ASSESSMENT OF DISTRIBUTION OF THE LEAD AND CADMIUM IN THE RABBIT'S ORGANISM THROUGH KLARK OF DISTRIBUTION (KD)

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SUMMARY

Investigation was conducted with 60 rabbits of New Zealand's breed divided in 4 groups in 60 days 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).

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 Klark. Differences of the distribution of the lead and cadmium in organs and tissues of the rabbits were established.

Keyword: lead, cadmium, Klark of distribution, rabbits

INTRODUCTION

Understanding the global pattern of contamination in biota is useful in evaluating the health of individual species, population and communities, and in assessing potential risks to humans. Heavy metals can enter the food chain from natural and anthropogenic sources, and once in the body, are distributed among tissues or excreted (Burger et al 2002, Mochizuki et al 2002). With each step of the food chain, concentrations increase, resulting in bioamplification, with toxicodynamics differing among spaces. Top-level carnivores or omnivores are often used as bioindicators because they usually have much higher levels of contaminants than those that are lower on the food chain (Baykov et al 2003, Chan et al 2004).

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 2003). Elements 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. Some metals are essential for life, others have unknown biologic function. Those causing poisonings are the ones, which accumulate in the body through the food chain, water and air (Gotal et al 2002 Wayland et al 2001).

The dates in literatures have not criteria for assessment bioaccumulation or 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 rabbits, 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 60 rabbits of New Zealand's breed divided in 4 groups in 60 days age. The four groups are equalized by origin, sex and biomass. The animal 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 rabbits. The concentration of lead in the lever, kidney, heart and lungs of the rabbits in the control group are 0.097, 0.100, 0.033 and 0.043 mg/kg wet tissue respectively, as well as in the experimental groups with 10, 100 and 1000 fold bigger MRL the medium content of the lead gradually increase and reach in the group with 1000 fold bigger MRL for the same organs and tissues to 1.027, 2.357, 0.055 and 0.138 mg/kg wet tissue respectively (table 1). The higher concentration of the lead is in the kidney for all groups ($P < 0.05$), but the lower concentration is in the muscles ($P>0.05$). 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 (table 2) (Massanyi et al 2003, Chan et al 2004).

The Cd concentration in the lever of rabbits increase significantly ($P<0.05$) form 0.772 for control group to 12.487 mg/kg wet weight for IV-group (table 2). The mean content of the cadmium in the range between 0.023 in the control group to 1.777 mg/kg wet weight in the IV group ($P<0.5$). The higher content of the Cd in the lungs is 0.818 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 around MRL (0.046). The lower concentration of the Cd is in the bones, where is 0.004, 0.0137, 0.015 and 0.184 mg/kg wet weight respectively for four groups. Same results were established in the rabbits, roe deer and mousse (Massanyi et al 2003, Gotal et al 2002, Exon et al 1979).

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 (Massanyi et al 2000, 2003, Exson et al

1979, Chan et al 2004, Medvedev1999), 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 rabbits, 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 and bones increase gradually (figure 1). The Kd of lead in lever of rabbits for control group is 2.37 and increase to 2.67, 3.48 and 4.17 respectively for experimental groups. Data for kidney is 2.44, 3.94, 3.87 and 9.85 respectively for I, II, III and IV. For bones-5.71, 7.06, 7.96 and 8.30. The tendency in three organs and tissues is equally (figure 1).

The Klark of distribution of cadmium in the heart, lungs and muscles 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 11.70 for control group and decrease to 8.88 and 7.46 in II and III groups respectively, afterwards increase to 7.61 in IV group comparison with III group (figure 2a). The Kd of Cd in the muscles decrease proportionally for all groups (table 4 and figure 2b). In remaining organs and tissues the values of the Kd are increased with several characteristics for every organ and tissue.

The Kd of Cd in the kidney of animals from control group is 21.11 and increase to 25.41, 33.59 and 41.32 respectively for II, III and IV experimental groups (figure 2a). For the heart, Kd in the control group is 0.35 and increase to 0.55 in II group, but this value decrease to 0.45 in III group and increase to 1.08 in IV group. The Kd of Cd in lungs increase according increase the dose of the cadmium in the fodder with the exception of Kd in II group that decrease cooperation with the control group. For the muscles the values of Kd of Cd decrease according with increase the dose proportionally (figure 2b).

CONCLUSIONS

1. The concentration of lead decrease in the lungs, heart and muscles, and increase in the lever, kidney and bones according with increase of the dose in fodder. The concentration of Cd decrease in the lever and muscles, and increase in remaining organs and tissues.
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.

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

	I	II	III	IV
Liver	0.097 ± 0.03	0.216± 0.03*	0.397± 0.09*	1.027 ± 0.12*
Kidney	0.100± 0.01	0.319± 0.08*	0.441± 0.12*	2.357± 1.16*
Heart	0.023 ± 0,01	0.033±0,002	0.036 ± 0,01	0.055 ± 0,02
Lungs	0.043 ± 0,01	0.069± 0,03	0.081± 0,04	0.138 ± 0,06*
Muscle	0.022±0,005	0.030± 0,002	0.031±0,003	0.033 ± 0,011
Bones	0.234 ± 0,06	0.572± 0.18*	0.908 ± 0.27*	2.043 ± 0,80*
Fodder	0.58	1.08	10.80	74.74

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

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

	I	II	III	IV
Liver	0.772 ±0.16	1.430±0.29*	1.933 ±0.07*	12.487±0.65*
Kidney	1.393 ±0.36	4.193±1.70*	8.700 ±0.72*	67.77±10.66*
Heart	0.023 ±0.01	0.091±0.02*	0.117±0.04*	1.777±0.38*
Lungs	0.023 ±0.01	0.049 ±0.01*	0.119±0.03*	0.818±0.10*
Muscle	0.019 ±0.01	0.046±0.02	0.051±0.01*	0.248±0.09*
Bones	0.004 ±0.00	0.014 ±0.002*	0.015 ±0.00*	0.184 ±0.04*
Fodder	0.22	1.75	5.32	45.14

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

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

	I	II	III	IV
Liver	2.37	2.67	3.48	4.17
Kidney	2.44	3.94	3.87	9.58
Heart	0.59	0.41	0.32	0.22
Lungs	1.05	0.85	0.71	0.56
Muscle	0.54	0.37	0.27	0.13
Bones	5.71	7.06	7.96	8.30

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

	I	II	III	IV
Liver	11.70	8.88	7.46	7.61
Kidney	21.11	25.41	33.59	41.32
Heart	0.35	0.55	0.45	1.08
Lungs	0.35	0.30	0.46	0.50
Muscle	0.29	0.28	0.20	0.15
Bones	0.06	0.08	0.06	0.11