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Applying iodine-containing preparations as growth promoters in Russia's poultry farming

Eleonora Evgenievna Ostrikova*, Natalia Andreevna Ostapenko, Alexander Sergeevich Chernyshkov, Natalia Vladimirovna Lenkova

Don State Agrarian University, Persianovsky Settlement, Oktyabrsky District, Rostov Region 346493, Russian Federation
**Corresponding author:* eleonoraostrikova@yandex.ru

Abstract

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The Rostov Region is included in the iodine deficient biogeochemical province. Our research was aimed at studying the meat productivity and resistance of BIG-6 crossbreed turkeys when growing on feed using iodine-containing preparations Iodomidol, Iodinol, bentonite clay + iodine. It was found that under the influence of the above mentioned preparations these indicators are improved and the duration of the growing period is reduced. Ash content increases and fat content decreases in turkey meat. The positive effect of preparations on the morpho-biochemical parameters of blood and the immunological status of the test bird body was revealed. The positive influence of Iodimodol on the productive qualities of birds has been experimentally proved.

Theoretical and practical significance of the research involves the expediency of introducing Iodinol into the turkey ration at a dose of 0.4 g per 1 kilogram of live weight per day with food in the form of wet mash.

Keywords: poultry farming; BIG-6; crossbreed turkey; live weight; blood indices; body resistance; iodine-containing

Introduction

Reduced iodine content in feeds, water consumed by animals and birds, leads to the weakened immune system, therefore, to increased sensitivity to diseases, on the one hand, and to decrease in iodine content in animal meat, on the other hand. According to the World Health Organization (2003, 2018), the intravital formation of the microelement composition is the preferred method for correcting micronutrient deficiencies.

Iodine-containing preparations, with ubiquitous iodine deficiency in the Rostov Region, contribute to the active production of thyroid hormones, the biological effect of which extends to a variety of physiological functions of the body (Flachowsky, 2007; Gołkowski et al., 2007). In particular, they regulate the basal metabolic rate (Fleming, 1980), the growth and differentiation of tissues, protein carbohydrate and lipid metabolism (Punyani et al., 2006) water-electrolyte metabolism, the activity of the central nervous system, the gastrointestinal tract and hemopoiesis (Lauterbach & Uber, 2001), the function of the cardiovascular system, the need for vitamins, the body's resistance to infections.

Numerous scholars (Bespalov et al., 2010; Yalçin et al., 2010; Timofeeva, 2012; Honihoyeva, 2012; Słupczyńska et al., 2014) studied the effectiveness of iodine use when growing laying hens or broiler chickens. However, this issue was not covered in turkey breeding. Therefore, the aim of our research was to study the meat productivity and resistance of BIG-6 crossbreed turkeys when grown on rations using various iodine-containing preparations: Iodomidol, Iodinol, bentonite clay + iodine.

Theoretical and practical significance of the research consisted in substantiating the possibility of promoting the growth of turkey poults with the help of various iodine-containing preparations: Iodomidol, Iodinol, bentonite clay + iodine.

Materials and Methods

To conduct the experiment, four groups of one-day aged turkeys were formed. Birds were selected into groups by the principle of analogues. Poultry was fed with the preparation according to the experimental design (Table 1).

Birds' absolute (g) and relative (%) gain rate was determined.

When birds were 140-day-old, 4 heads from each group were sent to a control slaughter to determine the meat qualities:

• the preslaughter weight, which is determined after 12-16 hours of the bird's stay without feed and 4 hours without water;

• the uneviscerated poultry weight – the mass of a dead turkey without blood and feather;

• the semieviscerated poultry weight – the mass of a dead turkey without blood, feather, having intestines with cloaca, ingluvies (crop) and oviduct (in laying turkeys) removed;

• the eviscerated poultry weight – the mass of a dead turkey without blood, feather, head, feet, wings cut at the elbow joint, having all the internal organs except the lungs and kidneys removed;

• edible parts – the muscles of the chest, legs and torso, liver without gall bladder, heart, gizzard cuticle without contents, kidneys, lungs, skin with subcutaneous fat and visceral fat;

• inedible parts – feet, head, bones of the trunk and limbs, wings cut below the elbow joint, gastrointestinal tract (esophagus, crop, gizzard stomach, cuticle, intestines, including the contents, pancreas, gall bladder), oviduct, ovary, testes, larynx, trachea.

All the above indicators, except for the live weight, were determined during the anatomical separation (cutting-up) of carcasses.

Chemical composition indicates of nutritional value of poultry meat. In this case the study concerned:

• moisture content (%), which was determined by drying the sample in accordance with GOST 9793-74;

• fat content, which was analyzed according to GOST 23042-86 using Soxhlet extraction apparatus;

• protein content, which was measured by the Kjeldahl photometric method (GOST 25011-81);

• ash content, which was determined by ashing technique (sample combustion).

Blood tests were made in birds twice a month to determine the hemoglobin level and differential blood count. The determination of the main hematological parameters was carried out using a Micros 60 analyzer. Biochemical parameters of blood serum were determined by means of the Clima MC15 analyzer. Serum bactericidal activity was determined by nephelometry. Lysozyme activity was determined by the method offered by Dorofeychuk (1968).

All the studies were carried out at the Rostov Regional Veterinary Laboratory.

Statistical processing of the results was carried out using SPSS 11.5 statistical packages with the functional application Stat Soft Statistika 6.0 controlled by Windows XP Professional.

Results and Discussion

Turkey live weight and energy of its growth is an important indicator that characterizes the level of their productivity. The results of our studies showed that with the same feeding and maintenance technology, the live weight of the experimental turkeys varied in different ways (Table 2).

At the age of one day the live weight of the turkey poults of the experimental and control groups was approximately the same. However, at the age of 14 days the growth rate of turkeys was different. The highest growth energy was characteristic of the turkey poults of the experimental group II. They exceeded the control group herd mates by 280 g. The difference between the turkeys of the experimental groups was 51.14 and 71.05 g in favor of the second experimental group.

At the age of 56 days (8 weeks), the turkey poults of the experimental group I ranked below the turkeys of the experi-

Table 1. Experimental design of the 2nd stage

Group	Number of animals, head	Preparation	Dosage, g/turkey head per day
I experimental	30	Iodomidol	0.0024
II experimental	30	Iodinol	0.4
III experimental	30	Bentonite clay + iodine	0.4
control	30	–	–

Table 2. Dynamics of turkey live weight depending on the applied iodine-containing preparation, kg

Age, days		Group			
		control	I experimental	II experimental	III experimental
1		56.20±0.11	57.92±0.13	56.09±0.21	57.07±0.15
14		294.26±0.11	451.12±0.16	502.26±0.27	431.21±0.14
56		1924±101.15	2903±108.54	3413±108.11	3154±104.21
91	female	3373±111.49	5124±117.15	5561±124.41	5326±120.24
	male	4742±106.18	7055±114.63	7832±120.35	7470±123.11
115	female	4854±141.47	6814±137.86	7631±159.24	7311±151.61
	male	6542±140.71	9451±139.60	12081±121.73	9740±134.25
140	female	6058±131.31	8417±118.57	9031±114.14	8621±123.64
	male	8416±127.26	12143±121.17	12753±118.06	12407±121.38

mental group II by 510 g and those of the experimental group III by 529 g ($p > 0.999$) in terms of live weight. At the age of 91 days females and males of the experimental group II outperformed their herd mates of the control group by 1428 g or by 40.53% and 2310 g or by 49.73% ($p > 0.999$), respectively.

