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The effect of humic acids on the natural resistance of the body of broiler chickens and the quality of their meat

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Abstract. The aim of the work is to study the effectiveness of the concentration of humic acids of *Reasil Humic Vet* feed additive on the increase of the feed bioavailability for poultry and the probability of its negative impact on the safety and marketable characteristics of the final product. Studies were conducted on the basis of the Saratov State Agrarian University in two similar groups of broiler chickens 'Cobb 500', 100 heads each. Poultry feeding consisted of the same complete feed, but the drinking water for the broilers of the experimental group was enriched by humates in the amount of 0.5 ml L^{-1}. Based on the data obtained by daily weighing of the poultry and considering the feed intake, a positive trend of the influence of the feed additive on the average daily weight gain and feed conversion per unit of production was noted. The results of slaughter and anatomical cutting of broiler carcasses revealed that metabolic processes were more active in the body of an experimental poultry, reflected in the intensive growth of muscle tissue and fat deposition, which contributed to an increase in the yield of edible parts from carcasses by 9.9%. Studies of composition of broiler blood indicate non-toxicity of the recommended concentration of humates in the feed additive, its stimulation of non-specific resistance of the organism, contributing to the functioning of the immune system and the development of internal organs and, as a consequence, ensuring the safety of the products obtained from them.

Key words: body resistance, humic acid, *Reasil Humic* additive, live weight, muscle and adipose tissue, safety.

INTRODUCTION

The poultry industry occupies a significant place in the maintenance of the meat balance of Russia. This industry is capable to significantly increase its resources in the shortest time provided a reliable forage basis and, in particular, the biological availability of nutrients in the diet. However, the natural potential of meat productivity of agricultural poultry and the improvement of the composition and environmental friendliness of its meat is hampered by the use of mixed feeds. The problem is that these feeds are based on local crops, which have a large microbial contamination. They are supersaturated with chemical toxins that have a mutagenic and carcinogenic effect, and thus, a negative impact on adaptive and immune properties of the poultry organism (Gamko et al., 2015). At the same time, changes in the proteins and protein fractions, the dynamics of blood hematological parameters, the fluctuations in the activity of aminotransferases may indicate a lack of effectiveness of the body's protective properties on external stimuli, and may be accompanied by metabolic disturbances, lagging in poultry growth, development of internal organs, and the emergence of various diseases. To solve this problem, scientists and specialists of the agro-industrial complex are engaged in the development of feed additives and supplements based on natural components of various biochemical composition (Hayirli et al., 2005; Dolgopolov, 2006; Ghahri et al., 2009; Ghahri et al., 2010; Arif et al., 2016; Arafat et al., 2017; Vasiliev et al., 2018). World experience has shown that humic acids or humates are of practical interest for agriculture due to their composition and properties and the wide distribution of such raw materials as leonardite, brown coal, peat and saprofel (Schnitzer & Khan, 1972; Orlov, 1974; Orlov et al., 1996).

Scientific studies of humic acids have shown that in addition to their common properties there are a number of differences resulting from the nature of the original substance and the method of isolation. A common feature for humates is the presence of an aromatic substance, hydroxyl of alcohol or phenolic character, carbonyl, carboxyl and methoxyl groups. It is established that humic acids perform transportational, regulatory and protective functions in the body; they are harmless to animals, birds and humans, having no allergic, anaphylactogenic, teratogenic, embryotoxic and carcinogenic effects when used in recommended doses (Bollag & Mayers, 1992; Ziechmann, 1996; Anisimov & Likhatskaya, 2001; Potapova et al., 2012).

Humates, being biologically active compounds, can be sources of new various biologically active substances depending on the method of their processing in each specific case (Platonov et al., 2010; Nebbioso & Piccolo, 2011). In this regard, there is a great need for the development and implementation of additives based on humic acids of various origins in the production and processing of poultry meat.

The aim of our research was to study the effect of the humate-based product with the commercial name *Reasil Humic Vet* in combination with the main ration of feeding broiler chickens on the natural resistance of the organism and, as a consequence, the quality of meat.

