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Effects of Dietary Supplementation of Enzymatic Probiotic Complex "Cellobacterin-T" on Weight Gain and Digestibility of Nutrients in Young Brown Nick Cross Hens

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Abstract

The current study aimed to determine the optimal dose of the enzymatic probiotic complex (Cellobacterin-T) for introduction into the poultry diet, as well as determining the effect of this additive on the safety of poultry, productivity, and profitability of production. Experimental studies were conducted from 2018 to 2021 in the production conditions of the Avangard poultry farm of the Ruzaevsky Municipal District of the Republic of Mordovia, Russia. The object of the study was evaluate the dietary replacement for chickens with the egg direction of productivity of the Brown Nick cross at the age of 5 to 14 weeks. The sample consisted of 480 heads. During the study, the optimal dose of the supplement in diets was 100 mg per 100 g of compound feed. The results of the study indicated that the use of the enzymatic Cellobacterin-T probiotic in the diets of young Brown Nick cross could improve the productivity and profitability of production. The results of the study are of use for manufacturers and have scientific and practical implications.

Keywords: Commercial poultry, Cellobacterin-T probiotic, Enzyme, Diet, Metabolism

Full length article *Corresponding Author, e-mail: yu_k_7506@mail.ru

1. Introduction

Various feed additives contribute to the normalization of metabolism in the body as well as an increase in the body weight, productivity, safety, and resistance of the body to various diseases in poultry [1]. However, the complex inclusion of individual feed additives in the diet, such as enzymes, probiotics, and acidifiers, is not always economically justified and can increase the cost per unit of production [2-4]. Therefore, it is advisable to use an optimal dosage of multifunctional feed additives as they can play important roles during body metabolism, which leads to an increase in the productivity of poultry and improvement of livestock safety [2, 5]. According to the published studies, it has been established that the industrial use of multifunctional feed additives based on beneficial bacteria ensures the improvement of zoo-technical and economic indicators of poultry cultivation [6, 7], as well as the quality of the obtained products. Many researchers have confirmed that feeding in the optimal dosage of such additives improves the metabolism in the body of poultry, increases their productivity, and reduces feed costs per unit of production [7]. In studies on complex probiotics, the obtained results show the considerable effect of complex probiotics on the productivity and economic efficacy of poultry farms [8-10]. A new approach in poultry nutrition is using Enzyme-probiotic complex addition instead of single probiotic supplementation [11-12].

The effect of a newly developed Enzyme-Probiotic complex (Cellobacterin-t) on broiler chickens was studied by Ivanova et al. [13]. They reported an improvement in zoo-technical indicators, quality of meat products, and composition of poultry intestinal microflora. The present study aimed to study the effect of enzymatic probiotic Cellobacterin-t on weight gain and digestibility of nutrients in young brown nick cross to make a conclusive report on the efficacy of this new feed supplement in different strains of poultry.

2. Materials and methods

Experimental studies were carried out from 2018 to 2021 in the production conditions of the Avangard poultry farm of the Ruzaevsky Municipal District of the Republic of Mordovia, Russia. The research included the organization and conduct of scientific and economic experiments. The object of the study was the replacement chickens of the egg direction of productivity of the Brown Nick cross at the age range of 5-14 weeks. Experimental groups of young chickens were formed analogously by taking into account live weight, age, and Brown Nick cross. The young chickens in the experimental and control groups were kept in four-tier batteries of the rack type (TBU-4EP). The technology of keeping and feeding corresponded to the industry standard adopted for the cultivation of young egg crosses VNITIP - 2000. Poultry feeding was normalized in production conditions regarding the technology used on the farm. The rations were prepared according to the recommended standards developed specifically for the Brown Nick cross by H&N International Germany. The temperature and light conditions, humidity, feeding, and watering front corresponded to the same recommendations. For carrying out scientific and economic experiments, 480 heads of young chickens were selected, which were then divided into 4 groups of 120 heads, of which 30 heads were in each cage on each tier. At the time of the experiment, the chickens aged 5 weeks. Clinically healthy young chickens were selected for the experiment.

