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Effects of Paenibacillus-Based Probiotic (Bacispecin) on Growth Performance, Gut Microflora and Hematology Indices in Goslings

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Abstract: The probiotic "Bacispecin" having the bacterial titer of 10^8 CFU/mL was added to the diet of goslings at 1 mL per bird per day for 7 days and the treatment was repeated in 7 day cycles during the experimental period of 56 days. The use of the probiotic resulted in an increase of 17.4% in the average daily weight gain of goslings and a decrease of 9.3% in the consumption of the feed compared w ith the control group. The pre-slaughter weight exceeded the value in the control group by 13.9%, the dressed weight by 22.9%, the carcass yield by 4.6 absolute Percentage. The mass values of the glandular and muscular stomach, heart and liver were larger by 31.7, 20.2, 39.4 and 18.5%, respectively, than in the control group which points to a better development of internal organs in goslings of the experimental groups. Increased bifidobacteria and lactobacilli were found in the gut microflora of the experimental group goslings whereas the pathogenic and opportunistic pathogenic microflora decreased. Increased values of hemoglobin concentration, erythrocytes, total protein, creatinine, urea, uric acid, glucose, cholesterol, bilirubin were found within the physiological range. The breeding profitability increased by 13.5 absolute percentage.

Key words: Broiler type geese, probiotic "Bacispecin", broiler geese growth performance, nutrient digestibility, blood values, intestinal microbiocenosis, economic efficiency

INTRODUCTION

There is tendency in the world and Russia in particular to reduce or completely stop application of synthetic pharmacological products, antibiotics among them. Restoration of normal microflora with the help of probiotics, prebiotics and synbiotics is currently becoming an essential component of the livestock production technology (Alonge *et al*., 2017; Mazhari *et al*., 2016; Topuria *et al*., 2013). In this regard, one of the key tasks faced by probiotic developers today is to find the most effective bacteria, their strains and combinations of bacteria for best results.

It should be noted that up to the present time, imported products tended to dominate the Russian market of probiotics for animal husbandry. At present, however, the area is of great interest to biological sciences and businesses and the sphere is experiencing a rapid growth. There are large biotechnology companies in the Russian market today that invest in the development of new probiotics. High potential strains of resistant bacteria have been obtained and technologies for the production of probiotic products have been developed (Andreeva and Mulyukova, 2015; Ashayerizadeh *et al*., 2016; Goryacheva, 2013).

It has been proved that large-scale application of antibiotics as growth stimulators in animal husbandry in poultry farming in particular, leads to the formation of resistant microflora (Castanon, 2007; Graham *et al*., 2007; Park *et al*., 2016). The problem may be solved by finding alternative growth stimulation options, development of more effective probiotics, feed enzymes and supplements (Jin *et al*., 1997; Ganguly, 2013; Khan, 2013; Khan and Naz, 2013; Kerdyshov and Naumov, 2008; Royan, 2017).

To address the issue a new biological probiotic product "Bacispecin BM, ZhiP" (having the titer of no $<2\times10^8$ CFU/g) was studied. The product is designed as a feed supplement in livestock production to improve feed digestion, prevent digestive disorders, enhance livability and growth performance in livestock and poultry.

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The product is based on live cells and spores of the *Paenibacillus ehimensis* IB 739 strain (the former strain of *Basillus* sp. IB-739) as well as metabolic products such as phytohormones, extracellular enzymes and antibiotic substances, nutrient medium residues, a filler having the dry substance titer (p for powder) of no less than $1*10^8$ CFU/g, a filler having Liquid substance (L) titer of no $<1*10^9$ CFU/mL. The *Paenibacillus ehimensis* IB 739 strain is non-virulent and non-toxic. It features no toxigenicity and dissemination to internal organs. The strain has no significant dysbiotic impact on the intestinal microflora.

The aim of the study was to investigate the effects of the "Bacispecin" probiotic on the growth performance and development, morphological and biochemical values as well as factors affecting yield and meat quality and gut microbiocenosis in goslings.