MATERIALS AND METHODS

Preparation of the drug and bioavailability

The product under study is a dark-colored liquid obtained by alkaline extraction of natural leonardite and containing humates. The structural part of humate molecule consists of polysaccharides, peptides, amino acids, vitamins, minerals, sterols, hormones, fatty acids, polyphenol and ketone with subgroups, including flavonoids, flavones, flavins, catechins, tannins, quinones, isoflavones and tocopherols. At the same time, *Reasil Humic Vet* has a high bioavailability and according to the results of testing at the Testing Center of the FGBU 'Leningradskaya MVL', the maximum sorption capacity of the additive in relation to T-2 toxin, aflotoxin B1, zearalenone, and orahtraxin of feed is 84%; 100%; 100% and 97.7% respectively.

Experimental design and feeding program

An experiment on poultry 'Cobb 500' lasted for 42 days. It was conducted at the department of veterinary medicine and biotechnology of Saratov State Agrarian University, Russia. The research implied the analog principle, where two groups of 100 animals each were formed out of one hatch of broiler chickens: I – control, II – experimental. The chickens were kept in the same microclimatic conditions (Table 1).

Table 1. Experiment scheme

Group	Flock, heads	Duration, days	Feeding ration
I-C	100	42	BR (Basic ration)
II-E	100	42	BR + 0.5 mL *Reasil Humic Vet* per 1 liter water

I-C – control group; II-E – experimental group.

As a basic ration, experimental broiler chickens received mixed fodder (Table 2) prepared on the basis of individual entrepreneur farm 'Korostin' in the Markovsky district of the Saratov region.

Table 2. Composition and nutritional value of mixed feed for experimental poultry

Ingridients	Universal feed mixture from 7th to 42nd day of fattening, %
Wheat	40.61
Corn	15.00
Full-fat soya bean (FFS)(31.5% crude fat, 17% crude protein)	24.62
Soybean meal (45% crude protein)	1.00
Sunflower cake (34% crude protein, 18% crude fiber)	3.00
Fish flour (64% crude protein)	1.49
Monocalcium phosphate	0.53
Lime dust	0.75
Premix 2% Chicken premix 5 agrostimulus	2.00
100 g containing (nutrient composition, %):	
Metabolic energy, MJ	1.30
Crude protein	22.00
Crude fat	6.14
Linoleic acid	3.10
Crude fiber	4.50
Lysin	1.43
Methionine	0.62
Methionine+cystine	0.92
Threonine	0.87
Tryptophane	0.25
Ca	1.00
P	0.84
P digestible	0.50
Na	0.19
Cl	0.17
NaCl	0.10

The differences were that the drinking water for livestock of broiler chickens of the II E group was supplied with the feed additive based on humates at a dose of 0.5 mL L^{-1}, recommended by the manufacturer based on the literature data analysis. To achieve our goal, we studied a set of indicators of experimental poultry.

Measurement of growth performance

Changes in the live weight of broiler chickens were measured by their individual weekly weighing on electronic scales, each group starting from the 7th day of life. Based on the results of weighing, we calculated the absolute and average daily growth of broilers. Conversion of feed (kg kg^{-1} of body weight) was determined by the ratio of the amount of feed spent during the entire period of experiment to the number of products obtained.

Sample collection and measurements

To assess the physiological state of the broiler body when consuming humic acids, a clinical blood analysis was performed using the instrumental method on hematology analyzers *PSE 90 Vet*, *Biochem SA* (US-made). The safety of poultry was determined by daily accounting of dead birds.

Upon completion of fattening, a control slaughter (3 heads from each group with a live weight close to the average value) and the total slaughter of broilers in groups were conducted to study both the indicators of their meat productivity and anatomical and morphological composition of carcasses. When cutting carcasses, the following indicators were taken into account: a pre-slaughter mass, a mass of non-gutted (without blood, feathers, down) carcass, gutted carcasses (without internal organs, head, neck and legs), mass of internal organs. The slaughter yield was calculated as the ratio of the slaughter mass to the pre-slaughter live weight, expressed as a percentage. Subsequently, the skin and subcutaneous fat were removed from the carcass, the muscles were separated from the bones.

