Efficiency of phytobiotics in poultry farming

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Abstract. The impact of phytobiotics of Brassica juncea, Linum usitatissimum, and Nigella sativa L. oils on the physiological and technological indexes of broiler chickens, as well as on the average weight of broiler chickens, and on the biological full-value of the resulting meat was studied. A positive effect was found on the average weight of broiler chickens by the time of slaughter, the rate of growth of the average weight of chickens in the group, the average weight of white meat, liver, and heart, and the concentration of vitamin D3 in the liver both when using only phytobiotics and in combination with an antibacterial drug. There were signs of enhanced antibacterial and antitoxic blood functions, as well as activation of cellular and humoral immune system components in the experimental groups. The results thus obtained might show the prospects for the use of phytobiotics based on Brassica juncea, Linum usitatissimum, and Nigella sativa L. oils to improve the physiological condition and productivity indicators of broiler chickens as an alternative or addition to antibiotic prophylaxis.

1 Introduction

Prophylactic antibiotics and antibiotic growth promoters are still widely used to improve the performance of farm animals and poultry. According to consumption volumes of veterinary antibiotics in 190 countries, about 131,109 tons of antimicrobial agents (AA) were used for productive animals in 2013, and it is projected to reach 200,235 tons by 2030. Meanwhile, consumption levels vary by country, ranging from 8 mg of AA per kilogram of animal origin product in Norway to 318 mg per kilogram in China [1]. In this case, the main problem is antimicrobial resistance (AMR), since the microflora, with constant contact with non-therapeutic doses of antibiotics, develops resistance, and the mechanism of horizontal gene transfer promotes its spread. As a result, productive animals have become a more significant source of resistance genes (ARGs) than humans [1,2]. ARGs are transferred to humans mainly through the consumption of products of animal origin. For example, in bacteria isolated from animal products, the following genes bla, mcr-1, cfr, and tet are often detected, which are directly related to antibiotic resistance in human clinical performance [3]. Thus, poultry products contaminated with antibiotics, such as eggs and meat, are prohibited for use in many countries, including Russia. Nevertheless, many enterprises continue to use them not only for the treatment of livestock but also to stimulate the egg-laying capacity of hens

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and to enhance the liveweight gain of broilers [3,4]. Nowadays, it is known that reducing the use of antimicrobials in animals is no longer enough to contain AMR in humans [5]. Nonetheless, it is essential to find a replacement for traditional antibiotic prophylaxis, for example, drugs that do not cause resistance, new technologies for keeping animals, improving hygiene on farms, expanding veterinary services, etc. [1,2].

Probiotics and phytobiotics are currently one of the alternatives to prophylactic antibiotics. Phytobiotics are biologically active substances of plant origin. They have a wide range of physiological effects and are used in animal husbandry and poultry farming. Due to their antimicrobial, immunomodulatory, and stimulating actions, they have a positive effect on productivity, inhibit pathogenic microorganisms, normalize metabolism, and restore the balance of the normal flora of the body of an animal or poultry [2,6,7]. Phytobiotics are used to prevent disease in productive animals and poultry as an alternative to antibiotics and as standalone therapeutic agents. There is no resistance to plant metabolites. They do not inhibit the normal gut microbiome. Therefore, they can be applied for a long time as additives in the diet [8,9]. As a result, a comparison of the effects of avilamycin and phytobiotics based on oils: Brassica juncea, Linum usitatissimum, and Nigella sativa L. on the physiological parameters of broiler chickens appears relevant.

2 Materials and methods

The studies were conducted on broiler chickens of the Ross 308 cross. We formed four groups of 120 heads each. The birds were raised from 1 to 58 days. Part of the livestock from each group (50%) was subjected to control slaughter on day 37 in accordance with the standard technological plan. All the chickens were in the same conditions. At the beginning of the experiment, they had the same physiological condition.

