RESEARCHES REGARDING HIGHLIGHT OF SOME POLLUTANTS IN FEEDS

Nicoleta Bortă, Aida Albu, Cecilia Pop, I. M. Pop

"Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine Iaşi, Faculty of Animal Husbandry, Iaşi
e-mail: nicoleta_f_b@yahoo.com

Abstract

The existence of pollutants in feed is a special problem in animal production, particularly in the light of current approaches to food safety for consumers of food of animal origin. Pollutants, whatever group they are by high concentrations of soil and in plants or in foods, their toxic effect may be critical risks that could affect not only products but also animal health. Researches undertaken have focused on heavy metals, because they tend to be bioaccumulative. For carrying out the research it were collected feed samples from the two establishments in the area of Iasi, and as a method for the determination of lead and cadmium was used method by flame for atomic absorption spectophotometry (AAS) using the flame device GBC - AVANTA. Analysis of data that resulted in all kinds of feed was demonstrated residues present of Pb and Cd. The highest rate of accumulation of heavy metals was noticed in full fat soybean for the Pb content and in sunflower groats for content in Cd. However the results obtained for Cd and Pb are well below standards on LMA in Ord. ANSVSA no. 18/2007, in force in Romania.

Key-words: feeds, pollutants, lead, cadmium

INTRODUCTION

Feedingstuffs can be defined as a source of food of plant, animal, mineral, synthesis and biosynthesis origin, which is used to meet animal demand of energy and nutrients, in order to ensure the vital functions and performance of livestock production (2). Plants, the first link of the food chain, are most affected by harmful substances because they are directly related to the soil and water by the substances they use in these environments, with air by breathing, and they are taking a lot of the unwanted substances.

Pollution can occur when a substance or several substances present in the mixture or in the environment, in quantities or over a period which makes them dangerous for humans, animals and plants contribute to the danger or injury, or persons welfare (OMS 4). Given the global importance that presents environmental pollution, issue is addressed in order to evaluate the incidence of contamination with heavy metals in the feed of livestock on two farms in the food chain.

From all the pollutants, heavy metals present a unique feature that the bioaccumulation, so they can migrate into the food chain reaching to the final products intended for human consumption. Being aware that "dosis sola facit venenum" ("dose itself causes poisoning"), this feature of heavy metals is of particular importance (3).

MATERIAL AND METHOD

For carrying out the research were collected five samples of 17 feed, from two farms in the Eastern part of country, a dairy farm and a chicken farm. Collection and preparation of feed samples for analysis were made in compliance with the rules laid down in standards and animal health rules in force (STAS 21/2-73; STAS 7842-80; ISO 6497/2001).

From the first farm were collected five samples of the following feed: corn grain, wheat grain, full fat soybean, soybean groats and three types of combined feed respectively used for starting, growing and finishing. From the second farm were also collected five samples of the following feed: natural grass, blooming alfalfa, hay alfalfa, hay natural, grain beer, corn silage, corn

grain, wheat bran, groats flower sun and Sudan grass. To these feed it were set physical and chemical properties and nutritional values (Tab. 1 and 2).

Table 1
Nutritional value of food used to feed chickens for meat

Feed	ME (kcal/kg DM)	CP (g/kg DM)	Met + Cys (g/kg DM)	Lys (g/kg DM)	CF (g/kg DM)	Ca (g/kg DM)	P (g/kg DM)
Corn grain	3363	90	3.9	2.6	24.6	0.2	3
Wheat grain	3087	110	4.2	3.1	25.6	0.5	4
Full fat soybean	3896	370	11.2	15.6	58	2.5	5.6
Soybean groats	2216	440	13.6	29.3	72	2.3	5.8
Starter feed	3150	230	9	12	30	10.6	6.9
Grower feed	3070	200	7.6	10	34	9.7	6.5
Finisher feed	3150	180	7.1	8.7	38	8.3	6.1

DM = dry matter; ME = metabolizable energy; CP = crude protein; Met + Cys = methionine and cystine; Lys = lysine; CF = cellulose fiber; Ca = calcium; P = phosphorus.