In the meat samples, the following parameters were determined: moisture – by drying the substance to constant weight; protein (total) – by Kendall's method; fat – using the Soxhlet extractor, ashes – by burning the sample in a muffle furnace to constant weight; mineral substances – by atomic absorption spectrometry.

To determine the taste qualities of broiler meat, a tasting was conducted on the basis of the research and production laboratory of the Food Technology Department at the Saratov State Agrarian University; the taste was measured within 5-scale system. Firstly, poultry carcasses were evaluated in its raw form (uncut), and then on the cut product for such indicators as appearance, color, smell, texture. After the meat was subjected to heat treatment (cooking, frying) the smell (aroma), texture (hardness, tenderness), taste, weight loss, the yield of the finished product were estimated.

Statistical analysis

The obtained data was processed on a personal computer using software *Stat Plus* and *Microsoft Excel* (Glantz, 1998; Dolgopolov, 2006).

RESULTS AND DISCUSSION

Growth Performance

One of the main indicators determining the effectiveness of growing broiler chickens is their live weight. It was established that with almost the same starting weight of experimental chickens at 7 days of age (Table 3), broilers of group II, consuming the additives with humic acids, already surpassed their peers from group I by this indicator by 15.56 g (4.36%) at 14 days of age; at the end of the fattening period (42 days) they reached a live weight of 2,826 g, which was 228 g or 11.36% more than the control group broilers' weight. The advantage of poultry in the group with humates was also manifested in the intensity of the growth energy. Thus, the absolute and average daily gain in live weight of broilers of the experimental group for the reporting period was equal to 2,734.33 g and 71.95 g against 2,444.67 g and 64.33 g in the control group respectively.

Table 3. Live broiler weight dynamics, g (n = 12)

Age of poultry, days	I-C	II-E
7	93.33 ± 0.56	91.67 ± 0.32*
14	357.17 ± 1.11	372.73 ± 1.17**
21	685.75 ± 1.82	781.82 ± 2.22**
28	1,237.42 ± 1.44	1,336.64 ± 1.61**
35	1,857.75 ± 1.23	2,009.09 ± 2.02**
42	2,538.00 ± 1.44	2,826.00 ± 2.05**

* – $p \leq 0.05$; ** – $p \leq 0.001$, experimental group (II-E) compared to the control group (I-C).

Feed intake

The best feed conversion in the compared groups was observed in broiler chickens of group II and amounted to 1.93 kg kg^{-1} increase in live weight, which is 0.3 kg or 13.5% less than that of the control poultry. This was due to the fact that humic acids in the composition of the studied feed additive help stimulate the development of intestinal villi, increase the amount of enzymes secreted, enhance absorption processes and improve feed digestibility by suppressing the growth of pathogenic bacteria.

Blood parameters

Blood in the body of a bird is the most important biological fluid that provides almost all metabolic, protective and adaptive functions. When there are changes in the external environment, compensatory mechanisms, that restore disturbed properties, are activated. This sets a new level of homeostatic indicators. Therefore, a more accurate picture of the effect of the studied additive on the biochemical processes in the body of broiler chickens can be obtained by analyzing their blood. It was established that the use of humates in the composition of the studied feed additive did not have a significant effect on the number of red blood cells in the blood of broiler chickens (Table 4). The level of red blood cells in the control poultry at the age of 42 days was 2.54 million μl^{-1} (normal 3–4 million μl^{-1}). The broilers of the experimental group showed a slight tendency to increase to 2.57 million mL^{-1}. A similar trend, which does not go beyond the criteria of the physiological norm, is traced in relation to the amount of hemoglobin as the main component of red blood cells, the main function of which is to transfer oxygen from the lungs to the tissues, and carbon dioxide, the main function of which is to transfer oxygen from the tissues to the lungs and participate in maintaining acid-base balance in the body, thus possessing buffer properties. In our studies, the control group hemoglobin level was 115.67 g L^{-1}, *Reasil Humic Vet* group hemoglobin level was 117 g L^{-1} or 1% more, with the norm of 115–128 g L^{-1}.