MATERIALS AND METHODS

Goslings of the Lind breed were studied on the farm "OOO Bashkirskaya Ptitsa" (Limited liability partnership) in Blagovarsky District of the Republic of Bashkortostan. To conduct the farm based scientific experiment one-week old goslings were randomly put in one control group and three experimental groups with 30 goslings per each group (Table 1).

Goslings of the control group were assigned to a standard diet without the tested product. Goslings of the second experimental group were fed the probiotic "Bacispecin" having the bacterial titer of 107 CFU/mL at a dose of 1 mL/1 kg of live weight once a day for 7 days with treatment repeated in 7 day cycles, the third experimental group was assigned to the diet with the probiotic having the titer of 108 CFU/mL at a dose of 1 mL/1 kg of live weight once, a day for 7 days, the treatment was repeated in 7 day cycles and the fourth experimental group was fed the probiotic hiving the titer of 107 CFU/mL at a dose of 1 mL/1 kg of live weight every day during the whole experimental period. The probiotic "Bacispecin" was added with pre-boiled and chilled drinking water once a day. Each group was kept in individual rooms of the rearing house under identical sanitary and hygienic conditions. A balanced diet containing the basic nutrients, macro and microelements, essential critical amino acids was fed to the goslings during the experimental period (Table 2 and 3).

The productive qualities, the level of nutrient digestibility, the calcium and phosphorus use, clinical and biochemical values in goslings were assessed based on the standard techniques developed at VNITIP (All-Russia Research and Technology Institute of Poultry Breeding). The obtained data were biometrically processed based on standard procedures employing Excel of Microsoft Office 2013 program.

Table 1: Farm-based scientific experiment scheme

Group	Dietary features
1st control group	Complete feed with nutrition values in line with the standards set at All-Russia research and technology institute for poultry breeding (basal diet)
2nd experimental group	Basal diet+Probiotic "Bacispecin" of 10^7 CFU/mL at 1 mL/1 kg of live weight given once a day for 7 days, the treatment repeated in seven day cycles
3rd experimental group	Basal diet+Probiotic "Bacispecin" of 10^8 CFU/mL at 1 mL/1 kg of live weight given once a day for 7 days, the treatment repeated in seven day cycles
4th experimental group	Basal diet+probiotic "Bacispecin" of 10^7 CFU/mL at 1 mL/1 kg of live weight given once a day on a daily basis

Table 2: Ingredient composition of the complete feed diet for goslings, % of the weight

Ingredients	Goslings aged 1-20 days old	Goslings aged 21-63 days
Corn	33.00	-
Wheat	35.80	52.00
Barley	-	23.00
Sunflower seed oil-cake	14.00	5.50
Fodder yeasts	10.00	7.00
Fish flour	3.00	4.00
Feeding fat	-	3.50
Meat-and-bone meal	1.00	2.00
Fodder lime	3.00	2.50
Sodium chloride	0.20	0.50
Chemical composition of 100 g of feed		
Exchange energy (MJ)	1.19	1.18
Rudeprotein (g)	20.50	18.30
Rudefiber (g)	5.30	5.80
Calcium (g)	1.70	1.70
Phosphrus (g)	0.90	0.90
Lisyne (mg)	960.00	930.00
Methionine+cystine (mg)	680.00	430.00

Table 3: Daily complete feed intake

Age of goslings (days)	Complete feed, g/per 1 bird/day
6-10	100
11-20	120
21-30	230
31-40	290
41-50	338
51-63	345

RESULTS AND DISCUSSION

Observation of live weight growth performance and feed consumption during the 56 days experimental period indicates that the average daily weight gain was by 15.8 and 17.4 higher in the second and third experimental groups along with 100% livability and the average daily weight gain tended to increase by 6.1.% in the fourth experimental group compared to the first control group ($p<0.05$) whereas the feed consumption per 1 kg of weight gain decreased by 5.5 and 9.3%, respectively (Table 4). Nutrient digestibility rates are illustrated in Table 5.