Morphological blood parameters may be used for assessing the state of metabolic processes in the body of animals. Mullakayeva and Volkov (2010), Pogodaev et al. (2012) and others found that the morphological composition of the turkeys' blood depends on the conditions of feeding, maintenance, breed and other factors. Red blood count is one of the important morphological indicators of blood. Erythrocytes transport oxygen from the lungs to the tissues of the body and carbon dioxide from the tissues to the lungs. Red blood cells are involved in the regulation of acid-base balance and water-salt metabolism in the body and in a number of enzymatic processes, take part in the normalization of the immune system state, as well as in the regulation of blood coagulation (Kondrakhin et al, 2003).

Our investigations established that the morphological composition of the blood turkey poults aged 2 days was the same in the control and experimental groups. However, significant differences were revealed in the course of the experiment (Table 3).

Thus, by the age of 56 days in the control group RBC has increased by 0.28×10^{12}/l or 11.1%, WBC has grown by 3.56×10^{9}/l (23.29%) and Hb – by 12.76 g/l (13.75%). In the experimental group I blood count growth made: RBC – 0.41×10^{12}/l (16.2%), WBC – 3.69×10^{9}/l (24.16%) and Hb – 14.72 g/l (15.94%). In the experimental groups II and III these parameters increased by 0.5×10^{12}/l (19.92%) and 0.43×10^{12}/l (17.06%); 3.58×10^{9}/l (23.42%) and 3.55×10^{9}/l (23.26%); 16.54 (17.87%) and 14.86 g/l (16.07%), respectively.

Blood of the birds in the experimental groups was characterized by a larger blood count and hemoglobin content. They outperformed their herd mates of the control group in RBC by 0.14×10^{12}/l (5%), 0.21×10^{12}/l (7.5%), 0.15×10^{12}/l (5.36%).

Table 3. Morphological blood parameters in turkeys

Parameter	Group			
	control	I experimental	II experimental	III experimental
2-day old				
Red Blood Count, $*10^{12}$/l	2.52±0.09	2.53±0.06	2.51±0.09	2.52±0.07
White Blood Count, $*10^{9}$/l	15.28±0.47	15.27±0.42	15.28±0.44	15.26±0.42
Hemoglobin, g/l	92.53±1.30	92.42±1.29	92.54±1.30	92.49±1.31
56-day old				
Red Blood Count, $*10^{12}$/l	2.80±0.14	2.94±0.13	3.01±0.14	2.95±0.13
White Blood Count, $*10^{9}$/l	18.84±0.55	18.96±0.48	18.86±0.52	18.81±0.49
Hemoglobin, g/l	105.26±1.54	107.16±1.37	109.08±1.42	107.35±1.34
140-day old				
Red Blood Count, $*10^{12}$/l	2.92±0.18	2.97±0.17	3.03±0.19	2.98±0.21
White Blood Count, $*10^{9}$/l	17.72±0.72	18.13±0.64	18.24±0.49	18.07±0.34
Hemoglobin, g/l	109.37±1.94	112.12±1.24	115.09±1.32	110.27±1.27

Resistance of birds to adverse environmental factors is determined by the state of immune defences. White blood excell count characterizes the immune status. WBC increased by 0.12×10^9/l (0.63%) in the turkey blood of the experimental group I and by $0.02x10^9$/l (0.1%) in the turkey blood of the experimental group II, respectively.

Hemoglobin is an essential component of blood. Its increase in blood contributes to the inflow of oxygen to the tissues and enhances the body tissue turnover. The complex mechanism of oxidation-reduction processes in the body is highly correlated to hemoglobin. The level of hemoglobin content depends on the function of the hematopoietic organs and the liver, as well as the supply of the body with a native protein, macro- and trace elements. Hemoglobin level increased by 1.9 (1.8%) in the experimental group I; by 3.82 (3.63%) in the experimental group II and by 2.09 g/l (1.98%) in the experimental group III.

In 84 days of the experiment RBC increased by 0.12×10^{12}/l (4.28%) in the control group, by 0.03×10^{12}/l (1.02%) in the experimental group I, by 0.02×10^{12}/l (7.5%) in the experimental group II, and by 0.03×10^{12}/l (1.02%) in the experimental group III. And as compared to the 56-days' age WBC decreased by 1.12×10^9/ (5.94%) in the control group, by 0.83×10^9/l (4.37%) in the experimental group I; by 0.62×10^9/l (3.28%) in the experimental group II; and by 0.74×10^9/l (3.93%) in the experimental group III. Despite the overall dynamics of the decrease in leukocytes, white cells were found in larger numbers in the blood of turkeys grown with iodine-containing preparations. Thus, the blood of turkeys of the experimental group I contained WBC by 2.31 % more than that of the control group, these figures being larger by 2.93% in the experimental group II and by 1.97% in the experimental group III. With advancing age hemoglobin content increased by 3.90% in the blood of turkeys of the control group; increasing by 4.62 in the experimental group I; by 5.51 in the experimental group II and by 2.72% in the experimental group III. Experimental groups outperformed the control one in the parameter under study by 2.51; 5.22 and 0.82%, respectively.

Thus, it can be concluded that the high content of erythrocytes, leukocytes and hemoglobin in the blood of turkeys grown with iodine-containing preparations applied indicates more intensive oxidation-reduction processes in the body, which is also confirmed by their higher growth and development.

Table 4. Content of protein and its fractions in serum, g/l

Parameter	Group			
	control	I experimental	II experimental	III experimental
2-day old				
Total protein	60.19±0.45	60.42±0.51	60.34±0.51	60.16±0.43
albumins	26.18±0.32	26.34±0.33	26.88±0.37	26.54±0.34
globulins	34.01±0.17	34.08±0.16	33.46±0.17	33.62±0.17
α-globulins	12.00±0.19	11.97±0.18	11.93±0.17	11.98±0.18
β-globulins	9.90±0.17	9.92±0.15	9.94±0.15	9.93±0.16
γ-globulins	12.11±0.18	12.19±0.16	12.29±0.15	11.71±0.16
56-day old				
Total protein	63.58±0.54	67.08±0.48	70.00±0.49	68.64±0.51
albumins	28.25±0.29	28.67±0.31	30.27±0.33	29.17±0.30
globulins	35.33±0.13	38.41±0.14	39.73±0.19	39.47±0.15
α-globulins	12.00±0.14	12.17±0.16	13.49±0.19	12.86±0.15
β-globulins	10.05±0.12	10.18±0.12	10.82±0.13	10.33±0.12
γ-globulins	13.28±0.22	16.06±0.24	15.42±0.25	16.28±0.22
ASAT, mmol/l	1.82±0.08	1.88±0.08	2.03±0.09	1.96±0.07
ALAT, mmol/l	1.97±0.07	1.94±0.06	1.89±0.07	1.91±0.07
140-day old				
Total protein	65.74±0.60	68.16±0.56	73.47±0.57	70.15±0.42
albumins	30.23±0.38	30.88±0.37	32.79±0.32	31.48±0.27
globulins	35.51±0.15	37.28±0.17	40.68±0.17	38.67±0.16
α-globulins	11.88±0.16	12.46±0.18	13.53±0.18	13.20±0.15
β-globulins	9.93±0.15	10.26±0.17	11.58±0.17	11.03±0.16
γ-globulins	13.70±0.34	14.56±0.32	15.57±0.31	14.44±0.31
ASAT, mmol/l	1.70±0.06	1.86±0.06	2.31±0.08	2.11±0.08
ALAT, mmol/l	1.86±0.05	1.93±0.06	2.10±0.08	2.04±0.06

Kondrakhin (2003), Kountz and Schubert (2015) found that with the change of the thyroid gland secretion under the influence of iodine, the course of metabolic processes in the body changes as well. With this in mind, some indicators of protein metabolism were studied (Table 4).