Table 4. Morphological and biochemical blood parameters of broiler chickens

Indicator	Measuring Unit	Group I-C	Group II-E
Morphological parameters			
Erythrocytes	mln pcs mL^{-1}	2.54 ± 0.13	2.57 ± 0.04
Leucocytes	thousand μL^{-1}	22.38 ± 0.74	20.41 ± 0.66
Hemoglobin	g L^{-1}	115.67 ± 2.60	117.00 ± 7.23
Thrombocytes	thousand pcs	18.00 ± 2.08	20.67 ± 0.33
Hematocrit	%	33.46 ± 1.04	32.70 ± 0.73
Biochemical parameters			
Total bilirubin	μmol L^{-1}	11.43 ± 1.15	11.20 ± 1.09
Aspartate – transaminase *(AST)*	u L^{-1}	87.83 ± 6.61	55.17 ± 9.85*
Glutamic-pyruvic transaminase *(GPT)*	u L^{-1}	62.43 ± 10.71	49.73 ± 7.34
Total protein	g L^{-1}	82.57 ± 4.86	61.90 ± 3.44
Total creatinine	μmol L^{-1}	152.00 ± 5.07	112.67 ± 5.74*
Blood urea	mmol L^{-1}	5.50 ± 0.29	7.03 ± 0.23*
Glucose	mmol L^{-1}	6.00 ± 1.62	7.47 ± 0.58
Cholesterol	mmol L^{-1}	5.10 ± 0.29	4.17 ± 0.43
Ca	mmol L^{-1}	4.20 ± 0.21	4.80 ± 0.21
P	mmol L^{-1}	1.73 ± 0.12	2.33 ± 0.13
Mg	mmol L^{-1}	1.13 ± 0.09	1.40 ± 0.06
Na	mmol L^{-1}	126.77 ± 2.66	124.33 ± 0.62
K	mmol L^{-1}	22.36 ± 0.99	23.50 ± 0.60
Fe	μmol L^{-1}	24.73 ± 0.93	24.57 ± 0.52

* – $p \leq 0.01$; experimental group (II-E) compared to the control group (I-C).

In the poultry blood, leukocytes serve as an important link in the mechanism of immunological protection, interacting with lymphoid cells in certain phases of immunological reactions. Due to their phagocytic activity and participation in cellular and humoral immunity, the exchange of histamine, heparin, antimicrobial, antitoxic, antibody-forming and other important components of immunological reactions are performed.

The number of leukocytes in the blood of experimental broilers was within the physiological norm (20–24 thousand μl^{-1}) and amounted to 22.38 thousand μl^{-1} in group I-K against 20.41 thousand μl^{-1} in group II-E. Due to the fact that leukocytes play a major role in the specific protective reactions of the body, these results indicate the harmlessness of the feed additive based on humic acids.

Hematocrit is the ratio between the plasma volume and blood cells, expressed as a percentage by volume. It is essential to calculate hematocrit for an objective assessment of laboratory blood parameters. An increase in hematocrit value is noted in case of anemia, while a decrease points out to the thickening of blood and dehydration of the body. With an average hematocrit rate of 39–40% in poultry, this indicator was evenly lower than the norm in the blood of broilers of all groups by 6–7%.

Blood biochemical parameters are necessary for assessing the physiological status of the body of poultry and for timely diagnosis of pathological conditions, allowing to evaluate the functional state of the body, the liver, kidneys, pancreas and other organs, as well as the state of protein, carbohydrate, fat and mineral metabolism and correct the diet in time.

According to our research, the content of bilirubin in the blood of broilers was within the physiological norms (8.5–20 μmol L^{-1}) and amounted to 11.43–11.2 μmol L^{-1}.

