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Digestibility and nutrient absorption in broiler chickens when replacing feed antibiotics in mixed feed with safe growth promoters

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***Abstract* – Productivity parameters of broiler chickens were studied including digestibility and nutrient absorption when replacing feed antibiotics in mixed feed with SafMannan and Immunosan feed supplements which are carbohydrate complexes in yeast cell walls. It was established that the live weight of male and female chickens received studied drugs was higher at the end of fattening, on average, by 0.7 and 1.8%, respectively and in comparison with the control group. According to digestion trial data, the digestion of tested feed was accompanied by an increase in the digestibility of dry matter, crude fat. When SafMannan drug was used in place of feed antibiotic, the digestibility of crude protein was increased. When Immunosan was added to the feed, the digestibility of crude protein corresponded to the control level what is also a significant argument in favor of using it as an alternative to feed antibiotics. Absorption of nitrogen, calcium and phosphorus by broilers of experimental groups was higher than in the control one by 5.8; 21.8 and 2.5%, respectively.**

Keywords – broiler chickens, feed antibiotics, nitrogen balance, nutrient digestibility, mannan-oligosaccharides.

I. INTRODUCTION

In meat poultry farming, feed antibiotics are used to increase productivity parameters and livability of chickens. However, these drugs have a number of negative effects [1,2,3,4,5]. The most important one is that pathogenic microorganisms become resistant to antibiotics. In this regard, in some countries there are restrictions on the use of antibiotics in animal husbandry. It is rather difficult to stop using feed antibiotics, in view of their high effectiveness as poultry growth promoters; this requires a sufficiently effective alternative.

A number of studies have shown that various feed supplements can replace feed antibiotics in poultry diet. These include: pro- and prebiotics, phytobiotics, bacteriophages, yeast cell walls, mannan-oligosaccharides, colloidal silver, etc. Currently, yeast cell walls preparations are widespread in order to prevent diseases and increase productivity [6]. They support intestine functions from the first days of life improving the absorption of feed nutrients what contributes to the growth of poultry [7]. Mannan-oligosaccharides synthesized from yeast cell walls have a strong antibacterial effect; they bind a wide range of pathogenic microorganisms including salmonella and E. coli, as well as mycotoxins [8].

Mannan-oligosaccharides (MOS) can function as a non-pathogenic antigen that can have adjuvant activity and have a good effect on the immune function of the host. This immunomodulating effect of MOS can be associated with the presence of many protective cells of mannose receptors on their surface which are involved in antigen recognition. β-1,3/1,6-glucans can bind to specific CR3 macrophage receptors by recognizing specific sugars found in glycoproteins of epithelial surface causing a cascade reaction that activates macrophages to perform phagocytosis, as well as starts the production of cytokines and eicosanoids, such as IL-1 , TNF-α and PGE2, thus activating the proliferation of CD4 + and CD8 + lymphocytes what leads to an increase in both innate and acquired (cell-mediated and humoral) immune response.

The goal of this research was to study the productivity parameters of broiler chickens including digestibility and nutrient absorption with the replacement of feed antibiotics in mixed feed with SafMannan and Immunosan feed supplements which are carbohydrate complexes in yeast cell walls.

II. MATERIALS AND METHODS

Experimental part of this study was carried out under the production conditions of OAO "Ptitsefabrika "Sredneuralskaya" on broiler chickens of Ross 308 cross-breeding in 2018. Groups for scientific-economical and physiological experiments were made and the scientific basis of this research was chosen in accordance with the recommended techniques of the Federal Research Center "All-Russian Research and Technological Poultry Farming Institute" of RAS (2013).

At the age of 1 day, 3 groups of broiler chickens with an average weight of 44 g were formed. Poultry was divided by sex. Male (80) and female chickens (80) were kept in different cages during the research. The experiment lasted for the entire raising period (38 days).

The control group received the basic diet (BD) adopted on the farm, with nutritional value corresponding to the recommendations for cross. BD from the 1st to the 10th day of broiler chickens raising included Albac feed antibiotic (0.5 kg/ton of mixed feed), from the 11th to the 30th days of raising – Fortrazin 150 feed antibiotic (0.6 kg/t of mixed

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feed). Experimental groups of broiler chickens from the 1st day of raising and to the end of fattening period received BD where feed antibiotic was replaced with alternative safe growth promoters which were the carbohydrate complexes of yeast cell walls: in 1 experimental group – SafMannan supplement in the amount of 0.5 kg/t of mixed feed, in 2 experimental group – Immunosan supplement in the amount of 1 kg/ton of mixed feed.