The relevance of studying serum proteins is determined by a wide range of biological functions performed by them. Blood proteins maintain a constant oncotic pressure, blood pH, play an important role in the formation of immunity.

To assess the state of protein metabolism, the dynamics of total protein and its fractions in turkey blood serum was determined.

In the course of the study, it was found that at the 2-day age the content of serum protein and its fractions in turkeys was approximately the same. However with advancing age its concentration increased.

Thus, at the age of 56 days the total serum protein level in the control group poultry increased by 3.39 g/l or 5.63%, while in the experimental group I it rose by 6.66 g/l or 11.02%, by 9.66 g/l or 16.0% in the experimental group II and by 8.48 g/l or by 14.09% in the experimental group III. High protein content was characteristic of the turkey blood serum obtained from poultry grown with the use of Iodinol. They outperformed the herd mates of the control group by 6.42 g/l or 10.09% in terms of this parameter. The poultry from the experimental group I, grown using Iodomidol, outperformed the control group by 3.5 g/l or 5.50%; the turkeys from the experimental group III, grown using bentonite clay in combination with a 1% aqueous solution of iodine, showed increase by 5.06 g/l or 7.96%.

The albumin level also tended to grow. Thus, in the control group with advancing age, this indicator increased by 2.07 g/l or 7.91%, rising by 2.33 g/l or 8.84% in the experimental group I, by 3.39 g/l or 12.61% in the experimental group II and by 2.63 g/l or 9.91% in the experimental group III. While comparing the content of albumins in the blood serum of the experimental poultry, it should be noted that the difference between the control and experimental groups was: 0.42 g/l (0.59%), 2.02 g/l (7.15%), 0.92 g/l (3.25%), respectively.

The content of globulins in serum also increased with advancing age. Thus, the level of α-globulins increased by 0.2 g/l or 1.67% in the experimental group I, by 1.56 g/l or 13.07%, in the experimental group II and by 0.88 g/l or 7.34% in the experimental group III. While comparing with the control group, in which the number of α-globulins remained unchanged, the difference with the experimental groups was 0.17 g/l (1.42%); 1.49 g/l (12.42%); 0.86 g/l (7.16%), respectively. Over 52 days of the experiment, the amount of β-globulins increased by 0.26 g/l (2.62%) in the experimental group I, by 0.88 g/l (8.85%) in the experimental group II and by 0.4 g/l or 4.03% in the experimental group III. As compared to the control group, the content of β-globulins in the serum of the poultry in experimental groups was 0.13 g/l (1.29%); 0.77 g/l (7.66%); 0.28 g/l (2.78%). By the age of 56 days the concentration of γ-globulins increased by 1.17 g/l (9.66%) in the control group, rising by 3.87 g/l (20.93%) in the experimental group I, by 2.14 g/l (16.11%) in the experimental group II and by 3.0 g/l (22.59%) in the experimental group III.

By the age of 140 days, the total serum protein content in the control group poultry increased by 2.16 g/l or 3.39%, with the increase by 1.08 g/l or 1.61% in the experimental group I, by 3.47 g/l or 4.95% in the experimental group II and by 1.51 g/l or 2.2% in the experimental group III. The difference between the studied parameter in the control and experimental groups makes 3.68; 11.75 and 6.70%.

With advancing age the level of the albumin fraction increased by 1.92 g/l in the control group; rising by 2.21 g/l in the experimental group I, by 2.52 g/l in the experimental group II and by 2.31 g/l in the experimental group III or by 7.0; 7.70; 8.32 and 7.92%, respectively. When comparing the parameters of the control and experimental groups, attention should be paid to the fact that a larger content of albumin fraction was typical for the blood serum of turkeys of the experimental group II. They outperformed the control group parameters by 0.65 g/l or 2.15%. In the blood of the turkeys of the experimental groups I and III albumin levels were by 0.65 and 1.25 g/l or by 2.15 and 4.13% higher, respectively.

The level of α- and β-globulin fraction did not change in the control group with advancing age, which cannot be said about the experimental groups. Thus, by the age of 140 days, the content of α-globulins in the blood serum of the turkeys increased by 0.29 g/l in the experimental group I, by 0.04 g/l in the experimental group II and by 0.34 g/l in the experimental group III, or by 2.38 ; 0.29 and 2.64%, respectively. The difference between the parameters of the control and experimental groups was 0.53 g/l in the experimental group I, 1.65 g/l in the experimental group II and 1.32 g/l in the experimental group III or at 4.88; 13.88 and 11.11%, respectively. With advancing age the amount of β-globulins increased by 0.08 g/l (0.78%) in the experimental group I, by 0.76 g/l (7.02%) in the experimental group II and by 0.7 g/l (6.77 %) in the experimental group III. The excess over the control group parameters amounted to 3.32; 16.61 and 10.07%, respectively. Analyzing the dynamics of the γ-globulin fraction, it should be noted that in the control group its concentration was 13.7 g/l, increasing by 0.42 g/l or 3.19% in 84 days. In the experimental groups I and III, the content of the γ-globulin fraction decreased by 1.5 and 1.84 g/l or 9.33 and 11.3%, respectively, as compared with the 56-day age. In the experimental group II, the parameter under study slightly

Table 5. Parameters of nonspecific resistance, %

Parameter	Age, days	Group			
		control	I experimental	II experimental	III experimental
SBA	2	51.34±1.67	52.06±1.38	51.87±1.49	51.44±1.27
	56	44.82±1.85	45.42±1.64	47.58±1.81	46.33±1.59
	140	36.93±1.58	38.93±1.56	40.28±2.09*	37.16±1.88
SLA	2	42.94±1.33	48.80±1.48	53.11±1.34*	47.91±1.22
	56	40.89±1.58	40.56±1.70	42.62±1.61	41.15±1.52
	140	36.68±1.22	37.02±1.18	36.64±1.21	36.82±1.19

Note: SBA – serum bactericidal activity, SLA – serum lysozyme activity

increased by 0.15 g/l or 0.9%. Compared with the control group parameters, the level of γ-globulin in the serum of turkeys was higher by 0.86 g/l or 6.27% in the experimental group I, by 1.87 or 13.6% in the experimental group II and by 0.74 g/l or 5.40% in the experimental group III.

Numerous biochemical processes in the body occur with the most active participation of enzymes. Enzymes as biological catalysts accelerate biochemical processes in the body, controlling the metabolism, determine the intensity of growth and the formation of individual tissues.

Currently, it is impossible to explain the changes in the intermediate metabolism without the participation of enzymes. Aminotransferases are one of the key enzymes of the nitrogen metabolism. Aspartate aminotransferase (ASAT) and alanine aminotransferase (ALAT) are involved in the transamination processes. These enzymes have a significant effect on the synthesis of protein in the body. They perform linkage via ketoglutaric, oxalic-acetic and pyruvic acids between protein, carbohydrate and lipid metabolism, and catalyze the synthesis of the most common amino acids.