The experimental young hens of the control group received the main diet. however, those in the experimental groups received the basic diet supplemented with the enzymatic Cellobacterin-T probiotic. Cellobacterin-T (*Cellobacterinum-T*) is a feed additive produced by Biotrof LLC®, Russia. Chickens in the first, second, and third experimental groups were respectively fed basic diet and Cellobacterin-T at the rates of 70, 100, and 130/100 g of compound feed according to the Federal Animal Research Center method. The indicators monitored during the experiment included dynamics of live weight of chickens (by weekly weighing of chickens with subsequent calculation [g]), absolute increase in live weight (the difference in live weight according to the results of weighing at the beginning and the end of the study period [g]), average daily live weight gain (by dividing the gross live weight gain by the period of poultry rearing [g]), uniformity of the herd (the number of chickens from the number of chickens weighed at a certain age to the average weight, expressed as a percentage, with a tolerance for a difference in live weight within ± 10% of the average), safety by considering the percentage of the case and culling of livestock.

During the scientific and economic experiment, the determination of the chemical composition of feed and manure was carried out in the laboratory of the poultry farm of Avangard LLC, and in the department of chemical-analytical, toxicological and radiological analysis of the Federal State Budgetary Institution (FSBI), State Center of Agrochemical Service, Mordovian, and Russia. Hematological studies were carried out at the State Budgetary Institution (SBI), Mordovian Republican Veterinary Laboratory, and Russia. Statistical processing of the obtained results was carried out in Microsoft Excel (Version 16.39) and R-Studio (Version 1.1.453, https://rstudio.com). Differences were assessed using Student's t-test. Results were considered significant at $p<0.05$, $p<0.01$, and $p<0.001$.

3. Results and Discussions

Control over changes in the live weight of treatment groups and their uniformity was carried out during the scientific and economic experiment. To do this, the experimental chickens were weighed regularly (once a week). The number of chickens weighed was 120 heads in each group (4 tiers of 30 heads in each cage). Based on the results of the weighings, the weighted average dynamics of the live weight of the experimental chickens were calculated (Table 1).

The dynamics of the live weight of the experimental chickens during the entire growing period were examined by calculating the absolute and average daily increases in live weight according to the generally accepted methodology (Tables 2, 3). Absolute growth was calculated by the formula: $A=W-W_0$, where, W denotes live weight at the end of the period (g), and W_0 is the live weight at the beginning of the period (g). The average daily gain was determined as follows: $C= W-W_0/t_2 - t_1$, where, W signifies live weight at the end of the period (g), W_0 refers to live weight at the beginning of the period (g), t_1 is the age at the beginning of the period (days), and t_2 denotes the age at the end of the period, days. According to the obtained results of calculating the indicators of the absolute increase in the live weight of the experimental chickens, it was found that this indicator in the poultry of the first experimental, second, and third groups exceeded the control by 3.38%, 6.62%, and 6.51%, respectively. As can be seen in Table 3, the chickens of the experimental groups differed by a higher average daily increase at the end of each age period. The superiority in this indicator was noted by the second and third experimental groups of young hens, in which the daily increase averaged 14.83 g and 14.82 g exceeding the control by 6.61% (0.92 g) and 6.54% (0.91 g), respectively. This indicator in the poultry of the first experimental group was higher than the control by 0.47 g (3.38%).

Thus, it can be concluded that the inclusion of the enzymatic probiotic Cellobacterin-T in the diet of chickens in the experimental groups contributed to an increase in absolute and average daily gains in live weight, compared to those in the control group. At the end of the experiment, a controlled slaughter was performed on four heads from each group to study the effect of various doses of the enzymatic Cellobacterin-T probiotic on the slaughter parameters. The investigated parameters included the formation and development of the internal organs of the experimental chickens. The analysis of the slaughter results showed when the probiotic Cellobacterin-T was included in the main diet, its supplementation could positively affect the slaughter traits. Thus, chickens in the second and third experimental groups had a higher pre-slaughter mass of 42.5 g and 30.0 g, respectively, compared to those in the control group. According to the weight of the half-gutted carcass, the best results were also noted in young hens of the second and third experimental groups who received the probiotic Cellobacterin-T in the amount of 100 and 130 mg/100 g of feed, respectively, as a part of their diets.