Table 4: Growth performance values during the 56 days period, X±Sx

	Group (n = 30)			
Values	1st control group	2nd experimental group	3rd experimental group	4th experimental group
Live weight at a week's age (g)	135.2±11.39	146.8±14.79	136.9±16.15	146.8±19.91
Live weight at a 9 week age (g)	3609.1±179.3	4166.4±185.8*	4214.6±189.1*	3828.9±126.2
Absolute weight gain (g)	3473.9±155.8	4019.6±166.4*	4077.7±188.6*	3682.1±176.2
Average daily weight gain (g)	62.0 ±3.05	71.8 ±3.26*	72.8±3.72*	65.8 ±2.62
Percent ratio to the control group	-	115.8	117.4	106.1
Livability (%)	98.0	100	100	100
Feed consumption per 1 kg of weight gain (kg)	5.06	4.78	4.59	4.89
Percent ratio to the control group	-	94.5	90.7	90.6

*Difference is valid in relation to the 1st control group at $p<0.05$

Table 5: Nutrient digestibility ratings (X±Sx) (%)

	Group (n = 5)			
Nutrient values	1st control group	2nd experimental group	3rd experimental group	4th experimental group
Rude protein	84.9±0.78	88.1±0.94*	88.3±0.89*	85.6±1.02
Rude fat	84.1±0.66	85.2±0.76	86.3±0.98	85.6 ±0.88
Rude fiber	22.5±1.22	24.6±1.33	24.8±1.44	23.8±1.26
Nitrogen free extractives	73.5±0.78	76.2±0.86*	76.8±0.92*	75.8±0.88

*Difference is valid in relation to the 1st control group at $p<0.05$

The research found an increase in digestibility of protein and nitrogen-free extractives in the second and third experimental groups. The values of protein and nitrogen-free extractive digestibility were 88.1 and 88.3, 76.2 and 76.8%, respectively which was by 3.2-3.4 and 2.7- 3.3 absolute percentage higher than the values of the control group ($p<0.05$).

The balance of nitrogen, calcium and phosphorus was positive in all groups. Goslings of the second and third experimental groups had 4.0 and 4.05 g of nitrogen retained in the body, respectively which was higher by 20.8-22.4%, so, the level of nitrogen absorption in relation to the amount taken in was higher by 5.8-6. The 1 absolute percentage as compared to the first control group ($p<0.05$). We could not confirm any reliable differences the level of calcium and phosphorus consumption between the first control group and the 2nd and 3rd experimental groups but the research indicates that the 2nd and 3rd experimental groups tended to have better consumption of the elements.

Morphological and biochemical blood tests showed that all the studied indices were within the physiological range as specified in the reference literature. Hemoglobin, erythrocytes, total protein, creatinine, urea, uric acid, glucose, cholesterol and bilirubin values were improved in the third experimental group. Addition of the probiotic product "Bacispecin" having the titer of microorganisms 10^8 CFU/mL to the standard diet at 1 mL/bird/day for 7 days with the treatment repeated in 7 day cycles had the best effect on goslings, improved metabolism and helped reach their genetic potential.

Analysis of the slaughter check showed the largest pre-slaughter weight in the second and third experimental groups which exceeded the value of the control group by 11.6 and 13.9%, respectively. Similarly, the 2nd and the 3rd experimental groups had larger values of dressed weight and carcass yield by 19.2-22.9% and 4.0 and 4.6 absolute percentage, respectively, compared to the control group at $p<0.05$. Anatomical carcass cutting showed that addition of the probiotic "Bacispecin" to the diet of goslings ensured better development of their internal organs. The 3rd experimental group had the best values. Masses of the glandular and muscular stomach, heart and liver were higher by 31.7, 20.2, 39.4 and 18.5%, respectively in the third experimental group than in the control group at $p<0.05$.