The results of our studies indicate that the activity of transamination enzymes in the blood of the experimental turkeys was different (Table 4).

With advancing age, the level of ASAT and ALAT decreased by 0.12 and 0.11 mmol/l in the control group. The content of transamination enzymes did not change with advancing age in the experimental group I, whereas in the experimental groups II and III it significantly increased by 0.27 and 0.21; 0.15 and 0.13 mmol/l, respectively.

The increase in the activity level of transamination enzymes in the blood serum of turkeys until 140 days of age is related to the fact that in this period of development, turkeys have intensive processes associated with the synthesis of protein for building muscle tissue.

Parameters of nonspecific resistance in turkeys

Natural resistance is understood as the ability of a body to resist physical, chemical and biological impacts originating from the external environment.

The level of natural resistance depends on the functional state of the body and environmental factors – climatic parameters, conditions of feeding and maintenance, etc.

In this research, the humoral factors of the body defence were evaluated in the experimental turkeys. Humoral factors include cutaneous and mucosal barriers, bactericidal properties of secrets, lysozyme, interferon and other properties.

Lysozyme proves rather essential in the implementation of the barrier function. In addition to antibacterial activity, it also has the property of stimulating phagocytosis. It is known that lysozyme is contained in all media of the body and microbes from the cocci group are especially sensitive to it.

Parameters of nonspecific resistance of turkeys are given in Table 5, Fig. 1 and Fig. 2.

Bactericidal properties of blood develop as a result of impact on the pathogen of the entire complex of humoral factors of nonspecific defence – lysozyme, complement, and interferon. Bactericidal activity of blood serum allows assessing the overall level of nonspecific body forces, and in this sense it is an indispensable tool in the study of humoral immunity.

The maximum parameters of serum bactericidal activity were found in the turkey poults of the experimental group I at the age of 2 days. Their values exceeded the parameters of the control group turkeys by 0.72%.

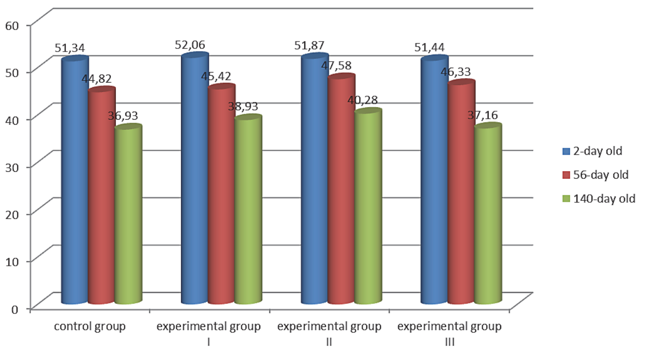

Fig. 1. Serum bactericidal activity (SBA) of turkey poults, %

At the age of 56 days, the serum bactericidal activity was higher in the turkey poults of the experimental groups I, II and III which were fed with iodine-containing preparations as compared to the control group turkeys by 0.6; 2.76 and 1.51%, at the age of 140 days – by 2.0; 3.35 and 0.23%, respectively.

At the age of 2 days, the serum lysozyme activity in the experimental groups was enhanced and exceeded the control group parameters by 5.82; 10.17 and 4.97%, respectively. At the age of 56 days, the highest lysozyme content was typical for blood serum of the experimental group II turkeys, which were grown using Iodomidol. The excess over the control group made 1.73%, being 0.26% in the experimental group III.

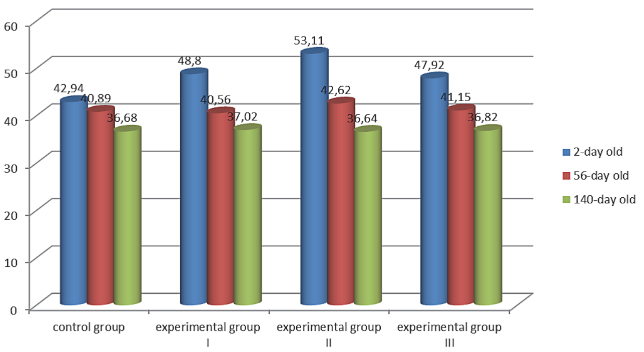

Fig. 2. Serum lysozyme activity (SLA) of turkey poults, %

At the age of 140 days, no significant differences were found in the SLA level

Thus, the positive impact of iodine-containing preparations on the serum bactericidal and lysozyme activity was established.

Turkey meat productivity and chemical composition of meat

The data on live weight and body conformation are intravital indicators of meat productivity. However, they cannot sufficiently characterize the meat qualities, the most complete representation can only be obtained after the slaughter of the poultry. At the same time, both the quantitative characteristics of the product and its qualitative assessment become available. Meat productivity of BIG-6 crossbreed turkeys was evaluated at slaughter at the age of 140 days.

The post-slaughter evaluation of the carcass makes it possible to determine the meat quality of the sold poultry, that is, the set of biological and organoleptic indicators that determine its suitability for satisfying human needs in nutrients.

The results of the anatomical cutting of the carcasses of the experimental turkeys (Table 6) show that the birds of the experimental groups outperformed the control analogues by all parameters.

Poultry carcasses of the experimental groups had a larger uneviscerated weight. The difference with the control group was 2.27; 2.75 and 2.19 kg or 28.9; 33.09 and 28.25%, respectively (Fig. 3).

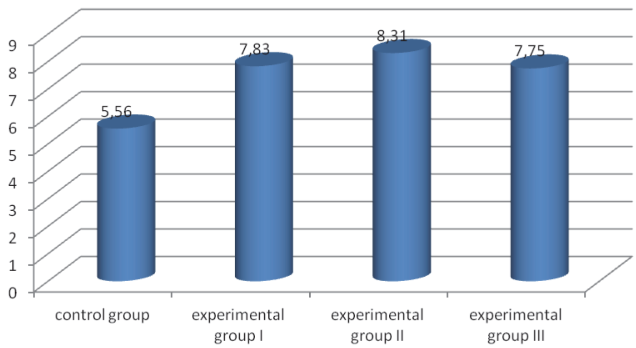

Fig. 3. Uneviscerated turkey weight, kg

Semi-eviscerated poultry weight was also higher in the experimental groups. The excess over the control group made 2.19; 2.53 and 2.35 kg. Slaughter yield was by 0.71-4.18% in the experimental groups than in the control group.

Similar results were obtained when cutting carcasses of male turkeys (Table 7).