According to the results of weighing the internal organs of the experimental young, it was found that the chickens of the second experimental group showed an increase in liver weight by 1.50 g and the length of the intestine by 8.02 cm, compared with the control chickens.

However, it should be noted that the heart mass of the second group was lower by 0.50 -1.00 g, compared to the experimental chickens. Zhao et al. [8] reported a significantly higher villus height, and villus height/crypt depth value in the duodenum of broilers fed the sorghum-based diet supplemented with the enzyme-probiotic complex. Therefore, the obtained results of the present study accorded with those of Zhao et al [8]. Similarly, Afrilasari and Meryandini [14] reported probiotic and enzyme supplementation could increase the intestinal weight and length of catfish. Based on the results of scientific and economic experiments, the effect of various dosages of Cellobacterin-T on the indicators of the experimental chickens was investigated in the current study. The conducted studies showed that immune system measures of livestock in the experimental groups improved better than those in the control group. This effect was also observed in quails [15] and chickens [16] fed enzymes along with probiotics. The best indicator was achieved in the third experimental group with an immunity index of 100%. The epizootic was just one head in the first and second experimental groups and the safety level was 99.20%, while it was indicated as three heads in the control group (safety level = 97.50%). The safety indices in the first and second experimental groups (2.30%) and the third group (2.50%) were higher than that of the control group.

Regarding the use of various dosages of Cellobacterin-T, it was revealed that uniformity in all groups met the recommended regulatory requirements of the Brown Nick cross. The uniformity of the experimental chickens in all four groups was above 80%, which corresponded to the recommended standards for the Brown Nick cross. The uniformity of young hens in the three experimental groups was higher than those in the control group by 4.7%, 2.5%, and 3.8%, respectively. Table 4 indicates the positive effects of different dosages of the enzymatic probiotic Cellobacterin-T on digestion of the main nutrients of the diets in Brown Nick cross. The present finding was in agreement with the obtained results of a study by Hidayatiningtyas et al. [17] on papain enzyme- probiotic supplements in fish. According to the digestibility analysis, the use of Cellobacterin-T in the diets of the young Brown Nick cross contributed to an increase in the digestibility of crude fat by 1.65%, 2.70%, 2.10% in the first, second, and third experimental groups, which consequently affected the energy of nutrition in poultry body. The probiotic diet at different doses improved the digestibility of crude protein by 2.77%, 6.96%, and 2.91% in the first, second, and third experimental groups, respectively. The digestibility of crude fiber in the first, second, and third experimental groups was higher than the control group by 3.51%, 4.61%, and 4.06%, respectively. According to the results of the physiological experiment, it was established that the nitrogen balance in the experimental chickens was positive, but at the same time, there were certain differences in the processes of its assimilation due to the supplementation of the studied feed additive into the main diet. Thus, the Cellobacterin-T probiotic in the diet of the second experimental group (100 mg/100 g of compound feed) contributed to an increase in the digestibility of nitrogen, compared with the control.

According to the results of the current research, it was revealed the young hens in the second experimental group had an advantage in terms of the amount of nitrogen assimilated by the experimental chickens. There was a significant increase in nitrogen assimilated by young chickens of the second experimental group by 6.91% (0.12 g), compared to the control group. The nitrogen assimilation rates in the first and third experimental groups were also higher than that of the control group by 2.21% and 2.65%, respectively. Digestibility analysis indicated the effect of supplementation of Brown Nick cross chickens' diet with Cellobacterin-T (Tables 5 and 6). These findings were in agreement with those reported by Trubnikov et al. [18] on pigs indicating an increased digestion rate when they were fed enzyme-probiotic supplements. Moreover, a similar effect was observed by Ogorodnichuk and Datsyuk [3, 4] on pigs fed with the celozyme-probiol supplement. The use of calcium increased when different doses of the probiotic Cellobacterin-T were added to the diets of young hens. Thus, the rate of calcium deposition was 0.40 g in the control group and 0.45-0.48 g in the experimental groups. The percentage of calcium used in the experimental groups was higher than the control group by 6.49%, 10.06%, and 6.71% in the first, second, and third experimental groups.

