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Method of Increasing Ecological and Consumer Qualities of Meat and Intensification of the Digestive Metabolism Processes in Broilers Grown in Technogeneous Areas

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Abstract.
The problem of organizing rational use of natural resources by using high content of heavy metals and tolerated levels of aflatoxin B_1 of adsorbent in the diets of broilers is urgent for enhancing the ecological and nutritional value of poultry meat.
The purpose of research is developing a method of rational use of natural resources by activating the processes of digestive metabolism, and increasing the ecological and consumer qualities of meat of broilers grown on diets containing large amounts of heavy metals and tolerated levels of aflatoxin B_1 due to adding various dosages of the Detox adsorbent into feed.
Methods: The objects of the research: broiler chickens. Digestibility and assimilation of nutrients of feed were examined using the conventional method. Concentration of heavy metals was studied by the atomic-absorption method, aflatoxin B_1 by the immunoenzymometric method. The results of the research were processed by the method of Student variation statistics.
The results of the research. In the technogeneous environment of North Ossetia - Alania, broiler feed with high content of heavy metals and tolerated levels of aflatoxin B_1 should be supplemented by the Detox adsorbent at the dosage of 1,500 g/t of feed. In the femoral and breast muscles of broilers, aflatoxin B_1 was not detected. Chicken from the 2-nd experimental group digested dry matter, organic matter, crude protein, nitrogen-free extractive substances of the diet better, and assimilated the nitrogen of the feed better, too. In broilers from the 2-nd experimental group, content of dry matter and protein in the breast and the thigh muscles was higher. Their samples of breast muscle contained less zinc – by 3.48 times, cadmium – by 3.52 times, and lead – by 3.47 times. With that, the presence of zinc, cadmium and lead in the meat of broilers in all experimental groups was below the MPL.
Scope of application: Environmental protection and rational nature management.
Keywords: broilers, heavy metals, aflatoxin B_1, adsorbent, rational use of environmental resources, digestibility and absorption, environmental and consumer qualities of meat.

INTRODUCTION

At present, the state of the environment is an essential criterion for determining activity of the man and the society. The increased content of many heavy metals caused by technogeneous processes is detected in all natural environments: in the atmosphere, water, soil, plants, animals and humans [1].

Among heavy metals, the most dangerous toxicants are lead, zinc, cadmium, since their technogeneous accumulation in the environment is going fast. This is due to the presence of a series of large nonferrous metallurgy enterprises in the Republic of North Ossetia – Alania (RSO – Alania). The territory of the Prigorodny district of the republic features extremely high level of soil and forage crops pollution with ions of zinc, lead and cadmium, which cause significant harm to the environment, including productivity, environmental and food safety of the meat of broilers grown in the technogeneous area. Recently, various adsorbents of the new generation [2] are widely used in poultry feed for their detoxification.

However, the greatest danger in organizing environment protection is the combined effect of several intoxicants simultaneously present in the feed on the organisms of meat poultry. On this basis, further increase in production of poultry meat depends on the quality of the feed, which is often contaminated with moulds and fungi in the humid climate of North Ossetia – Alania. The harmful effect of the feed affected by mold fungi on the organism of broiler chicken is due to the presence of toxic substances – mycotoxins - that are produced by microscopic fungi during storage. Among mycotoxins, aflatoxins - metabolites of fungi *Aspergilius flavus* and *Aspergilius parasitikus* [3] - feature toxic and carcinogenic characteristics.

Given the fact that in our region formulations of feed mainly include cereals like maize and barley, and legumes

like soy, increasing digestibility and absorption of nutrients, and the ecological and nutritional value of poultry meat was a relevant problem of organizing rational use of natural resources through the use of feed adsorbent of the new generation in the diets of broilers with high content of heavy metals and tolerated levels of aflatoxin B_1. The purpose of research is to develop a method of activating the processes of digestive metabolism, and increase the ecological and consumer qualities of meat of broilers grown on diets containing large amounts of heavy metals and tolerated levels of aflatoxin B_1 due to adding various dosages of the Detox adsorbent into the feed.

MATERIAL AND RESEARCH METHODS.

This goal was achieved by making an experiment in the conditions of JSC "Poultry Farm "Vladikavkaz" RNO – Alania. The object of this research were broilers of the "Smena-7" cross, from which 4 groups of 100 head each were formed at the age of one day using the method of analogous groups.

Feeding of experimental chicken was performed in accordance with the scheme shown in Table 1, basic diet (BD), represented by standard compound feed based on locally produced corn, barley and soybeans with an increased content of heavy metals and tolerated levels of aflatoxin B_1.