Male turkey meat productivity was higher in the experimental groups than in the control group. Uneviscerated poultry weight in the experimental group I was by 3.51 kg higher than in the control group; being higher by 4.41 kg in the experimental group II and by 3.76 kg in the experimental group III. Semi-eviscerated poultry weighted heavier by 3.39; 4.14 and

Table 6. Female turkey meat productivity

Parameter	control	I experimental	II experimental	III experimental
Preslaughter weight, kg	6.05±0.13	8.42±0.12	9.03±0.11	8.62±0.12
Uneviscerated poultry weight, kg	5.56±0.10	7.83±0.19*	8.31±0.08	7.75±0.07***
Semieviscerated poultry weight, kg	5.32±0.06	7.51±0.14**	7.85±0.11	7.67±0.13***
Eviscerated poultry weight, kg	4.65±0.08	6.90±0.11**	7.27±0.06*	6.72±0.15**
Slaughter yield, %	77.65±1.25	81.83±1.69	80.72±1.16	78.36±2.19

Table 7. Male turkey meat productivity

Parameter	control	I experimental	II experimental	III experimental
Preslaughter weight, kg	8.42±0.13	12.14±0.12	12.75±0.12	12.41±0.12
Uneviscerated poultry weight, kg	7.78±0.18	11.29±0.12*	11.92±0.17*	11.54±0.47
Semieviscerated poultry weight, kg	7.41±0.22	10.80±0.12*	11.34±0.17*	10.92±0.28
Eviscerated poultry weight, kg	6.65±0.15	9.95±0.06*	10.64±0.24*	10.05±0.13*
Slaughter yield, %	79.77±0.41	81.95±1.00	83.56±0.56*	80.89±2.03

3.76 kg, respectively in the experimental groups. Slaughter yield was also higher in the experimental groups. The excess over the control group made 2.18; 3.79 and 1.12%.

When comparing meat quality in female and male turkeys, it should be noted the latter had the highest indicators.

Slaughter yield in female and male turkeys also had some differences which are shown in Fig. 4.

Slaughter yield difference was 2.17-2.84% in the control and experimental groups II and III. Slaughter yield in the experimental group I, where turkeys were grown using Iodomidol, practically did not differ from the control group values.

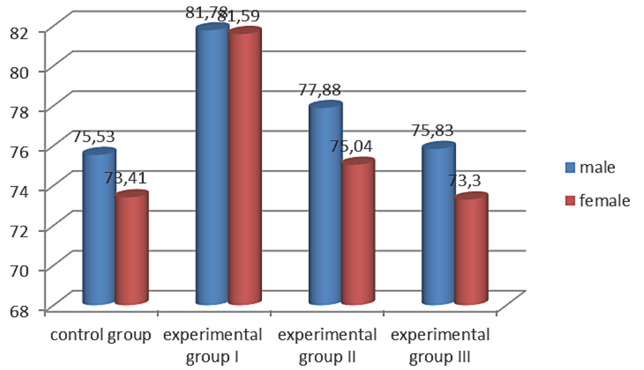

Fig. 4. Slaughter yield, %

Weight of internal organs (heart, liver, gizzard stomach) was also studied in the course of the experiment (Table 8).

Weight of internal organs was higher with the different degree of confidence in the experimental female turkeys than in the control ones. Weight of heart, liver and gizzard of female turkeys was higher in the experimental groups than in their control analogues, respectively: by 14.4% ($p < 0.001$), 20.9% ($p < 0.001$) and 3.1% in the experimental group I; by 1.9%, 14.7% ($p < 0.001$) and 1.8% in the experimental group II; and by 29.8% ($p < 0.001$), 21.5% ($p < 0.001$) and 5.3% ($p < 0.05$) in the experimental group III.

When weighing the internal organs of male turkeys, the following results were obtained (Table 9).

In terms of weight of heart, liver and gizzard male turkeys of the control group lagged behind the experimental poultry, respectively: by 15.5% ($p < 0.01$), 33.7% ($p < 0.001$) and 9.7% in the experimental group I; by 12.3% ($p < 0.01$), 23.8% ($p < 0.001$) and 6.5% in the experimental group II; and by 16.4% ($p < 0.01$), 36.3% ($p < 0.001$) and 11.3% in the experimental group III.

Thus, while studying the effect of iodine-containing preparations (Iodomidol, Iodinol and bentonite clay + 1% iodine solution) on some parameters of turkey meat productivity, the maximum positive effect was obtained in females and males when they were administered Iodomidol.

The primary parameter of the meat quality is its chemical composition, that is, the content of protein, fat, water and dry residue, or ash in the muscle tissue.

The chemical composition of the muscle tissue of the experimental turkeys is shown in Table 10.

The amount of protein increased by 0.2% and 0.1% in the chemical composition of meat samples of experimental groups II and III, while in the experimental group I it decreased by 0.5%. The water content slightly increased – by 0.3% and 0.01% in the meat of the birds of the experimental groups I and II, though the moisture decrease by 0.3% was noted in the experimental group III. The amount of dry matter in the samples of the experimental groups was higher by 10.8%, 18.9% and 15.3%, respectively, as compared to the control group.

Table 8. Weight of internal organs in female turkeys, g

Group	Internal organ		
	heart	liver	gizzard stomach
control	34.67±0.82	118.00±1.25	184.33±2.84
I experimental	39.67±0.75***	142.67±1.19***	190.00±0.94
II experimental	35.33±0.72	135.33±2.13***	187.67±1.19
III experimental	45.00±1.25***	143.33±1.36***	194.00±1.70*

Table 9. Weight of internal organs of male turkeys, g

Group	Internal organ		
	heart	liver	gizzard stomach
control	73.33±1.36	168.33±1.36	206.67±5.93
I experimental	84.67±1.19**	225.00±2.36***	226.63±7.20
II experimental	82.33±1.91**	208.33±3.60***	220.00±4.71
III experimental	85.33±2.23**	229.33±2.84***	230.00±9.43

Table 10. The chemical composition of experimental animals' meat, %

Parameter	Group			
	control	I experimental	II experimental	III experimental
Water	73.64±0.88	73.53±0.85	73.40±0.65	73.56±0.64
Protein	21.15±0.20	21.18±0.14	21.19±0.24	21.04±0.20
Ash	1.23±0.11	1.28±0.08	1.32±0.13	1.11±0.03
Fat	2.57±0.62	2.88±0.50	3.20±0.68	2.91±0.67

The amount of fat in poultry meat samples of the experimental groups I, II and III decreased by 5.8, 8.7 and 17.0%, respectively, in comparison with the control group, the difference is unsubstantiated in all cases.

It should be noted that feeding the poultry with the tested preparations resulted in an insignificant increase in the content of protein in the turkey meat of the experimental groups II and III by 0.2 and 0.1% and its decrease by 0.5%; in the samples of the experimental group I; the amount of water was practically the same relative to the control in the experimental group II, being higher by 0.3% in the experimental group I and lower by 0.3% in the experimental group III.

The fat content decreased and the ash content rose in the meat of turkeys of all experimental groups. The increase in all the desired parameters of meat quality was maximal in the experimental group III, which received the complex of preparations. Data on the concentration of macronutrients in meat from the experimental turkeys are given in Table 11.

In the samples studied, the amount of calcium was the same in all experimental groups. The level of phosphorus in the meat of birds of experimental groups was slightly lower than the control one: by 10.5% in the experimental groups I and II and by 5.3% in the experimental group III. The potassium content increased by 1.5% in the experimental group I and by 2.2% in the experimental group II, however, in the experimental group III the amount of potassium decreased by 1.9%. The concentration of sodium in the experimental groups I and II was lower by 1.8% and 5.5% and in the experimental group III it was higher by 1.8% than the control parameter. The amount of magnesium in the turkeys of the experimental group I was equal to that in the control group, being lower by 6.7% in the experimental group II and higher by 3.3% in the experimental group III.

Thus, the content of macronutrients in the meat of the experimental turkeys slightly fluctuated, which can lead to the conclusion that there is no negative effect of the preparations studied on the macronutrient composition of turkey meat.

Iron, copper, manganese, zinc, selenium are considered to be microelements that are obligatory for the life of the animal.