Table 2
Nutritional value of food used to feed dairy cows

Feed	DM (g/kg)	UFL	PDIN (g/kg DM)	PDIE (g/kg DM)	Ca (g/kg DM)	P (g/kg DM)	UEL
Natural grass	176	0.89	94	89	7.5	4.0	1.05
Blooming alfalfa	190	0.72	109	83	16.7	3.1	1.06
Sudan grass	280	0.90	62	75	4.5	2.5	1.02
Hay alfalfa	850	0.66	110	92	15.4	2.3	1.1
Hay natural	858	0.70	56	67	9.4	3.2	1.1
Grain beer	850	0.95	165	119	2.1	4.8	1.03
Corn silage	300	0.91	53	67	3.5	2.5	1.13
Corn grain	868	1.29	84	126	3.5	0.3	-
Wheat bran	870	0.91	117	98	1.6	12.9	-
Sunflower groats flower sun	892	0.80	239	126	3.1	10.1	-

DM = dry matter; UFL = fodder unit milk; PDIN = intestinal protein digestion on nitrogen fermentescible; PDIE = intestinal digestion of protein-based energy fermentescible; Ca = calcium; P = phosphorus; UIDL = unit loading milk digestion.

To achieve the research we have used the following tools and equipment specific to their use such as: analytical balance, drying stove, oven burning, exicator, the GBC-AVANTA.

Method for determination of lead and cadmium was the atomic absorption spectofotometry (AAS) in flame using a mixture of acetylene-air to ensure maximum 2250 ^{0}C, using the flame-GBC AVANTA. Thus plant substrates were processed by dry mineralization according to the following steps: calcination of samples at 500 ^{0}C; washing ash results with HCl and distilled water, bringing the ash washed from one convenient volume, the reading of sample to the device (calibration curve). Calibration mean the graphic absorbtion depending on the concentration and was done for each metal in five different points thereby to lead at 0.5 ppm, 1 ppm, 2.5 ppm, 5 ppm and 7.5 ppm and for cadmium at 0.2 ppm, 0.5 ppm, 1 ppm, 1.5 ppm and 2 ppm. Wavelength used to determine by atomic absorption in spectofotometry of lead was 217 nm and for the cadmium 228.8 nm. The results of these measurements were expressed in mg/kg or ppm by reference to a moisture content of feed of 12%.

RESULTS AND DISCUSSION

Following tests carried out to reveal that in all feed taken into account (natural grass, blooming alfalfa, hay alfalfa, hay natural,

grain beer, corn silage, corn grain, wheat bran, sunflower groats and Sudan grass - farm dairy - and corn grain, wheat grain, full fat soybean, soybean groats and three types of feed combined starting, growing and finishing - farm chicken meat -), were detected quantities of lead and cadmium, the results being presented in tab. 4-9

Experts from FAO / WHO shows that, although the chemical pollution varies from one area to another, animals and people exposed to chemical contamination is universal, hence the concern in all countries for the identification and quantitative evaluation of the heavy metals in foods of plant origin and animal and their influence on production and animal health. In Romania, the National Sanitary Veterinary and Food Safety has established maximum levels for undesirable substances in animal feed by Order no. 18/2007 (tab. 3) transposing Directive of the European Parliament and Council 2002/32/EC on undesirable substances in animal feed, as last amended by Commission Directive 2006/77/CE so they do not represent any danger to public health, animal health or the environment and may adversely affect livestock production (4).