The total protein content in the blood characterizes the protein metabolism in the body. A decrease in its level in blood serum is observed with a low protein content in the diet, with a disturbance of the digestive system. In our experiment, the level of protein in the blood of control group before slaughter deviated from the average norm (53–59 g L^{-1}) by 39% and amounted to 82.57 g L^{-1} with a significantly low rate of the same indicator in the experimental group, which was much closer to physiological norms.

Along with proteins, blood serum contains various nitrogen-containing non-protein substances, which are called residual nitrogen, the main component of which in poultry is urea.

The amount of uric acid in the blood depends not only on the kidney function, but also on the amount of protein consumed or the rate of its breakdown in the body. In particular, the concentration of uric acid in the blood increases with bleeding, gout, leukemia, or pneumonia. The lack of protein in the diet, on the contrary, leads to a decrease in the concentration of uric acid in the blood serum.

The normal concentration of this indicator in poultry ranges from 2.5 to 8.32 mmol L^{-1}. It was established that the urea content in the blood of all experimental chickens was within the physiological norm. However, in the blood of broilers consuming the feed additive, this figure was 7.03 mmol L^{-1}, which exceeds the same indicator in control group broilers by 1.52 mmol L^{-1}.

Along with the calculation of uric acid concentration in blood, it is recommended to determine – as an additional factor – the concentration of creatinine synthesized in the liver and transported to skeletal muscle. The concentration of creatinine in the blood is fairly constant, reflecting muscle mass and not dependent on feeding and other factors.

Normal serum creatinine concentrations are 44–100 μmol L^{-1}. In our experiment, elevated creatinine levels were noted in all groups. At the same time, in the blood of chickens of the control group, 152 μmol L^{-1} creatinine was found, and in the blood of experimental chickens, the creatinine levels were much closer to the physiological norm (112.67 μmol L^{-1}) and significantly lower than in the control group ($p \leq 0.05$). This indicates that in the poultry consuming humates more amino acids worked for the anabolic processes and a higher supply of potential energy was accumulating in glycogen of the muscle tissue.

Blood glucose is the main indicator of carbohydrate metabolism. It reflects the ratio between the processes of its formation and use in tissues. Depending on the type of feeding, the concentration of glucose in the blood usually varies within the physiological norm. The blood glucose concentration rate is the result of the hormones balance regulating it.

In our studies, the blood glucose level in experimental chickens did not significantly differ from the norms (6–9 μmol L^{-1}) and was 6 mol L^{-1} in the control group with a tendency to increase to 7.47 mmol L^{-1} in the experimental group ($p \leq 0.05$), treated with humates added to drinking water (0.5 mL L^{-1}).

Cholesterol is found in all tissues of the body, being a component of cell membranes. It can be synthesized in small quantities by the intestinal wall and supplied with food. Based on it, bile acids, sex hormones, adrenal hormones are synthesized, the product of cholesterol oxidation in the skin is converted into vitamin D3. According to the research it was found that the level of cholesterol in the blood of broiler chickens in the experimental group was 4.17 mmol L^{-1} (at a rate of 3.6) versus 5.1 mmol L^{-1} in the control group. Such elevated cholesterol in the blood of broiler chickens can be observed when feeding with rations enriched with solid feed fats.

The basis of many pathological and pre-pathological states of the body in poultry is the disruption of the enzyme systems. The pathological process is accompanied by an increase in the permeability of cell membranes or the death of cells. Thus, the enzymes from the cells enter the blood, where the corresponding enzymatic activity increases dramatically, since the content of enzymes in the cell is much higher than in the blood. An increase in the activity of blood enzymes can be the result of accelerating the processes of synthesis, lowering the rate of elimination of enzymes, increasing the permeability of cell membranes, the action of activators and cell necrosis. A decrease in the activity of blood enzymes on the contrary indicates an increase in the rate of elimination of the enzymes, the action of inhibitors and inhibition of synthesis.