Table 1. Scheme of the scientific and economic experiment

Group	Feeding features
Reference	Basic diet (BD)
1 experimental	BD + Detox at the dosage of 1,000 g/ton of feed
2 experimental	BD + Detox at the dosage of 1,500 g/ton of feed
3 experimental	BD + Detox at the dosage of 2,000 g/ton of feed

Note: n = 100

Detox is a feed additive for adsorbing mycotoxins, heavy metals and other toxins in the feed. Detox contains the following active substances: walls of inactivated *Saccharomyces cerevisiae* dry yeast cells and montmorillonite (up to 100%).

Digestibility and assimilation of nutrients in the feed were studied by making physiological experiments on chicken at the age of 28-35 days, for which purpose inert indicator - chromium oxide - was introduced into the feed in the amount of 0.5% by the mass of feed [4].

After the experiment, reference slaughter of broiler chicken at the age of 42 days was made. For this purpose, 5 typical chickens (by the live weight and fatness) were taken from each group. Anatomical dissection of the carcasses was performed in accordance with the conventional methods.

Using a spectrophotometer AAZ-115-M1, the concentration of heavy metals was studied in the samples of animal feed and meat by the method of atomic-absorption analysis, and in mean samples of the feed, the content of aflatoxin B_1 was determined by the immunoenzymometric analysis (EIA) with the use of Ridoscreen@AflatoxinTotal test systems.

The results of the research were processed by the method of Student's variation statistics with the use of the "Microsoft Excel" software package.

RESULTS

To reduce the cost of the feed compound, this company purchases grain cereals and soy mainly from farms in North Ossetia – Alania, the territory of which is characterized by high air humidity. On this basis, the contents of certain mycotoxins: T-2 toxin, ochratoxin A and aflatoxin B_1 in the grain feed ingredients of the experimental broilers were studied (Table. 2).

Table 2. The content of mycotoxins in grain of cereals and soybeans, mg/kg

Feed	Mycotoxins					
	aflatoxin B_1		T-2-toxin		ochratoxin A	
	MPC	actual	MPC	actual	MPC	actual
Corn grain	0.05	0.08	0.1	0.08	0.05	0.07
Barley grain	0.05	0.07	0.1	0.11	0.05	0.05
Soybeans	0.05	0.08	0.1	0.09	0.05	0.04

During the research, in terms of the content of aflatoxin B_1, an excess of the maximum permissible concentration (MPC) was detected in soybeans – by 1.60 times, in corn – by 1.60 times, and in barley – by 1.40 times.

According to the data of chemical analysis, it was found that excess of MPC for the T-2 toxin was detected only in barley grain – by 1.10 times, and for the content of ochratoxin A - only in corn grains – by 1.40 times.

Using the practice of mixing corn, barley and soybeans that are affected by mycotoxins, and other unharmed ingredients, we managed to reduce T-2 toxin and ochratoxin A in the feed compound of experimental poultry below the maximum permissible concentrations (MPC). The level of aflatoxin B_1 did not exceed the tolerated amount of 0.25 mg/kg [5].

The content of heavy metals was studied in the composition of experimental poultry feed prepared according to formulations PK-5 and PK-6 (Table. 3).

Table 3. The content of heavy metals in compound feed for experimental poultry

Compound feed formulation	Cadmium, mg/kg	Lead, mg/kg	Zinc, mg/kg
MPC	0.4	5.0	100.0
PR-5 (age 1-28 days)	0.50	5.98	130.4
In % to the MPC	125.0	119.6	130.4
PR-6 (age 29-42 days)	0.48	5.94	128.7
In % to the MPC	120.0	118.8	128.7

In the feed of experimental poultry, excessive concentrations of heavy metals were observed. With that, in the formulation of compound feeds PK-5 and PK-6, excessive concentrations of cadmium by 25.0% and 20.0%,

of zinc – by 30.4% and 28.7% and of lead – by 19.6% and 18.8% were observed, respectively.

The combined toxic effect of aflatoxin B_1 and heavy metals has depressive influence on the digestibility and assimilation of nutrients in the feeds. To study digestibility and assimilation of nutrients in the diets under the influence of various feeding dosages of the Detox adsorbent, a physiological exchange experiment was made on the experimental chicken.

The coefficients of nutrients digestibility in the diets of experimental poultry are shown in Table 4.

The highest coefficients of nutrients digestibility were observed in broilers of the 2-nd experimental group that received the Detox preparation at the dosage of 1,500 g/t of feed in the diets with high content of heavy metals and tolerated levels of aflatoxin B_1. Chickens in the 2-nd experimental group veraciously ($P<0.05$) better digested dry matter in the diet by 3.88%, organic matter – by 3.87%, crude protein – by 4.24%, and nitrogen-free extractive substances – by 4.49% than those in the reference group.