Table 3
Maximum permissible levels for lead and cadmium content in feed (ppm), according to Order no. 18/2007 ANSVSA (4)

Substance	Products intended for animal feed	Maximum level in feed with 12% humidity (ppm)
Lead	Forage materials except:	10
	▪ green feed	30
	Complete feedingstuffs	5
Cadmium	Feed materials of plant origin	1
	Feed materials of animal origin	2
	Complete fodder for cattle, sheep and goats, except:	1
	▪ complete feedingstuffs for calves, lambs and kids	0,5

Heavy metal is a controversial term which is generally used for metals that have a high density and are generally toxic residues causing their environmental pollution. Heavy metals widely accepted are: bismuth, iron, copper, lead, zinc, tin, nickel, cadmium, chromium and uranium. Heavy metals are natural constituents of the earth crust that can not be broken down or destroyed. They get into our body in a very small quantity, with food, water or air. Some heavy metals (eg. copper, selenium, zinc) are vital in maintaining the metabolism of the human body, however in high concentrations they can be toxic. Negative effect of heavy metals can result, for example, through consumption of contaminated drinking water (eg. lead pipes), high levels in the air surrounding the issuing sources or assimilation through food chain (bioaccumulation). From all these metals our studies are stopped on two of them, namely lead and cadmium, these elements are not useful in body but they are found in varying amounts in both animal kingdom and in the plants, in quantities representing a threat for these.

Lead is a gray soft metal, with a low chemical reactivity, good acid resist. It is used in large quantity for alloys screens for radiation absorption, water pipes, plates for radiators, to obtain matches, pigments, etc (5). Another major source of pollution contributing to lead contamination for all levels of the food chain is the residue and waste resulting from production processes in industry, agriculture, transport, maritime and river activities, and from different laboratories, petrol stations, waste water treatment etc. Plants can be contaminated with lead from soil, air or water, environments that can hardly be protected by this metal in view of the multiple sources listed above. It was demonstrated that lead is hardly absorbed from the soil by plant roots even at very high concentrations in the substrate is difficult

because it is hard soluble and interacts very strongly with soil particles (3).

The highest average value, in terms of lead content in the feed from chickens farm, has been met in full fat soybean, the average value of 1.09 ppm is 9 times smaller compared to the maximum permissible (10 ppm). Among the combined feed, starter feed was the richest in the lead due to the high share of full fat soybean used in this mixture, although the average level of 0.92 ppm was almost 5 times below the permissible maximum of 5 ppm. The lowest average was observed in wheat beans (0.18 ppm), about 55 times less than the maximum limit of 10 ppm, and in finishing feed (0.43 ppm) 12 times lower compared to maximum permissible (5 ppm).

Table 4
Average lead content (ppm) in some raw materials used to produce feed used in the holding of chicken meat

No.	Feed	No. stamples	$\overline{X} \pm s_{\overline{X}}$	s	V%	LMA (ppm)
1	Corn grain	5	0.630 ± 0.023	0.052	8.324	10
2	Wheat grain	5	0.180 ± 0.007	0.016	8.784	10
3	Full fat soybean	5	1.090 ± 0.005	0.012	1.124	10
4	Soybean groats	5	1.060 ± 0.008	0.019	1.1765	10

Table 5
Average lead content (ppm) in combined feed analyzed

No.	Feed	No. stamples	$\overline{X} \pm s_{\overline{X}}$	s	V%	LMA (ppm)
1	Starter feed	5	0.920 ± 0.007	0.016	1.719	5
2	Grower feed	5	0.700 ± 0.005	0.012	1.750	5
3	Finisher feed	5	0.430 ± 0.007	0.016	3.677	5

Table 6
Average lead content (ppm) in feed coming from dairy cows (1)

No.	Feed	No. stamples	$\overline{X} \pm s_{\overline{X}}$	s	V%	LMA (ppm)
1	Natural grass	5	0.600 ± 0.009	0.021	3.536	30
2	Blooming alfalfa	5	0.640 ± 0.008	0.019	2.923	30
3	Sudan grass	5	1.690 ± 0.010	0.023	1.388	30
4	Hay alfalfa	5	0.530 ± 0.008	0.019	3.520	30
5	Hay natural	5	2.530 ± 0.008	0.017	0.685	30
6	Grain beer	5	1.930 ± 0.008	0.019	0.969	10
7	Corn silage	5	1.030 ± 0.009	0.021	2.060	30
8	Corn grain	5	0.950 ± 0.013	0.029	3.069	10
9	Wheat bran	5	0.190 ± 0.008	0.019	9.846	10
10	Sunflower groats flower sun	5	2.460 ± 0.008	0.019	0.760	10