Aspartate – transaminase *(AST)* is not specific for the liver, but its level in poultry can indirectly show the function of this organ. Normal values are up to 330 u L^{-1} for most bird species. Elevation usually occurs with muscle damage or liver cell damage. In our experiment, the *AST* data in the control group amounted to 87.83 u L^{-1} with significantly low values in the experimental group of 55.17 u L^{-1}, which indicates a more intensive biosynthetic process.

Of the blood mineral substances, the important role of the constant concentration of calcium and inorganic phosphorus should be noted. The level of serum calcium and phosphorus is regulated by derivatives of vitamin C, calcitonin and parathyroid hormone. The calcium content in the blood depends on the species, age, constitution of the bird, the quality of the water taken in, and the amount of calcium in the diet.

Phosphorus is found in biological compounds and tissues in the form of phosphoric acid. It takes an active part in the metabolism of carbohydrates, proteins, fats and minerals also regulating acid-base balance. A low content of phosphorus in the blood is noted in cases of vitamin D avitaminosis, hyperparathyroidism, impaired intestinal absorption, an incomplete diet and kidney disease. The normal level of phosphorus is 0.64–1.45 mmol L^{-1}. The phosphorus content in the blood of chickens from the control and experimental group exceeded the physiological norm by 19.3% and 60.7%, respectively.

Calcium provides mechanical strength of bones, takes an active part in the metabolism of proteins, fats, carbohydrates and mineral and in the process of blood coagulation, activation of enzymes and hormones. The normal level of calcium in the blood is from 2 to 4.5 mmol L^{-1}. Increased calcium content may occur when the amount of vitamin D3 is exceeded or as a result of normal physiological changes. Reduced calcium levels occur in diets that consist only of grain mixtures, or may be caused by kidney disorders. It was found that the level of calcium in the blood of broiler chickens of all groups was also within the physiological limits from 4.2 mmol L^{-1} in the control group to 4.8 mmol L^{-1} in the experimental group.

The physiological norm of magnesium usually does not exceed more than 1.2 mmol L^{-1}. In our experiment, the control group (1.13 mmol L^{-1}) fits into this norm, and the experimental group shows minor deviations in magnesium. The difference constitues 0.27 mmol L^{-1}.

In the blood of experimental broilers, the sodium level was almost within the normal range (138–146 mmol L^{-1}) and amounted to 126.77–124.33 mmol L^{-1}. However, there was a tendency to a decrease in this indicator by 2.44 mmol L^{-1} in chickens consuming humates.

At the same time, the safety of the flock of the experimental broiler chickens was within 98% and did not depend on the factor studied; the loss of the population was the result of technological trauma or asphyxiation.

Development of the internal organs

The work of the internal organs has a great importance for the growth and development of the skeleton, muscles and other tissues of the body. According to the results of the control slaughter of the experimental poultry population at the age of 42 days, the greatest weight of the heart was observed in chickens of group II – 16.86 g, which is 20.7% more than the control counterparts (Table 5).

A similar pattern is noted for the mass of the liver, spleen, and gallbladder.

An important role in the formation of the gastrointestinal tract is played by the pancreas, the mass of which in the chickens of the control group turned out to be less than the experimental group data by 13.6%. At the same time, the poultry of the experimental group was inferior in weight of the stomach by 4.0% of the counterparts from the control group.

Table 5. Humic acid impact on the development of the internal organs of broilers, g (n = 3)

Indicator	I-C	II-E
Heart weight	13.96 ± 0.25	16.86 ± 0.17**
Liver without gall	49.90 ± 0.15	61.20 ± 0.21**
Spleen	2.23 ± 0.08	3.03 ± 0.02**
Pancreas gland	3.96 ± 0.05	4.50 ± 0.19*
Gallbladder	2.60 ± 0.23	4.00 ± 0.03
Gizzard stomach	27.76 ± 0.14	26.66 ± 0.25*

* – $p \leq 0.05$; ** – $p \leq 0.001$, experimental group (II-E) compared to the control group (I-C).