The amount of calcium deposition was 0.42 g in the control group, and 0.47 g, 0.54 g, and 0.50 g in the first, second, and third experimental groups, respectively. The rate of calcium use was higher in the experimental groups (5.12%, 13.35%, and 9.09% in the first, second, and third experimental groups) than in the control group. According to the digestibility analysis, phosphorus deposition in the body of chickens in the first, second, and third experimental groups was 0.24 g, 0.25 g, and 0.25 g, respectively. Compared to the control group, the level of phosphorus was significantly higher in the first, second, and third experimental groups by 3.72%, 6.38%, and 5.85%, respectively. A blood test was used to determine the physiological state of the chickens since it could well represent the changes that occur in the body. Therefore, hematological studies were conducted to examine the effect of the probiotic Cellobacterin-T on the poultry body.

There was no significant difference in the level of hemoglobin according to morphological and biochemical parameters of the blood. However, the total protein content in the experimental groups was higher than the control group by 3.34%, 6.30%, and 3.35%, respectively. This is due to the stabilization of deceptive processes in the body of young chickens. The level of erythrocytes in the blood of young hens in the second experimental group was 20.59% higher than chickens in the control group. A similar effect was reported by Khabirov et al. [19] in broiler chickens after supplementation of complex probiotics. Biometric analysis of the data obtained did not reveal a significant difference among the experimental groups.

Table 1: Dynamics of live weight of experimental chickens by groups from the 5th to the 14th week, g

Indicators	Groups			
	Control	**1st experimental**	**2nd experimental**	**3rd experimental**
at the beginning of the experiment: - 5 weeks	365.50±3.45	346.33±2.92	356.00±2.83	343.67±2.91
- 6 weeks	472.67±4.09	456.00±3.27	470.67±3.29	452.67±3.49
- 7 weeks	577.82±4.13	565.17±3.87	585.00±3.71	563.17±3.70
- 8 weeks	677.63±4.68	671.67±5.02	692.17±4.78*	669.33±4.73
- 9 weeks	779.49±5.16	780.00±5.26	807.39±5.23**	780.83±5.03
- 10 weeks	875.04±5.78	879.33±5.39	914.62±5.12**	895.33±5.40*
- 11 weeks	964.96±6.14	971.43±5.66	1010.25±6.00**	993.00±5.58**
- 12 weeks	1,059.66±6.21	1,068.74±5.43	1,107.06±5.79**	1,090.17±5.50**
- 13 weeks	1,151.79±6.63	1,160.00±4.82	1,198.32±5.71**	1,182.67±4.99**
at the end of the experiment - 14 weeks	1,242.39±6.38	1,252.77±4.99	1,290.42±5.26	1,277.17±4.93

Note: *) P≤0.05; **) P≤0.01

Table 2: Dynamics of absolute increase in live weight of chickens, g

Indicators	Groups			
	Control	**1st experimental**	**2nd experimental**	**3rd experimental**
5-6 weeks	107.17±5.27	109.67±4.12	114.67±4.65	109.00±4.49
6-7 weeks	105.59±4.98	109.17±4.92	114.33±4.86	110.50±4.93
7-8 weeks	99.66±5.88	106.50±6.13	107.17±5.83	106.16±5.69
8-9 weeks	102.39±6.63	108.33±6.87	115.46±6.82	111.50±7.21
9-10 weeks	95.56±8.13	99.33±7.24	107.23±6.46	114.50±7.35
10-11 weeks	89.91±8.05	92.77±7.98	95.63±7.42	97.67±7.10
11-12 weeks	94.70±9.30	97.31±8.30	96.81±8.54	97.17±6.98
12-13 weeks	92.14±9.19	91.26±6.89	91.26±8.08	92.50±7.38
13-14 weeks	90.60±8.36	92.77±6.56	92.10±8.09	94.50±6.86
Total (5-14 weeks)	**876.41±7.94**	**906.05±5.81**	**934.45±6.26**	**933.50±6.15**