Improved assimilation of protein through effective detoxification of heavy metals and mycotoxins in the organisms of broilers was achieved through adding the Detox preparation at the dosage of 1,500 g/t of feed (Table 5).

With the help of adding the Detox preparation at the dosage of 1,500 g/t of feed, it was possible to achieve the greatest detoxifying effect in case of combined action of heavy metals and aflatoxin B_1 in the organism, which allowed the meat poultry in the 2-nd experimental group to lay daily 4.94% ($P<0.05$) more nitrogen than that of the reference group. At the same time, they significantly ($P<0.05$) better used nitrogen in the feed from the taken quantities (by 2.80%), compared to the reference group.

Upon reaching the age of 42 days, reference slaughtering of the chicken was made (Table 6).

The highest stimulating effect on the slaughter indicators of the experimental poultry was noted for addition of the Detox preparation at the dosage of 1,500 g/t of feed, which provided in broilers from the 2-nd experimental group a veracious ($P>0.95$) increase in the weight of semi-eviscerated carcass by 14.7%, of eviscerated carcass – by 13.7%, and the slaughter yield of 1.6%, compared to the reference group.

Given the high growth rate in the modern breeds of meat poultry, one should consider the influence of the detoxification method on the chemical composition, and ecological and consumer properties of poultry meat (Table 7).

Table 4. Coefficients of nutrients digestibility in diets, %

Indicators	Group			
	reference	1 experimental	2 experimental	3 experimental
Dry matter	79.49±0.49	82.35±0.45	83.37±0.47	82.26±0.39
Organic matter	81.05±0.50	83.90±0.43	84.92±0.63	83.81±0.45
Crude protein	83.20±0.44	85.89±0.39	87.44±0.51	86.09±0.48
Crude fiber	11.50±0.52	12.19±0.36	11.72±0.59	11.99±0.40
Crude fat	86.05±0.56	85.95±0.59	86.09±0.79	85.90±0.80
Nitrogen-free extractive substances	86.55±0.58	89.99±0.38	91.04±0.71	89.83±0.69

Note: n=5

Table 5. Assimilation of nitrogen in the feed of broiler chickens, g

Indicator	Group			
	reference	1 experimental	2 experimental	3 experimental
Taken with the feed	3.132±0.012	3.114±0.004	3.120±0.013	3.139±0.015
Excreted: in the litter in the excrements in the urine	1.512±0.003 0.527±0.002 0.985±0.001	1.429±0.005 0.440±0.002 0.989±0.003	1.420±0.055 0.392±0.002 1.028±0.004	1.449±0.005 0.439±0.005 1.01±0.005
Laid	1.62±0.003	1.68±0.004	1.70±0.004	1.69±0.005
Used from the taken, %	51.76±0.60	54.18±0.45	54.56±0.52	53.89±0.56

Note: n = 5

Table 6. The results of experimental poultry slaughtering

Indicator	Group			
	reference	1 experimental	2 experimental	3 experimental
The pre-slaughter weight of 1 chicken, g	2,054.9 ± 7.1	2,232.9 ± 6.5	2,280.8 ± 6.1	2,225.8±6.6
The weight a semi-eviscerated carcass, g	1,676.7 ±5.9	1,842.1 ± 5.7	1,922.7± 5.5	1,843 ±5.9
In % of the live weight	81.6	82.5	84.3	82.8
The weight an eviscerated carcass, g	1,321.2 ± 4.5	1,458 ± 3.7	1,502.9± 3.6	1,460.2 ± 4.3
Slaughter yield, %	64.3	65.3	65.9	65.6

Note: n = 5

Table 7. Chemical composition and ecological and consumer properties of broiler chicken meat, %

Indicator	Group			
	reference	1 experimental	2 experimental	3 experimental
Chest muscle				
Dry matter, %	25.17±0.18	25.79±0.22	26.21±0.12	26.00±0.14
Protein, %	21.76±0.14	22.65±0.17	23.00±0.13	22.88±0.13
Fat, %	2.22±0.03	2.14±0.05	2.02±0.03	2.19±0.03
Zinc (MPC=70 mg/kg)	89.04±0.28	65.43±0.24	25.57±0.30	63.77±0.20
Cadmium (MPC=0.05 mg/kg)	0.074±0.003	0.045±0.002	0.021±0.003	0.024±0.004
Lead (MPC=0.5 mg/kg)	0.80±0.01	0.47±0.04	0.23±0.02	0.28±0.04
Thigh muscle				
Dry matter, %	23.69±0.20	24.39±0.17	24.85±0.14	24.52±0.11
Protein, %	18.84±0.12	19.72±0.14	20.43±0.19	20.00±0.15
Fat, %	3.30±0.04	3.14±0.03	2.54±0.05	2.80±0.03
Zinc (MPC=70 mg/kg)	92.24±0.23	69.22±0.21	33.24±0.25	37.70±0.32
Cadmium (MPC=0.05 mg/kg)	0.081±0.002	0.048±0.004	0.027±0.005	0.032±0.003
Lead (MPC=0.5 mg/kg)	0.86±0.02	0.46±0.03	0.30±0.03	0.35±0.05