The chickens were fed with industrial-made mixtures. In groups #1 and #2, "Maxus G-100" antibiotic was added to the feed. It was used as an additive in the diets in industrial conditions of poultry farms at a dose of 300 g/t of feed. Maxus G-100 (Eli Lilly and Company, USA) as the main active ingredient contains avilamycin A, belonging to the class of orthosomycins, which disrupts protein synthesis on ribosomes. It is active against gram-positive bacteria, including clostridium, enterococci, lactobacilli, listeria, staphylococci, and streptococci.

In groups #2 and #3, a phytobiotic agent was introduced into the diet in the form of a water-in-oil emulsion to be added to the feed for 21 days. To prepare the drug, raw mustard seed oil (Brassica juncea), flax seeds (Linum usitatissimum), and seeds of Nigella sativa (Nigella sativa L.), obtained by cold pressing at the Research Institute of Agriculture of the Crimea were used. The oil was mixed with distilled water in a ratio of 1:20 (mustard), 1:5 (linseed), and 1:10 (field fennel flower oil). The resulting emulsion was added to the feed of chickens from groups # 2 and # 3 once a day in an amount of 50 ml per liter of feed. Chickens of group #4 (control) got only limited access to feed in accordance with the feeding period and norms; chickens of all groups had unlimited access to feed.

The effect of the drugs used on the health of broilers was evaluated. The dynamic of live weight was analyzed. The differential blood cell count, the number of T- and B-lymphocytes, the immunoregulatory index (IRI), phagocytosis indices, the number of circulating immune complexes, osmotic resistance of red blood cells, and products of blood lipid peroxidation were defined. To evaluate the biological full-value of broiler products in experimental conditions, we analyzed the weight indicators of meat, the content of malondialdehyde (MDA) in meat; the mass fraction of moisture, dry matter, protein, fat and ash in the pectoral muscles; the mass fraction of vitamins A, D_3, and E in the liver of broiler chickens from all groups.

3 Results

The dynamic of the live weight of broilers was analyzed. It was determined that the weight gain rate in the first 20 days was the highest in the second group. On day 37, the highest average weight was found in group #3, where chickens received phytobiotics with feed and averaged 2190 g. During the period of 38 –56 days, the calculation was made for the remaining chickens in the group (50% of the initial number). The fastest dynamics of weight gain and the highest indicators of broiler live weight on day 56 (average weight 3900 g) were also found in group # 3 during this period (figures 1, 2).

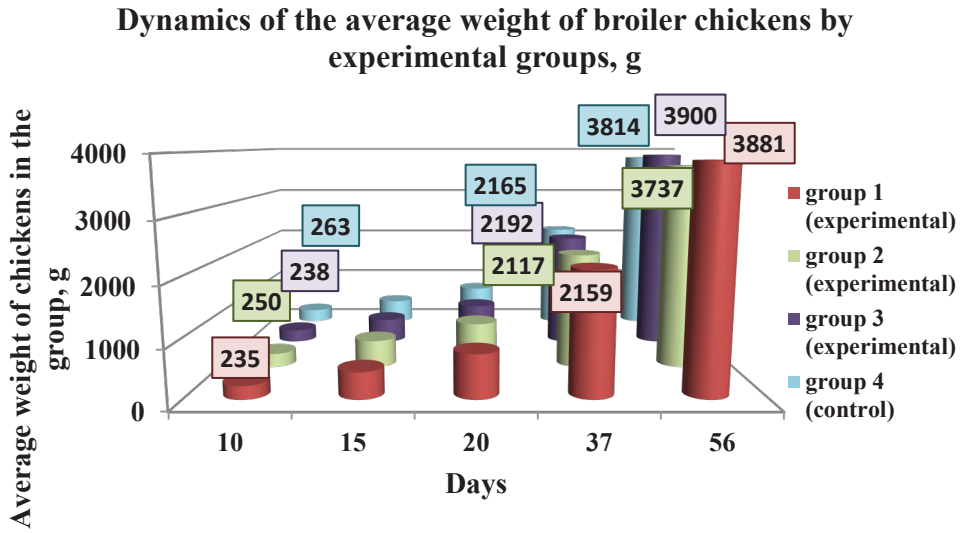

Fig. 1. Dynamics of the average weight of broiler chickens by group on the 10th, 15th, 20th, 37th, and 56th days.