To determine the digestibility of nutrients and the balance of nitrogen, calcium and phosphorus, a digestion (physiological) trial was conducted. For this, 5 male broiler chickens at the age of 28 days were selected; they were medium-sized in their group based on the live weight. The experiment was carried out in accordance with the recommended techniques of the Federal Research Center "All-Russian Research and Technological Poultry Farming Institute" of RAS (2013). Selected litter and mixed feed were homogenized and analyzed in "Uralskiy NIISKh" analytical laboratory – branch of FSBSI "Ural Federal Agrarian Research and Development Center" of Ural Branch of RAS.

III. RESULTS

Live weight dynamics is one of the most important parameters characterizing the adequacy of poultry feeding and health status. During the experiment, chickens were weighed weekly. Analysis of live weight dynamics was performed in accordance with the sex (Table 1). Over the entire raising period, the superiority of male broiler chickens of experimental groups in terms of live weight was observed in comparison with the control group, with the largest significant difference observed in 1st experimental group. Thus, at the age of 7 days, live weight of male broiler chickens in the 1st experimental group was higher than in the control one by 5.5% (P≤0.001), in the 2nd experimental group – by 4.4% (P≤0.01); at the age of 14 days, respectively, by 6.5 (P≤0.001) and 4.3% (P≤0.01); at the age of 21 days – by 10.3 (P≤0.001) and 5.2 (P≤0.01) %; at the age of 28 days – by 5.4 (P≤0.001) and 6.0 (P≤0.001) %; at the age of 35 days – by 5.3 (P≤0.01) and 1.4 %; at the end of fattening (38 days) – by 1.3 and 0.06 %.

Absolute increase in live weight of broilers for the raising period was higher in 1st and 2nd experimental groups compared to the control group by 1.3 and 0.07%.

TABLE I. DYNAMICS OF LIVE WEIGHT OF BROILER CHICKENS (M±M), (N=80)

Parameter	Male chickens			Female chickens		
	Control	*1 experimental*	*2 experimental*	*Control*	*1 experimental*	*2 experimental*
Live weight, g: - 1 day of life	44.0± 0.12	43.9± 0.14	44.1± 0.13	44.0± 0.12	44.1± 0.15	43.9± 0.13
- 7 days of life	175.3± 1.58	185.0± 1.66***	183.0± 1.90**	171.3± 1.95	186.6± 1.63***	183.7± 1.77***
- 14 days of life	473.8± 4.97	504.7± 4.58***	494.1± 5.40**	462.9± 5.85	479.7± 5.63*	473.3± 4.68
- 21 days of life	903.8± 10.22	996.6± 9.47***	950.8± 12.55**	855.0± 10.26	912.1± 11.22***	878.3± 11.14
- 28 days of life	1443.8± 16.68	1521.9± 15.91***	1530.4± 19.84***	1314.4± 15.55	1370.6± 18.17*	1338.9± 16.40
- 35 days of life	2015.0± 26.52	2121.3± 24.75**	2042.4± 32.0	1822.6± 19.42	1938.5± 24.34***	1832.7±19.34
- 38 days of life	2294.3± 29.96	2324.0± 27.47	2295.8± 28.86	2072.6± 24.10	2143.7± 24.63*	2075.0±23.06
Absolute weight gain, g	2250.3	2280.0	2251.8	2028.6	2099.7	2031.0
Livability, %	97.5	96.3	96.3	96.3	96.3	97.5

[a.]) *- P ⩽0.05; **- P ⩽0.01; ***- P ⩽0.001

Female broiler chickens, which received sorption drugs (SafMannan and Immunosan) instead of feed antibiotic, as well as male ones, had increased live weight in comparison with the control group (Table 1). So, at the age of 7 days, live weight of female chickens in the 1st experimental group was higher by 8.9 (P≤0.001) and 7.2 (P≤0.001) %; at the age of 14 days – by 3.6 (P≤0.05) and 2.2 %; at the age of 21 days – by 6.7 (P≤0.001) and 2.7 %; at the age of 28 days – by 4.3 (P≤0.05) and 1.9 %; at the age of 35 days – by 6.4 (P≤0.001) and 0.6 %; at the end of raising period (38 days) – by 3.4 (P≤0.05) and 0.1 %.

Absolute increase in live weight of female broiler chickens in 1st and 2nd experimental groups during the fattening period was higher than in the control group by 3.5 and 0.1%.

During raising period the highest livability was in mal chickens of control group; it amounted to 97.5%. In 1st and 2nd experimental groups, this parameter was at the level of 96.3% what is lower than in the control one by 1.2%.

Among female chickens, the 2nd experimental group showed the highest livability of 97.5%. In the control and 1st experimental groups, there was similar value of this parameter – 96.3%; it was lower in comparison with the 2nd experimental group by 1.2%.

Digestibility of nutrients is one of the most important parameters that determine the biological value and productivity of feed.

Table 2 shows the coefficients of digestibility of nutrients by broiler chickens obtained from digestion trial results.