Note: n = 5

Adding the Detox preparation at the dosage of 1,500 g/t of feed had most favorable effect on the chemical composition of poultry meat. Due to that, the content of dry matter and protein in breast and thigh muscles in the broilers of the 2-nd experimental group, as compared to the reference group, was veraciously (P>0.95) higher by 1.04% and 1.16%, and 1.24% and 1.59%, and fat content, by the contrast, was lower – 0.20% and 0.74% (P>0.95), respectively.

During the analysis of the chemical composition of these types of muscles in the carcasses of broilers, aflatoxin B_1 was not found, which is the evidence of environmental safety of their meat.

The ecological and consumer properties of poultry meat in the compared groups were assessed by the presence of heavy metals in it. Feeding the Detox preparation in this dosage ensured a veracious (P>0.95) decrease in the content of zinc – 2.77 times, cadmium – 3.00 times, and lead – 2.86 times in the birds of the 2-nd experimental group, compared to the reference group. Moreover, concentration of all three elements in the meat of broilers in the 2-nd experimental group was below the MPL.

However, in commodity assessment of poultry meat, white meat in considered more valuable. It has been established that the process of detoxification of the analyzed toxicants due to feeding the Detox preparation at the dosage of 1,500 g/t of feed was better in the organisms of the birds in the 2-nd experimental group, therefore, samples of their breast muscles contained veraciously (P>0.95) smaller amounts of zinc – by 3.48 times, of cadmium – by 3.52 times, and of lead – by 3.47 times. With that, the presence of zinc, cadmium and lead in the meat of broilers in all experimental groups was below the MPL.

DISCUSSION.

In case of the tolerated level of aflatoxin B_1 and elevated content of heavy metals in the feed during the experiment, it has been found that adding the Detox adsorbent at the dosage of 1,500 g/t of feed had higher stimulating effect on nutrients digestibility and on assimilation of protein in the feed. The process of detoxification in broilers in the 2-nd experimental group was ensured by increased coefficients of digestibility of dry and organic matter, crude protein and nitrogen-free extractive substances, as well as daily nitrogen retention in the organism.

It has been found that adding the Detox preparation at the dosage of 1,500 g/ton of feed into the diets in the conditions of the excessive content of heavy metals and tolerated level of aflatoxicosis in the feed had a positive effect on the slaughter indicators of broiler chickens in the experimental groups. Thanks to the high detoxification properties of the broiler chicken in experimental group 2, compared to the chicken in the reference group, the content of dry matter and protein in breast and thigh muscles was significantly higher, and the content of fat was lower. This is the evidence of the fact that the adsorbent in the indicated dosage intensified protein metabolism, and, conversely, inhibited fat metabolism.

Feeding the Detox preparation in this dosage ensured a veracious (P>0.95) decrease in the content of zinc, cadmium, and lead in the breast and thigh muscles of birds in the 2-nd experimental group, compared to the reference group. Concentration of all three elements in the meat of broilers in the 2-nd experimental group was below the MPL.

CONCLUSIONS.

1) In the technogeneous area of RNO – Alania, the Detox adsorbent at a dose of 1500 g/t of feed should be added as an efficient detoxicant into the corn-barley-soybean feed with high content of heavy metals and tolerated levels of aflatoxin B_1 for broilers. In the analysis of the chemical composition of thigh and breast muscles of broilers, aflatoxin B_1 was not found.
2) Feeding the tested preparation in the indicated dosage had a positive effect on digestibility and assimilation of nutrients in the diets of experimental birds.
3) Adding the Detox preparation at the dosage of 1,500 g/t of feed to mixed feeds with high content of heavy metals and tolerated levels of aflatoxin B_1 had the most favorable effect on the ecological and consumer properties of poultry meat, whereby in broilers of the 2-nd experimental group, compared to the reference

group, the content of dry matter and protein in breast and thigh muscles was veraciously (P>0.95) higher, and the content of fat was lower. Besides, their samples of breast muscles contained veraciously (P>0.95) less zinc – by 3.48 times, cadmium – by 3.52 times, and lead – by 3.47 times. With that, the presence of zinc, cadmium and lead in the meat of broilers in all experimental groups was below the MPL.

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