The level of micronutrients in turkey meat is given in Table 12.

The iron content increased by 5.0% in the experimental group I, by 5.7% in the experimental group II and only by 1.5% in the experimental group III compared with the control group.

In the muscle tissue of turkeys of the experimental groups I, II and III, manganese increase was observed by 50.0%, 50.0% and 80.0% > ($p < 0.05$), respectively, and the amount of copper remained at the same level in the experimental samples as in the control ones.

Table 11. Macronutrient content in the meat of the experimental turkeys

Parameter	Group			
	control	I experimental	II experimental	III experimental
Calcium, %	0.02±0.01	0.02±0.00	0.02±0.00	0.02±0.00
Phosphorus, %	0.19±0.01	0.17±0.02	0.17±0.01	0.18±0.01
Potassium, g/kg	3.14±0.10	3.26±0.13	3.30±0.10	3.17±0.11
Sodium, g/kg	0.55±0.04	0.54±0.01	0.52±0.02	0.56±0.02
Magnesium, g/kg	0.28±0.01	0.30±0.02	0.31±0.03	0.30±0.02

Table 12. Micronutrient content in the meat of the experimental turkeys, mg/kg

Parameter	Group			
	control	I experimental	II experimental	III experimental
Iron	11.34±0.94	12.01±1.27	10.87±1.20	11.06±0.89
Manganese	0.10±0.00	0.15±0.03	0.15±0.03	0.18±0.03*
Copper	0.19±0.03	0.19±0.03	0.19±0.03	0.19±0.06
Zinc	16.35±0.24	18.06±0.50*	16.47±0.27	16.56±0.34
Iodine	0.05±0.01	0.09±0.02	0.10±0.03	0.08±0.01

In the meat of poultry of the experimental groups I and III, the zinc content increased by 12.5% ($p < 0.05$) and 1.6%б respectively, and in the experimental group II it did not differ from the control parameter.

The concentration of iodine in the tested samples of the experimental turkeys' meat in relation to the control samples was as follows: lower by 44.4% in the experimental group I; higher by 11.1% in the experimental group II and lower by 11.1% in the experimental group III.

Thus, the introduction of iodine-containing preparations into the diet of turkeys did not lead to a significant change in the macro- and micronutrient content of meat; on the whole, the determined parameters varied insignificantly.

A significant increase in the content of zinc can be noted in the experimental group I and an increase in the level of manganese was established in all experimental groups, being significant in the experimental group III.

The biological value of various proteins is not the same and depends on the amino acid composition, primarily on the content of essential amino acids that are not synthesized in the body.

The content of essential amino acids in meat of the experimental turkeys is given in Table 13.

Most of the studied parameters as a whole differed slightly from the control ones. Thus, in the meat of the birds of the experimental group I, fed with Iodomidol, the level of tryptophan, threonine, valine, methionine, phenylalanine and methionine + cystine complex was similar to that of the control group. The content of isoleucine, leucine, lysine and arginine was slightly lower by 4.6, 2.0, 0.8 and 2.6%, respectively; the difference in all cases was insignificant. In the experimental group II, which received Iodinol, the amount of threonine, phenylalanine and methionine + cystine complex in meat was insignificantly less than the control parameters – by 1.2%, 9.6% and 1.5%, and the content of isoleucine, valine, leucine and arginine was less than in the control samples , by 9.2% ($p < 0.05$), 4.0%, 13.0% ($p < 0.05$) and 0.9%, respectively. With regard to tryptophan, methionine and lysine, the experimental and control parameters did not differ. In the meat of birds from the experimental group III, whose diet included bentonite clay with 1% iodine solution, the content of threonine, methionine and methionine + cystine complex was equal to that in the control group, the content of valine and phenylalanine was higher by 1.0% and 2.4%, and that of tryptophan, isoleucine, leucine, lysine and arginine was slightly lower, by 5.3, 3.9, 3.5, 0.8 and 4.3%, respectively.

The results of determining the concentration of non-essential amino acids in meat of the experimental turkeys are given in Table 14. The studied parameters varied insignificantly in experimental groups in all cases in relation to those in the control group.

Table 13. The content of essential amino acids in turkey meat

Amino acid	Group			
	control	I experimental	II experimental	III experimental
Tryptophan	0.19±0.00	0.19±0.00	0.19±0.00	0.18±0.02
Isoleucine	1.30±0.02	1.24±0.06	1.18±0.03*	1.25±0.05
Threonine	0.81±0.01	0.81±0.01	0.82±0.01	0.81±0.01
Valine	1.00±0.02	1.00±0.05	0.96±0.03	1.01±0.05
Methionine	0.35±0.00	0.35±0.00	0.35±0.00	0.35±0.00
Methionine + Cystine	0.65±0.01	0.65±0.01	0.66±0.00	0.65±0.01
Leucine	2.00±0.03	1.96±0.11	1.74±0.09*	1.93±0.09
Lysine	1.20±0.01	1.19±0.01	1.20±0.01	1.19±0.02
Phenylalanine	0.83±0.02	0.83±0.04	0.91 ±0.04	0.85±0.04
Arginine	1.17±0.01	1.14±0.05	1.16±0.05	1.12±0.05

Table 14. The concentration of non-essential amino acids in turkey meat, %

Parameter	Group			
	control	I experimental	II experimental	III experimental
Serine	0.83±0.03	0.77±0.06	0.87±0.09	0.83±0.03
Glycine	1.72±0.02	1.71±0.07	1.65±0.05	1.73±0.06
Alanine	1.13±0.02	1.13±0.05	1.08±0.03	1.15±0.05
Glutamine	3.26±0.06	3.26±0.14	3.10±0.11	3.30±0.16
Proline	1.00±0.03	1.07±0.14	0.93±0.06	1.03±0.08
Oxyproline	0.03±0.00	0.03±0.00	0.04±0.00	0.03±0.00

In the muscle tissue of turkeys of the experimental group I, the amount of alanine, glutamine and oxyproline did not differ from the control data, the amounts of serine and glycine were less by 7.2%, and 0.3%, respectively, and the amount of proline was by 7.0% higher. In the experimental group II, the content of serine and oxyproline increased by 4.8% and 33.3%, respectively, while the amount of other amino acids decreased: glycine by 4.1%, alanine by 4.4%, glutamine by 4.9%, and proline by 7.0%. In the meat of birds of the experimental group III, in comparison with the control group, the concentration of serine and oxyproline was the same that of glycine, alanine, glutamine, and proline was higher by 0.6%, 1.8%, 1.2%, and 3.0%, respectively.

As a result of the conducted studies, it can be concluded that iodine-containing preparations introduced into the diet of BIG-6 crossbreed turkeys do not significantly affect the amino acid composition of poultry meat.

Vitamins are not an energy source and a material for building tissues and organs for animals. However, many of them are part of the enzymes or participate in enzyme systems that catalyze the transformation of proteins, lipids, carbohydrates and salts supplied from food into the body. The amounts of fat-soluble vitamins A and E and the water-soluble vitamins of group B were determined in the turkey meat.

The results of determining the concentration of vitamins in turkey meat are given in Table 15.