Following the analysis of feed from dairy farm, the highest average lead content has been emphasized in natural hay (2.53 ppm), value less than the maximum allowed (30 ppm) by nearly 12 times. The minimum average value of Pb content was found in the composition of wheat bran, found at 0.19 ppm value wich is 52 times lower compared to 10 ppm (maximum allowed).

Cadmium can be found mainly in the earth crust being always in combination with zinc. This metal is found, also in industry, as an inevitable byproduct of zinc extraction, lead and copper. Reaches the environment primarily through the ground they may be included in fertilizers and pesticides. Although cadmium seems to be a nonessential there can be trace of element in animal and human body, being virtually absent at birth, it accumulates in tissues with age. Compared to lead, cadmium can be absorbed more easily from the soil, but more difficult in the atmosphere from leaves surface deposits. This has been demonstrated in spinach where lead contamination from the atmosphere exceeded the value of 85% and the cadmium was just over 23% (3).

In an experiment conducted by Zhang Fenqin and col. (2) has been shown that vetch (Vicia sativa) is more tolerant to the presence of cadmium in the environment than beans (Phaseolus aureus). Thus, to avoid the harmful effects of these pollutants, plants have developed mechanisms of antioxidative defense, but these mechanisms have evolved differently depending on the plant species, age and environmental conditions.

Table 7
Average cadmium content (ppm) in some raw materials used to produce feed used in the holding of chicken meat

No.	Feed	No. stamples	$\overline{X} \pm s_{\overline{X}}$	s	V%	LMA (ppm)
1	Corn grain	5	0.155 ± 0.002	0.004	2.326	1
2	Wheat grain	5	0.025 ± 0.001	0.001	4.899	1
3	Full fat soybean	5	0.180 ± 0.001	0.002	0.878	1
4	Soybean groats	5	0.180 ± 0.001	0.002	1.242	1

Table 8
Average cadmium content (ppm) in combined feed analyzed

No.	Feed	No. stamples	$\overline{X} \pm s_{\overline{X}}$	s	V%	LMA (ppm)
1	Starter feed	5	0.081 ± 0.001	0.003	3.148	1
2	Grower feed	5	0.115 ± 0.001	0.002	1.845	1
3	Finisher feed	5	0.111 ± 0.001	0.002	1.424	1

Following tests carried out on feed from chickens farm, was shown an higher average cadmium composition in samples of full fat soybean, giving them the same level of contamination as the grist of soybean, respectively 0.18 ppm, although than 6 times less than maximum permissible limit (1 ppm). From combined feed, the highest average value was seen in growing feed (0.155 ppm), more than 6 times compared with the maximum permissible limit (1 ppm). The lowest values were observed, same as lead in wheat beans (0.025 ppm), a value 40 times lower compared to the maximum allowed. Regarding the presence of cadmium in combined feed, the minimum average was shown at starter feed (0.081 ppm) 12 times less than the maximum, because the amount of cadmium in maize was much closer to full fat soybean value than the situation presented in the case of lead, where the lowest value was observed in finishing feed.