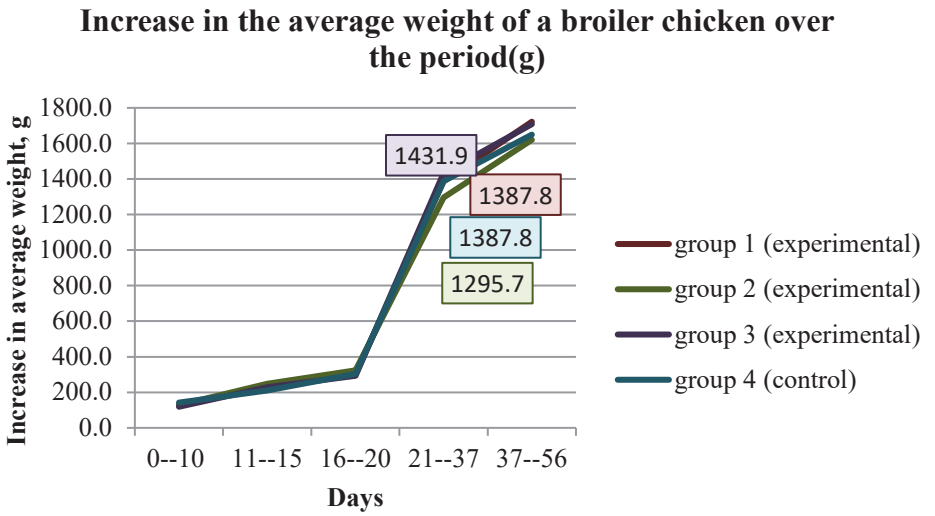

Fig. 2. An increase in the average weight of broiler chickens in different periods by groups.

Analysis of meat obtained from broiler chickens slaughtered on day 37 showed that the average weight of white meat in control group #4 and experimental group #3 was 242.6 g and 245.3 g. The lowest indicator was in group #1 (228.6 g). For the mass of the liver and heart, the following picture was determined: in the #1 group, the indicators were the lowest-on average, 40.0 g and 10.3 g, respectively. The highest values were found in group #3 – 43.1 g and 13.3 g, respectively.

While analyzing the content of malondialdehyde (MDA) in the pectoral and femoral muscles of broiler chickens, no statistically significant differences between the groups were found (P>0,05). The highest concentration of MDA was recorded a day after slaughter and ranged from 0.102±0.011 mmol/l to 0.109±0.013 mmol/l in white meat by groups on average, from 0.083±0.020 mmol/l to 0.107±0.003 mmol/l in red meat. In the following period studies, after the freezing of muscle tissue samples, there was a slight reduction in the concentration of MDA in all groups.

Analysis of the moisture retention capacity (MRC) of samples of pectoral muscles of broilers showed the highest values of this indicator in the #2 group – on average, 67.79 ± 5.73%. In other groups, the average MRC was lower by 6.6-8.8%. Nevertheless, a comparison of the obtained values did not reveal statistically significant differences between the groups (P>0,05).