The study of the composition of 63 days old goslingsfaecal microflora indicated that the probiotic "Bacispecin" affected the quantitative composition of some microflora species (Table 6).

The study found that feces of the second, third and fourth experimental group goslings contained a decreased number of *E. coli* by 50.0, 54.2 and 50.0%, respectively and an increased number of lactobacilli by 54.5, 56.8 and 54.5%, respectively, compared to the control group ($p<0.05$).

The research of the microbiocenosis in goslings showed that the second and third experimental groups experienced a decrease of 46.9 and 50.0% in the number of staphylococci ($p<0.05$) an increase of 44.7 and 42.6% in the number of bifidobacteria was found in feces of the third and fourth experimental groups as compared to the control group figures ($p<0.05$). Feces of the third experimental group goslings contained fewer Streptococci (by 42.0%) than those of the control group. No reliable data on the difference in Enterococci and Clostridia among the control and experimental groups were detected.

Table 6: Values of fecal microbiocenosis in goslings (X±Sx), 1 gCFU/g

	Group (n = 3)			
Values	1st control group	2nd experimental group	3rd experimental group	4th experimental group
Escherichia coli	2.4±0.32	1.2±0.24*	1.1±0.28*	1.2±0.26*
Enterococci	3.2±0.46	2.2±0.26	2.0±0.32	2.1±0.38
Staphylococci	3.2±0.36	1.7±0.32*	1.6±0.38*	1.7±0.48
Lactobacilli	4.4±0.52	6.8±0.56*	6.9±0.64*	6.8±0.62*
Bifidobacteria	4.7±0.42	6.2±0.44	6.8±0.52*	6.7±0.52*
Lacterial streptococci	6.9±0.72	4.2±0.74	4.0±0.48*	4.3±0.84
Clostridia	1.9±0.22	1.8±0.26	1.7±0.32	1.6±0.42

*Difference is valid in relation to the 1st control group at $p<0.05$

Thus, comparatively higher values of bifidobacteria and lactobacilli and lower values of pathogenic and opportunistic pathogenic microflora prove the positive effect of the probiotic "Bacispecin" on the microbial composition of the gastrointestinal tract in goslings. The most optimal microflora pattern was found in the feces of goslings fed the probiotic "Bacispecin" having the microbial titer of 10^8 CFU/mL at 1 mL/1 kg of live weight once a day during 7 days with the treatment repeated in 7 day cycles.

Farm tests showed that the probiotic "Bacispecin" increased the breeding profitability level in the 2nd, 3rd and 4th experimental groups by 12.7, 13.5 and 8.3%, respectively, compared to the control group. The greatest profit was obtained in the third experimental group where goslings were fed the probiotic "Bacispecin" having the titer of 10^8 CFU/mL at a dose of 1 mL/bird/day during 7 days in 7 day cycles.

CONCLUSION

Thus, "Bacispecin" product possesses a high probiotic effect, positively affecting the growth performance, productivity and livability of gosling broilers, nutrient digestibility, balance of nitrogen, calcium and phosphorus, microbial composition of feces and morphological and biochemical blood values.

The effect of the probiotic on the microbial composition of the gastrointestinal tract in goslings is seen in comparatively higher levels of bifidobacteria and lactobacilli and lower values of pathogenic and opportunistic pathogenic microflora. A decrease of 54.2% in the number of *E. coli* along with an increase of 44.7% in the number of bifidobacteria and of 56.8% in the number of lactobacilli has been detected. Within the physiological range improved blood values of hemoglobin, erythrocytes, total protein, creatinine, urea, uric acid, glucose, cholesterol, bilirubin have been reported. In order to enhance profitability of gosling rearing it is recommended that the probiotic "Bacispecin" having the microbial titer of 10^8CFU/mL be fed at 1 mL/bird for 7 days with the treatment repeated in 7 days cycles.

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