The concentrations of vitamins A, E and B-complex vitamins differed slightly in the meat of turkeys of experimental groups. Thus, the meat of birds of the control group and experimental group I contained the same amount of vitamin A, its content being lower by 1.2% in the experimental group II and higher by 1.2% in the experimental group III than in the control group. The level of vitamin E in the samples of the experimental groups I and III was higher by 0.9% and 2.4%, and lower by 0.6% in the samples of the experimental group II in comparison with the control samples. The content of vitamin B_1 in the meat of turkeys of the experimental groups I and III was higher by 1.5% in comparison with the control data, whereas the samples of the experimental group II showed lower content of vitamin B_1 by the same amount – 1.5%; the concentration of vitamin B_2 was higher by 0.8% and 2.2% and lower by 0.8%, respectively. The concentration of vitamin B_3 was the same in the control group and experimental group II, in the experimental group I it was lower by 0.3% and in the experimental group III it was higher by 1.3% with respect to the control one. The meat of birds of all experimental groups contained vitamin B_5 more than the control group samples: by 8.4% in the experimental group I, by 0.7% in the experimental group II and by 0.2% in the experimental group III. As compared to the control group the level of vitamin B_6 in the meat of birds of the experimental groups was as follows: higher by 0.8% in the experimental group I, lower by 1.0% in the experimental group II, and higher by 2.2% in the experimental group III.

Table 15. The concentration of vitamins in turkey meat, mg/kg

Parameter	Group			
	control	I experimental	II experimental	III experimental
A	0.81±0.03	0.81±0.02	0.80±0.02	0.82±0.02
E	3.34±0.09	3.37±0.05	3.32±0.05	3.42±0.05
B_1	1.34±0.05	1.36±0.04	1.32±0.02	1.36±0.04
B_2	4.02±0.14	4.05±0.15	3.99±0.11	4.11±0.09
B_3	3.03±0.10	3.02±0.07	3.03±0.04	3.07±0.07
B_5	51.64±1.66	55.92±4.87	52.02±0.90	51.71±1.02
B_6	2.68±0.07	2.70±0.04	2.65±0.04	2.74±0.04

Consequently, the introduction of iodine-containing preparations into the diet of the turkeys did not essentially affect the vitamin composition of poultry meat, the figures for the control and experimental groups differ slightly and are not significant.

In industrial poultry breeding to increase meat productivity and quality of the products obtained a large number of additives are applied: antibiotics, hormones, micronutrients, biologically active substances, probiotics, etc. Most of the preparations used increase the protective properties of the body in response to the influence of unfavorable environmental factors and have a positive impact on productivity. Iodine-containing preparations may be referred to additives, as well. Studies by many authors confirm the advisability of using these additives in poultry farming (Kuznetsov & Kuznetsov, 2001; Nevinskaya et al., 2006; Flachowsky, 2007; Jiao et al., 2011; Shvydkov et al., 2012).

The findings indicate that the BIG-6 crossbreed turkeys that received iodine-containing preparations had a high growth energy at the age of 140 days: the female and male turkeys of the experimental group I exceeded their herd mates of the control group by live weight by 2359 g, or by 38.9% and 3727 g, or 44.3%, respectively; in the experimental group the live weight the female and male turkeys was higher by 2973 g, or by 49.1% and 4337 g, or by 51.5%; respectively; in the experimental group III the female and male turkeys exceeded their herd mates of the control group in terms of live weight by 2563 g, or 42.3% and 3991 g, or 47.4%, respectively. The obtained data are consistent with the results of other authors who conducted studies on poultry of other breeds and crossbreeds (Vladimirov et al., 2004; Hunchak et al., 2007; Meloyan, 2012; Long et al. 2012; Zelenkova & Pakhomov, 2013).

As a result of biochemical studies, it was established that the level of α- and β-globulin fractions of protein did not change in the control group with advancing age, which cannot be said about the experimental groups. Thus, by the age of 140 days, the content of α-globulins in the blood serum of turkeys grown with Iodomidol has increased by 0.29 g/l, rising by 0.04 g/l in poultry grown with Iodinol and by 0.34 g/l in the experimental group III; or by 2.38; 0.29 and 2.64%, respectively. The difference between the parameters in the control and the experimental groups was 0.53 g/l in the experimental group I, 1.65 g/l in the experimental group II and 1.32 g/l in the experimental group III, or 4.88 g/l; 13.88 and 11.11%, respectively. A similar regularity was described by Romaschenko et al. (2015). During the experiment, the amount of β-globulins in the experimental groups increased on average by 0.7 g/l (6.77%). The excess over the control was 3.32; 16.61 and 10.07%, respectively. The level of γ-globulin in the blood serum of poultry in the experimental groups was higher than the control parameters by 0.86 g/l or 6.27% in the experimental group I, by 1.87 or 13.64% in the experimental group II, and by 0.74 g/l or 5.40% in the experimental group III. Our findings are consistent with the results obtained by Ignatovich (2011), Zelenkova, et al. (2015), Ostrikova and Ostapenko (2017) in the experiments on ducks and quails.

In the course of the experiment, it was found that feeding poultry with the iodinol and a mixture of bentonite clay and an aqueous solution of iodine led to an insignificant increase in the protein content of meat by 0.2 and 0.1% and a 0.5% decrease in the experimental group I. The amount of water in the meat was higher by 0.3% in the experimental group I and lowers by 0.3% in the experimental group III as compared to the control group. The increase in all the desired parameters of meat quality turned out to be maximal in the experimental group III receiving the complex of preparations. Rassolov et al. (2011) noted an increase in protein content in poultry meat by 2.5%.

Conclusions

When using iodine-containing preparations, turkey meat productivity had the following trend at the age of 140 days: male and female turkeys of the experimental group I predominated over herd mates of the control group by 2.359 g and 3.727 g in live weight, exceeding them by 2.973 g and 4.337 g in the experimental group II and by 2.563 g and 3.991 g in the experimental group II, respectively.

The revealed high content of erythrocytes, leukocytes and hemoglobin in the blood of turkeys grown using iodine-containing preparations is indicative of a higher intensity of oxidation-reduction processes in the body, which is confirmed by their higher growth and development.

At the age of 140 days the level of total protein in the blood serum of poultry increased by 2.16 g/l or 3.39% in the control group; by 1.08 g/l or 1.61% in the experimental group I; by 3.47 g/l or 4.95% in the experimental group II and by 1.51 g/l or 2.2% in the experimental group III. The difference between the parameter under study was 3.68; 11.75 and 6.70% in the control and experimental groups.

Over 140 days of the experiment the level of the albumin fraction increased by 1.92 g/l in the control group; by 2.21 in the experimental group I; by 2.52 in the experimental group II and by 2.31 g/l in the experimental group III. The difference in values was 0.65 g/l or 2.15% between the control group and the experimental groups I and II; making 1.25 g/l or 4.13% in the experimental group III.

By the 140-day age, the content of α-globulins in the blood serum of male turkeys increased by 0.29 g/l in the experimental group I, by 0.04 g/l in the experimental group II, and by 0.34 g/l in the experimental group III; β-globulins by 0.08 g/l (0.78%), 0.76 g/l (7.02%), 0.7 g/l (6.77%), respectively. The level of γ-globulin in the blood serum of the control group poultry was 0.86 g/l or 6.27%, 1.87 or 13.64%, and 0.74 g/l, or 5.40%, respectively.

The highest bactericidal activity was found in the serum of the experimental group III turkeys, which was by 3.35% higher than the control parameter.

Feeding turkeys of the experimental groups II and III with iodine-containing preparations resulted in an increase in the content of protein in meat by 0.2 and 0.1%, whereas poultry of the experimental group I showed decrease by 0.5%.