Humic acid impact of the slaughter quality of broilers

The results of slaughter showed that the use of humic acids with drinking water did not significantly affect the slaughter yield of broiler chickens (Table 6). This indicator in group II was 74.89%, which is 0.55% more than in control group chickens.

Muscle, connective and adipose tissue play the largest role in the tissue composition of muscles. The ratio between these components characterizes the multifunctional state of muscle, in addition to many morphological and chemical indicators that determine the quality of meat.

The results of the anatomical cutting of poultry carcasses indicate that the inclusion of *Reasil Humic Vet* in a dose of 0.5 mL per 1 liter of water to the basic ration of broilers had a positive effect on the synthesis of muscle and fat tissue. Thus, the carcasses of broilers of group II showed muscle mass equal to 1,251.2 g, fat – 31 g, which is more than the benchmark by 111.3 g and 6.7 g, respectively. In terms of the content of edible parts, the chickens of the experimental group turned out to be the best and surpassed their counterparts from the control group by 9.9%.

Table 6. Slaughter and meat qualities of broilers, g (n = 3)

Indicator	Group	
	I-C	II-E
Pre-slaughter mass	2,511.70 ± 1.09	2,788.40 ± 1.15**
Mass of gutted carcass	1,867.20 ± 2.45	2,088.30 ± 6.64**
Slaughter yield, %	74.34	74.89
Muscle mass with skin	1,337.00 ± 2.01	1,465.00 ± 2.75**
Skin mass with subcutaneous fat	197.10 ± 2.47	213.80 ± 1.96*
Muscle mass	1,139.90 ± 1.34	1,251.20 ± 0.77**
% by weight of the gutted carcass	61.0	65.2
Subcutaneous fat	24.30 ± 0.56	31.00 ± 0.95*
Edible parts (muscle + skin + fat)	1,361.30 ±0. 89	1,496.00 ± 2.13**

* – $p \leq 0.01$; ** – $p \leq 0.001$, experimental group (II-E) compared to the control group (I-C).

Meat guality

The data of the chemical composition of broiler meat presented in Table 7 show that the protein content in chickens of the control and experimental groups was almost at the same level and was respectively 22.03–22.31%. At the same time, the amount of fat in samples of meat of broilers of group II, which received humic acids with drinking water, was less by 1.5% than in the meat of their control counterparts.

Table 7. Chemical composition of broiler chickens, %

Indicator	I-C	II-E
Water	66.90 ± 0.1	67.90 ± 0.1*
Dry matter	32.85 ± 0.1	31.44 ± 0.1*
Protein	22.03 ± 0.1	22.31 ± 0.1
Fat	9.40 ± 0.1	7.90 ± 0.1*
Ash	1.42 ± 0.1	1.23 ± 0.1

* – $p \leq 0.01$; experimental group (II-E) compared to the control group (I-C).

The appearance assessment of the broiler carcasses showed that the smell was mild, and in the experimental groups the presence of light acidity was noted. The skin of all carcasses was thick, elastic, and the color ranged from white to yellow. Fat deposition was observed in the neck and cloaca area in the same amount in all groups.

The results of the organoleptic assessment indicate that the use of the examined feed additive in the drinking water of broiler chickens did not lead to a decrease in the taste of meat. It should be noted that the samples in the control group scored the maximum number – 19 points on organoleptic indicators, and samples of group II were 1.7 points less when boiled and 2 points less when fried.

The maximum yield of the finished product when cooked is set in group II (81.7%, which is 16.6% more than that of the control broilers). A similar trend is observed when frying carcasses. In the control group the yield of the finished product was 66.8%, while in the experimental group this indicator was 2.5% higher.

CONCLUSIONS

Thus, the introduction of the dietary supplement *Reasil Humic Vet* based on humic acids of natural origin at the rate of 0.5 ml L^{-1} of drinking water to the diet of broiler chickens has a positive effect on the body's natural resistance and feed digestibility. At the same time, protein metabolism as well as the utilization of protein substances in biosynthetic processes in the poultry muscle tissue become more intensive, which makes it possible to obtain larger body weight gains and yields of edible carcass parts.

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