TABLE II. COEFFICIENTS OF DIGESTIBILITY OF NUTRIENTS BY BROILER CHICKENS, % (N=5)

Parameter	Group		
	Control	*1 experimental*	*2 experimental*
Dry matter	66.1	70.4	71.2
Crude protein	91.9	93.5	91.9
Crude fat	72.8	82.3	86.0
Crude fiber	26.0	20.4	23.2
Nitrogen-free extracts	76.1	74.4	78.8

Broilers in 1st and 2nd experimental groups digested the dry matter of their feed better by 4.3 and 5.1%, respectively, in comparison to the control group. Higher digestion of crude protein was observed in 1st experimental group, 1.6% more than in the control one. The digestibility of crude protein in 2nd experimental group was the same as in the control one reaching 91.9%. Chickens in 1st and 2nd experimental groups digested crude fat from feed much better than in the control group, by 9.5 and 13.2%, respectively. Fiber digestibility was the highest in the chickens of the control group amounting to 26%. In the 1st and 2nd experimental groups, fiber digestibility was lower than the control level by 5.6 and 2.8 %. The digestibility of nitrogen-free extracts in the control group was at the level of 76.1%, in 1st experimental group this value was lower than the control one by 1.7%, and in the 2nd experimental group it was higher than in the control one by 2.6%.

Nitrogen balance in the body of broiler chickens when replacing feed antibiotics in the diet with sorption drugs is shown in Table 3.

TABLE III. NITROGEN BALANCE IN THE ORGANISM OF BROILER CHICKENS, G/CHICKEN PER DAY (N=5)

Parameter	Group		
	Control	*1 experimental*	*2 experimental*
Taken	4.96	4.97	4.47
Excreted with litter	1.89	1.48	1.56
Deposit in organism	3.07	3.49	2.91
Absorbed from taken with feed, %	61.9	70.3	65.1

Male chickens in the control group deposited 3.07 g of nitrogen in the body what was 61.9% of nitrogen received with feed. In chickens of 1stexperimental group, nitrogen deposition was higher than in the control one – by 0.42 g, as a result, absorption of this element was 70.3% from the amount taken with feed. Nitrogen absorption in 2nd experimental group was 65.1% while nitrogen deposit amounted to 2.91 g what is less than in the control group by 0.16 g.

Minerals – calcium and phosphorus – are included in the "crude ash" group. Their amount to a great extent defines the reaction which determines acid-base ratio in the diet and blood alkaline reserve.

Table 4 shows calcium balance. Male broiler chickens of the control group took with feed, at the average, 1.2 g of calcium/ chicken per day during the reference period of digestion trial; with an average of 0.64 g being excreted with litter. As a result, the deposition of calcium in their bodies per day was 0.57 g, or 47.1% of that taken with feed.

TABLE IV. CALCIUM BALANCE IN THE ORGANISM OF BROILER CHICKENS, G/CHICKEN PER DAY (N=5)

Parameter	Control	1 experimental	2 experimental
Taken	1,20	1,15	1,55
Excreted with litter	0,64	0,38	0,45
Deposit in organism	0,57	0,77	1,09
Absorbed from taken with feed, %	47,1	67,1	70,7

Calcium intake in the 1st experimental group for the same period was slightly lower than in the control group (by 0.05 g), while the excretion of calcium with litter was 0.38 g, and 0.77 g of calcium was deposited in the body, that is, 67.1%, what exceeds the control value by 20.0%.

Male chickens in 2nd experimental group digested calcium better than others. Its absorption rate from the amount taken with feed was 70.7%. At the same time, calcium intake was maximal and amounted to 1.55 g/chicken per day, 1.09 g of this calcium was deposited in the body.

Absorption of phosphorus in chickens of the control group was at the level of 46.3% (Table 5).

TABLE V. PHOSPHORUS BALANCE IN THE ORGANISM OF BROILER CHICKENS, G/CHICKEN PER DAY (N=5)

Parameter	Group		
	Control	*1 experimental*	*2 experimental*
Taken	0.72	0.89	0.86
Excreted with litter	0.39	0.42	0.48
Deposit in organism	0.33	0.47	0.39
Absorbed from taken with feed, %	46.3	53.0	44.6

Male chickens of the 2nd experimental group demonstrated the value of this parameter lower by 1.7% in comparison to the control group. The best phosphorus absorption was observed in 1st experimental group of broilers (53%), it was higher than in the control one by 6.7%.

Thus, the conducted research demonstrates the effectiveness of replacing feed antibiotics in the diet of broiler chickens with feed supplements that are carbohydrate complexes in yeast cell walls. This is confirmed by the increase or compliance with the control values of digestibility and nutrient absorption by poultry and as a result by an increase in its live weight.

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