng. S, S. Lee, Y. Liu, S. Yang and P. Liou. 1997. Effect of Lead ingestion on concentration of Lead in Tissues and eggs of laying Tsaiya Ducks in Taiwan. Poultry Science, vol.76: 13–16.
11. Korenekova. B, A. Jackova, J. Kottferova, P. Siklenka, M. Skalicka, M. Korenek. 2002a. Effect of Vitamin D3 on cadmium retention by Laying Hens. Taylor & Francis AS, part of Taylor & Francis Group, vol 52, No 2, 81–84.
12. Lisunova. L, V. Tokaver and A. Lisunova. 2003. Influence of cadmium on physiological parameters and efficiency of chickens-broilers. Proceedings of the first international conference on environmental research and assessment, Bucharest, Romania, March 23–27.
13. Massanyi. P, L. Bardos, R. Toman, S. Hluchy, J. Kovacik and N. Luhac. Distribution of cadmium and its effects on the organ concentrations of retinoids and beta-carotene. 6th internet world congress for biomedical sciences, February 14–25, 2000.
14. Medvedev. N. Levels of heavy metals in Karelian wildlife. Environmental Monitoring and Assessment, vol.56: 177–193, 1999.
15. Wayland. M, A. Fernandez, E. Neugebauer and H. Gilchrist. Contaminations of cadmium, mercury and selenium in blood, liver and kidney of common eider ducks from the Canada Arctic. Environmental Monitoring and Assessment, vol.71: 255–267. 2001.

Table 1. Lead content in organs and tissues of hens (mg/kg wet weight)

	I	II	III	IV
Liver	0.016 ± 0.003	0.033± 0.004*	0.073± 0.017*	0.721 ± 0..72*
Kidney	0.013± 0.003	0.072± 0.048	0.153± 0.081*	0.784± 0.432*
Lungs	0.027 ± 0,019	0.065±0,019	0.110 ± 0,026	0.606 ± 0,244
Heart	0.018 ± 0,007	0.026± 0,006	0.053± 0,021	0.062 ± 0,027*
Gizzard	0.026± 0.005	0.031± 0.006	0.053± 0.032	0.172± 0.054*
Muscle	0.030±0,008	0.037± 0,010	0.040±0,011	0.055 ± 0,003*
Skin	0.02± 0.003	0.153± 0.037	0.225± 0.144	0.342± 0.156*
Bones	0.124 ± 0,019	0.178± 0.022*	0.980 ± 0.048*	14.656 ± 4.708*
Feather	0.183±0.044	0.433± 0.276	0.718± 0.261*	0.886± 0.091*
Fodder	0.45	1.13	9.95	95.48

* significantly comparison with control group ($P < 0.05$)

Table 2. Cadmium content in organs and tissues of hens (mg/kg wet weight)

	I	II	III	IV
Liver	0.825 ± 0.179	2.363± 0.537*	4.120± 1.200*	47.750 ± 9.993*
Kidney	1.567± 0.059	3.787± 0.200	13.983± 2.948*	102.660± 18.428*
Lungs	0.153 ± 0,039	0.217±0,030	0.237 ± 0,014*	1.153 ± 0,110*
Heart	0.021 ± 0,007	0.035± 0,015	0.086± 0,022*	0.969 ± 0,043*
Gizzard	0.593± 0.073	1.287± 0.227*	1.567± 0.862*	5.807± 1.519*
Muscle	0.029±0,014	0.038± 0,012	0.068±0,040	0.826 ± 0,084*
Skin	0.024± 0.013	0.052± 0.003*	0.097± 0.046*	1.547± 0.105*
Bones	0.034 ± 0,007	0.091± 0.071	0.110 ± 0.037*	0.915 ± 0.298*
Feather	0.253±0.015	0.424± 0.098	0.866± 0.130*	2.107± 0.408*
Fodder	0.38	1.01	6.21	68.87

* significantly comparison with control group ($P < 0.05$)

Table 3. Klark of distribution of lead in hen's organs and tissues (Kd)

	I	II	III	IV
Liver	0.291	0.333	0.316	0.385
Kidney	0.236	0.727	0.662	0.418
Lungs	0.491	0.657	0.467	0.323
Heart	0.327	0.263	0.229	0.033
Gizzard	0.473	0.313	0.229	0.092
Muscle	0.545	0.374	0.173	0.029
Skin	0364	1.545	0.974	0.182
Bones	2.255	1.798	4.242	7.817
Feathers	3.327	4.374	3.108	0.473

Table 4. Klark of distribution of cadmium in hen's organs and tissues (Kd)

	I	II	III	IV
Liver	8.777	11.815	10.457	10.789
Kidney	16.670	18.935	35.490	23.195
Lungs	1.628	1.085	0.602	0.261
Heart	0.223	0.175	0.218	0.219
Gizzard	6.309	6.435	3.977	1.312
Muscle	0.309	0.190	0.173	0.187
Skin	0.255	0.260	0.246	0.350
Bones	0.362	0.455	0.279	0.209
Feathers	2.691	2.120	2.198	0.476