While studying the mass fraction of moisture, dry matter, and ash in the samples of pectoral muscles from broilers of the experimental and control groups subjected to slaughter on day 37, no significant differences between the groups were established. In groups #1 and #3, the average mass fraction of moisture was 76.3%, in group #2 it was 76.9%, and in control group #4 it was 76.7%. The average mass fraction of dry matter was 23.7% in groups #1 and #3, 23.1% in group #2, and 23.9% in group #4 (control). The pH value of hydrogen was higher in the meat of chickens from groups #1 and #2 (treated with an antibiotic) and was 6.23 and 6.39 in groups #1 and #2, respectively. In groups #3 and #4, the average pH was 6.04 and 6.05 pH units. The protein content in the pectoral muscles of broiler chickens was highest in control group #4 (22.01%) and the lowest in group #2 (21.59%). In groups #1 and #3, this parameter averaged 21.92%. It was determined that the mass fraction of fat was higher in broilers of groups # 2 and #3. As a dietary supplement, these animals were given phytobiotics. It averaged 2.3%, while in the #1 and #4 groups it was at 2.0%.

The vitamin content in the livers of broilers was analyzed after slaughter on day 37. The greatest differences between the groups-by 3.8 times-were detected for the concentration of vitamin D3. The minimum concentration of D3 in the liver was found in broilers of the control group #4, and the maximum, 1.3 mg/kg, in the group #3 receiving phytobiotics.

An immunohematology testing of the blood of broiler chickens revealed an increase in the average content of T-lymphocytes by 2–5% in groups #1, #3, and #4; an increase in the average content of B-lymphocytes by 6–9% in groups #3 and #4; and an increase in the average content of pseudoeosinophils by 10% in group #1, 20.5% in the #3 group, and by 13% in the #4 group. There was an increase in the average content of eosinophils by 6% in groups #1 and #2 and by 31.8% in group #3; an increase in the average content of basophils by 66.7% in groups #1 and #2; by 72.7% in group #3 and by 62.5% in group #4; and a decrease in the average content of lymphocytes by 6.3% in the #1 and #2 groups and by 18.8% in the #3 group. An elevated level of pseudoeosinophils associated with a decrease in lymphocytes, detected in group 3 chickens, indicated enhanced bactericidal and antitoxic blood functions. The registered slight rise in the relative content of T- and B-lymphocytes testified to the activation of cellular and humoral components of the immune system.

The concentration of malondialdehyde (MDA) in the blood serum of broiler chickens was also analyzed. The highest concentration of MDA was detected in the blood of broiler chickens in groups #2 and #4 – on average, 0.201±0.067 mmol/ml and 0.194±0.044 mmol/ml, respectively. In groups #1 and #3, the concentration of MDA was 0.162±0.045

mmol/ml and 0.154±0.017 mmol/ml. When the received values were compared between groups, there were no statistically significant differences (> 0,05). While assessing the osmotic resistance of red blood cells of broiler chickens, the degree of hemolysis in 0.9% NaCl solution was at the level of 0.7-3.2%. In 0.45% NaCl solution, the highest degree of hemolysis was recorded in 12% of samples from #3 and 9.5% of samples from #4 groups – 36.77±11.41% and 46.17±10.77%, respectively, while in #1 and #2 groups it averaged 26.67±7.13% and 26.43±6.01%.

4 Conclusion

Studies have demonstrated that the use of phytobiotics based on oils such as Brassica juncea, Linum usitatissimum, and Nigella sativa L., independently or simultaneously with antibiotics, had a positive effect on the indicators of the average weight of broiler chickens by the time of slaughter, the rate of increase in the average weight of chickens in the group, the average weight of white meat, liver, and heart, and vitamin D3 concentration in the liver. Moreover, an increased mass fraction of fat was detected in broilers receiving phytobiotics as an additive to the diet. The concentration of malondialdehyde in the pectoral and femoral muscles, moisture retention capacity, mass fraction of moisture, dry matter, and ash in samples of pectoral muscles in chickens of different groups had no significant differences. While examining the blood of chickens treated with phytobiotics, signs of increased bactericidal and antitoxic blood functions, as well as activation of cellular and humoral immune system components were revealed. The obtained findings indicate the potential for the use of phytobiotics based on Brassica juncea, Linum usitatissimum, and Nigella sativa L. oils to increase the physiological condition and productivity of broiler chickens as an alternative to antibiotic prophylaxis.

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