THE EFFECT OF DIETARY HUMIC-ALUMINOSILICATE PREPARATION ON THE CONTENT OF CADMIUM AND LEAD IN MUSCLE AND LIVER OF HENS HOUSED IN FREE RANGE SYSTEM

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Introduction

Poultry in free range systems and small farm flock results in uncontrolled access of birds to all the sources of environmental pollutants, since birds might accumulate elements not only from polluted soil, water, plants, geohelminths, as well as from various non-edible wastes and substances containing i.e. heavy metal compounds. Therefore, housing laying hens in free range system might lead to increased morbidity and mortality of birds (12) and poultry products, such as eggs, meat or giblets that might be polluted with toxic compounds (4,5,11).

Particular intensification of the exposure of poultry (and other animals) might occur in industrialized regions, in particular mine-metallurgical industry, where there are significant emissions and imissions of toxic metals, including Cd and Pb (9).

From the studies of many authors it results that heavy metals might accumulate in eggs content as well as in tissues and organs of galliform (13) and waterfowl (3). Moreover, existing compounds, organic and mineral, can reduce the accumulation of heavy metals in poultry tissues (1).

The aim of the present work was to assess the influence of the humic-aluminosilicate preparation (HAP), feed for laying hens, on the cadmium and lead accumulation in the tissues of hens housed in free range system.

Material and methods

The studies were performed on laying hens from the first production period (1 -2 year old) that were housed in free range system (FRS) in the 5 farms located in the region polluted by metallurgy industry and in the proximity of motor traffic (9).

The researches were performed during 2 seasons. In May 2004, samples of liver and muscles (thigh), after previously decapitation, were sampled from 3 clinically normal laying

hens from each farm. During 10 months, hens were feeding with mixture of fodder and humic-aluminosilicate preparation (HAP), which contain: bentonite, baidelite, humodetrynite, peat, phosphate and forage chalk, selenium and forage yeasts, plant fat in specified proportions (Patent application No. 371647, 2004). The participation of HAP in daily dose was not higher than 10 %. In March 2005 samples of liver and muscles (thigh) were sampled again from the same farms.

The samples were homogenized and after wet digestion with nitric acid in high pressure microwave digestion system - 2000 (CEM, USA) chemical analyses of Cd and Pb concentrations were performed with the use of ICP-MS technique by Varian Ultra Mass 700 (2).

The results were elaborated statistically by calculating the average values ($\bar{x}$), standard deviation (SD) and significances of differences between the content of analyzed elements in hens from I and II sampling (Microsoft Excel 2000).

Results and discussion

The obtained analytical results showed high diversification in the concentrations of determined heavy metals. The content of Cd in muscles and liver of hens are shown in table 1. In tissues from the first sampling the content of Cd were higher than the acceptable limit which is for meat on the level of 0.05 and for liver 0.5 $mg \cdot kg^{-1}$ of fresh mass (8). After the use of HAP (second sampling) the concentration of cadmium in muscles were lower average 29% (from 0,065 to 0,046 $mg \cdot kg^{-1}$ of fresh mass) and in liver even twice lower (from 0,962 to 0,486 $mg \cdot kg^{-1}$ of fresh mass).

The content of lead in the studied organs of laying hens is shown in table 2. In muscles and liver from the first sampling the content of Pb were, similarly like in case of cadmium, higher than the acceptable limit which is for meat on the level of 0.10 and for liver 0.5 $mg \cdot kg^{-1}$ of fresh mass (8). After the use of HAP (second sampling) the concentration of lead in tissues were statistically significant lower - in muscles average 34% (from 0,250 to 0,164 $mg \cdot kg^{-1}$ of fresh mass) and in liver even three times lower (from 0,624 to 0,218 $mg \cdot kg^{-1}$ of fresh mass). Nevertheless, the concentration of Pb in muscles was still higher than acceptable level, so this fact reduces consumption applicability of hen's meat.

In the available literature, there is the deficiency of data in this field. Only Kolacz et al. (6) analyzed the mentioned metals in laying hens in the extensive culture in the region polluted by mines and copper metallurgy. The results of these studies pointed out on high levels of Pb in muscles and livers (0.250 and 0.577 $mg \cdot kg^{-1}$ of fresh mass, respectively) and

cadmium (0.014 and 0.601 mg·kg^{-1} of fresh mass, respectively). However Zmudzki et al. (14) monitored trace elements, including cadmium and lead in tissues of hens from free range system (FRS) and farming system (FS) on the territory of Poland. The average values of Pb were evaluated in muscles 0.008 (FRS) and 0.010 (FS) and in livers 0.174 (FRS) and 0.024 (FS) mg·kg^{-1} of fresh mass. In the case of cadmium, were evaluated as 0.010 and 0.003 in muscles and 0.614 and 0.139 mg·kg^{-1} of fresh mass in livers.

In the other studies (7) it was found that in meat of broilers that were mechanically deboned, the average content of Pb was evaluated as 0.1 – 0.28 mg·kg^{-1} of dry mass and slightly lower level was determined in slaughtered geese: 0.09 - 0.16 mg·kg^{-1} of dry mass. According to the latest findings of Szkoda and Zmudzki (10), in the meat of broilers slaughtered in Poland, the content of Pb was averagely 0.021 (max. 0.088) and the mean content of cadmium was 0.001 (max.0.005) mg·kg^{-1} of fresh mass. These values are relatively low when compared to the own studies. In this context it is worthy to add that Wegrzyn and Borys (13) also determined the contents of Cd and Pb in muscles and livers of chickens and turkeys. The authors found that the concentration did not exceed the acceptable levels of these toxic metals.

Tab.1. Concentrations of cadmium (Cd) in muscle and liver of laying hens (mg·kg^{-1} fresh mass)

No of farm	Sampling I		Sampling II	
	Muscle	Liver	Muscle	Liver
1	0,041	0,55	0,091	0,20
2	0,050	0,51	0,021	0,55
3	0,079	1,62	0,088	0,36
4	0,060	0,98	0,016	0,56
5	0,094	1,15	0,015	0,76
$\bar{x}$ ± SD	0,065±0,022	0,962±0,459	0,046±0,040	0,486±0,213

Tab.2. Concentrations of lead (Pb) in muscle and liver of laying hens (mg·kg^{-1} fresh mass)

No of farm	Sampling I		Sampling II	
	Muscle	Liver	Muscle	Liver
1	0,16	0,64	0,15	0,23
2	0,27	0,75	0,13	0,12
3	0,22	0,79	0,24	0,17
4	0,26	0,40	0,13	0,21
5	0,34	0,54	0,17	0,36
$\bar{x}$ ± SD	0,250±0,066a	0,624±0,159A	0,164±0,046b	0,218±0,090B

a – b p < -0,05 A – B – p < 0,01

Conclusion

Summarizing, it is necessary to state that poultry housing with the use of extensive (free range) system in the regions of environmental concern, creates the conditions that favour elevated bioaccumulation of lead and cadmium, reducing thus the consumption applicability of hen's meat and giblets. The use of HAP preparation decreases the concentrations of cadmium and lead in laying hen's tissues to the acceptable levels; in case of lead the differences were statistically significant.

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