Table 9
Average cadmium content (ppm) in feed coming from dairy cows (1)

No.	Feed	No. stamples	$\overline{X} \pm s_{\overline{X}}$	s	V%	LMA (ppm)
1	Natural grass	5	0.122 ± 0.001	0.002	1.739	1
2	Blooming alfalfa	5	0.054 ± 0.001	0.001	2.268	1
3	Sudan grass	5	0.063 ± 0.001	0.002	2.970	1
4	Hay alfalfa	5	0.024 ± 0.001	0.002	7.795	1
5	Hay natural	5	0.143 ± 0.001	0.002	1.640	1
6	Grain beer	5	0.058 ± 0.001	0.002	3.226	1
7	Corn silage	5	0.026 ± 0.001	0.002	7.195	1
8	Corn grain	5	0.054 ± 0.001	0.002	3.928	1
9	Wheat bran	5	0.020 ± 0.001	0.002	10.607	1
10	Sunflower groats flower sun	5	0.163 ± 0.001	0.002	1.301	1

Concern analysis of the feed from dairy farm (tab. 9), the highest value in the cadmium content was found in the composition of sunflower groats (0.163 ppm), below the maximum allowed by about 6 times, the lowest value was highlighted again, same as the lead in wheat bran (0.020 ppm), 50 times less compared to the maximum permissible (1 ppm).

CONCLUSIONS

Based on the dates obtained and analyzed on the assessment of content in Cd and Pb in forage products of plant origin, can detach the following conclusions:

- The highest average content of Pb were recorded in full fat soybean feed (1.09 ppm Pb/kg) and natural hay (2.53 ppm Pb/kg) but these values obtained was by 9 times less and respectively 12 times less than the maximum allowed;
- The highest average content of Cd were found in full fat soybean feed, soybean groats (0.180 ppm Cd/kg) and sunflower groats (0.163 ppm Cd/kg), values 6 times less the maximum permissible values for each feed in part;
- The lowest concentrations of Pb were observed in wheat beans (0.180 ppm Pb/kg), and wheat bran (0.190 ppm Pb/kg) values 55 times less and respectively 52 times lower than the maximum permitted;
- The lowest concentrations of cadmium were found in the wheat beans (0.025 ppm Pb/kg), and wheat bran (0.020 ppm Pb/kg) values 40 times less, respectively 50 times over maximum permitted;
- Even the values were found 5 to 50 times lower compared to the maximum permitted, there is no danger of poisoning, so the feed can be used in feed without risk on youth;
- From the results with come with the conclusion that level the aggression of pollutant factors in Iaşi area are situated at low level.

REFERENCES

Journal articles

[1] Albu Aida, Popescu O., Radu-Rusu R.M., 2008, Lead and cadmium residues in dairy cow feeds and their toxic potential to animals, Proceeding of the International Ph.D. Students Conference, published by University of South Bohemia in České Budějovice, Faculty of Agriculture, České Budějovice, Cehia

[2] Fenqin Zhang, Hongxiao Zhang, Guiping Wang, Langlai Xu, Zhenguo Shen, 2009, Cadmium-induced accumulation of hydrogen peroxide in the leaf apoplast of Phaseolus aureus and Vicia sativa and the roles of different antioxidant enzymes, Journal of Hazardous Materials, journal homepage www.elsevier.com

[3] Xiangyang Bi , Xinbin Feng , Yuangen Yang , Xiangdong Li , Grace P.Y. Shin , Feili Li, Guangle Qiu, Guanghui Li, Taoze Liu , Zhiyou Fu, 2009, Allocation and source attribution of lead and cadmium in maize (Zea mays L.) impacted by smelting emissions, Environmental Pollution, 157, p. 834-839, journal homepage www.elsevier.com

[4] www.ansv.ro Ordin nr. 18 din 1 februarie 2007 - Norme sanitar veterinare şi pentru siguranţa alimentelor privind substanţele nedorite din hrana pentru animale

Books

[5] Ifrim S., 2004. Dicţionar de chimie, Edit. Performantica, Iaşi, 2004

[6] Pop I. M., Halga P., Avarvarei Teona, 2006, Nutriţia şi alimentaţia animalelor vol. I, II, III, TipoMoldova, Iaşi

[7] Popescu O., Enache T., 1996, Medicină legală veterinară vol. II, Editura All, Bucureşti