In the meat of experienced turkeys the content of iodine was lower by 44.4% in the experimental group I; higher by 11.1% in the experimental group II and lower by 11.1% as compared to the control group.

References

Bespalov, V. G., Nekrasova, V. B., & Skal'nyy, A. V. (2010). Iodine-Elam – a product from kelp: application in the fight against iodine deficiency diseases: Manual for physicians. Nordmedizdat, St. Petersburg. (Ru)

Flachowsky, G. (2007). Iodine in animal nutrition and Iodine transfer from feed into food of animal origin. *Lohmann Information*, *42*(2), 47-56.

Flachowsky, G., Halle, I., Schultz, A. S., Wagner, H., & Dänicke, S. (2017). Long term study on the effects of iodine sources and levels without and with rapeseed cake in the diet on the performance and the iodine transfer into body tissues and eggs of laying hens of two breeds. *Landbauforsch – Appl Agric Forestry Res, 3/4*(67), 129-140.

Fleming, G. A. (1980). Essential micronutrients. 2. Iodine and Selenium. In: *Applied Soil Trace Elements*. Davies, D.E. (Ed.). Chichester, John Wiley & Sons, 199-234.

Gołkowski, F., Szybiński, Z., & Rachtan, J. (2007). Iodine prophylaxis – the protective factor against stomach cancer in iodine deficient areas. *Eur. J. Nutr*., *46*(5), 251-256.

GOST 23042-86. Meat and meat products. Methods of fat determination. (Ru)

GOST 9793-74. Meat products. Methods for determination of moisture content. (Ru)

Honihoyeva, S. V. (2012). Development of a complex fodder additive for the production of poultry meat enriched with selenium and iodine. Dissertation, Ulan-Ude. (Ru)

Hunchak, A. V., Ratych, I. B., Gutyj, B. V., & Paskevych, H. A. (2016). Metabolic effects of iodine in poultry for its deficiency or excess in the diet. *Scientific Messenger of LNU of Veterinary Medicine and Biotechnologies*, *18*(2/67), 70-76.

Ignatovich, L. (2011). Fodder additive from brown algae flour. *Poultry Farming, 5*, 18-20. (Ru)

Jiao, G., Yu, G., Zhang, J., & Ewart, H. S. (2011). Chemical structures and bioactivities of sulphated polysaccharides from marine algae. *Marine Drugs*, *9,* 196-223.

Kondrakhin, I. P., Talanov, G. A., & Pak, V. V. (2003). Internal non-communicable diseases. Colossus, Moscow. (Ru)

Kountz, D. S., & Schubert, M. F. (2015). Thyroiditis. A disease with many faces. *Postgraduate Medicine*, *98,* 101-108.

Kuznetsov, S. G., & Kuznetsov, A. P. (2001). Micronutrient compounds in poultry feeding. *Poultry Farming*, *2***,** 29-34. (Ru)

Lauterbach, A., & Uber, G. (2001). Iodine and Iodine Compounds. In: Kirk-Othmer Encyclopedia of Chemical Technology. John Wiley & Sons, Inc., 1-28.

Long, S. H., Yu, Z. Q., & Shuai, L. (2012). The hypoglycemic effect of the kelp on diabetes mellitus model induced by alloxan in rats. *International Journal of Molecular Sciences*, *13***(**3), 3354-3365.

Lysenko, M. (2011). Reduction of heavy metals in bird organs and tissues. *Poultry Farming*, *2*, 27-28 (Ru).

Meloyan, E. K. (2012). The use of a new iodine-containing drug in the treatment of chronic tonsillopharyngitis. In: *Proceedings of Internationaler Medizinischer Kongress Euromedica*, Hannover, 164-165.

Mullakayeva, M. O., & Volkov, A. K. (2010). Hematological parameters of turkeys of "Zalesny" farming company. *Transactions of the N.E. Bauman Kazan State Academy of Veterinary Medicine*, *201,* 281-283 (Ru).

Nevinskaya, N., Bulgakov, A., & Kuznetsov, D. (2006). Iodized starch and its effect on the bird's body. *Poultry Farming*, *8,* 22-23 (Ru).

ODS. (2018). Iodine: Fact Sheet for Health Professionals. Office of Dietary Supplements. National Institutes of Health.

Ostrikova, E. E., & Ostapenko, N. A. (2017). Hematological parameters of quails using iodine-containing preparations. *Progress in Modern Science and Education*, *7*(2), 178-180 (Ru).

Pogodaev, V. A., Kanivets, V. A., & Shinkarenko, L. A. (2012). Hematological parameters and growth rate of young turkeys of different genotypes. *Veterinary Pathology, 4*(42), 36-40. (Ru)

Punyani, S., Narayana, P., Singh, H., & Vasudevan, P. (2006). Iodine based water disinfection: A review. *Journal of Scientific & Industrial Research, 65*, 116-120.

Rassolov, S., Glazunova, O., & Yeranov, A. (2011). Chemical composition of meat of farm animals and poultry that received micronutrients of selenium and iodine. *Poultry Farm. Poultry Factory, 9,* 24-27. (Ru)

Romaschenko S. V., Shantyz, A. Y., & Shantyz, A. K. (2015). Broiler chicken thyroid morphological changes under iodine-containing additives. In: *Proceedings of the II International Congress Zootechnical and Veterinary Problems of the Agricultural Branch.* Kybernetika, Hannover.

Shvydkov, A., Zhbanova, S., Kotlyarova O., Lantseva, N., & Smirnov, P. (2012). Search for an alternative to antibiotics in broiler poultry breeding. *Poultry Farming*, *11,* 35-38. (Ru)

Słupczyńska, M., Jamroz, D., Orda, J., & Wiliczkiewicz, A. (2014). Effect of various sources and levels of iodine, as well as the kind of diet, on the performance of young laying hens, iodine accumulation in eggs, egg characteristics, and morphotic and biochemical indices in blood. *Poultry Science*, *93*(10): 2536-2547.

Timofeeva, E. (2012). Micronutrients in the feeding of laying hens. *Poultry Farming*, *1,* 25-30. (Ru)

Vladimirov, V. L., Deyneka, O. V., & Shaposhnikov, A. A. (2004). Use of iodovidone and P-carotene in chicken feeding. *Zootekhniya*, *10,* 20-21. (Ru)

WHO. (2003). Iodine in drinking-water. Background document for development of WHO Guidelines for drinking-water quality. World Health Organization.

Yalçin, S., Kahraman, Z., Yalçin, S., Yalçin, S. S., & Dedeoğlu H. E. (2004). Effects of supplementary iodine on the performance and egg traits of laying hens. *Journal British Poultry Science*, *45*(4), 499-503.

Zelenkova, G. A., & Pakhomov, A. P. (2013). Efficiency of using mineral additives in poultry feeding in combination with biologically active substances. *Bulletin of the Saratov State Agrarian University "N. I. Vavilov"*, *3,* 23-28 (Ru).

Zelenkova, G. A., Pakhomov, A. P., Zelenkov, A. P., Ostrikova, E. E., & Gak, Y. M. (2015). Compatibility of Various Doses of Ecoventura and Limestone in Feeding of Replacement Young Ducks. *Polythematic network electronic scientific journal of the Kuban State Agrarian University (KubGAU Scientific journal), 114* (10), 1-11 (Ru).

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