Note: *) P≤0.05; **) P≤0.01

Table 3: Dynamics of the average daily increase in live weight of chickens, g

Indicators	Groups			
	Control	**1st experimental**	**2nd experimental**	**3rd experimental**
5-6 weeks	15.31±0.75	15.67±0.59	16.38±0.66	15.57±0.64
6-7 weeks	15.08±0.71	15.60±0.70	16.33±0.69	15.79±0.70
7-8 weeks	14.24±0.84	15.21±0.88	15.31±0.83	15.17±0.81
8-9 weeks	14.63±0.95	15.48±0.98	16.49±0.97	15.93±1.03
9-10 weeks	13.65±1.16	14.19±1.03	15.32±0.92	16.36±1.05
10-11 weeks	12.84±1.15	13.25±1.14	13.66±1.06	13.95±1.01
11-12 weeks	13.59±1.33	13.90±1.19	13.83±1.22	13.88±1.00
12-13 weeks	13.16±1.31	13.04±0.98	13.04±1.15	13.21±1.05
13-14 weeks	12.94±1.19	13.25±0.94	13.16±1.16	13.50±0.98
On average (5-14 weeks)	**13.91±0.13**	**14.38±0.09**	**14.83±0.10**	**14.82±1.07**

Note: *) P≤0.05; **) P≤0.01

Table 4: Digestibility of nutrients in experimental groups.

Indicators	Group			
	Control	**1st experimental**	**2nd experimental**	**3rd experimental**
Taken with food, g				
dry matter	61.39±0.00	61.39±0.00	61.39±0.00	61.39±0.00
crude protein	10.63±0.00	10.63±0.00	10.63±0.00	10.63±0.00
crude fiber	3.64±0.00	3.64±0.00	3.64±0.00	3.64±0.00
crude fat	1.67±0.00	1.67±0.00	1.67±0.00	1.67±0.00
Oozed with litter, g				
dry matter	15.41±0.71	14.06±0.51	13.28±0.55	14.55±0.21
crude protein	5.28±0.31	4.98±0.24	4.54±0.07	4.97±0.17
crude fiber	3.04±0.19	2.91±0.10	2.87±0.19	2.89±0.24
crude fat	0.43±0.02	0.43±0.02	0.42±0.02	0.42±0.01
Assimilated, g				
dry matter	45.98±0.71	47.33±0.51	48.11±0.55	46.84±0.21
crude protein	5.37±0.25	5.65±0.22	6.10±0.08	5.68±0.15
crude fiber	0.60±0.19	0.73±0.10	0.77±0.17	0.75±0.23
crude fat	1.24±0.02	1.24±0.02	1.26±0.02	1.25±0.01
Assimilated from taken, %				
dry matter	74.89±1.15	77.09±0.83	78.37±0.90*	76.29±0.34
crude protein	50.38±2.87	53.15±2.22	57.34±0.66*	53.29±1.57
crude fiber	16.41±5.21	19.92±2.73	21.02±4.68	20.47±6.35
crude fat	72.75±1.33	74.40±1.47	75.45±1.27	74.85±0.42

Note: *) P≤0.05; **) P≤0.01

Table 5: Calcium usage and deposition rate in body tissues.

Indicators	Group			
	Control	**1st experimental**	**2nd experimental**	**3rd experimental**
Taken with food, g	0.88±0.00	0.88±0.00	0.88±0.00	0.88±0.00
Oozed with litter, g	0.46±0.02	0.41±0.03	0.34±0.02	0.38±0.01
Used, g	0.42±0.02	0.47±0.03	0.54±0.02	0.50±0.01
Used from taken, %	48.01±1.82	53.13±3.19*	61.36±2.41**	57.10±1.26*

Note: *) P≤0.05; **) P≤0.01

Table 6: Phosphorus use and deposition rate in body tissues. according to the data of the second digestible trial

Indicators	Group			
	Control	**1st experimental**	**2nd experimental**	**3rd experimental**
Taken with food, g	0.47±0.00	0.47±0.00	0.47±0.00	0.47±0.00
Oozed with litter, g	0.25±0.01	0.24±0.01	0.22±0.01	0.23±0.01
Used, g	0.22±0.01	0.24±0.01	0.25±0.01	0.25±0.01
Used from taken, %	46.28±1.02	50.00±1.84*	52.66±2.80**	52.13±2.53*

Note: *) P≤0.05; **) P≤0.01

There was a tendency to increase calcium level (–15.64%) compared to the control. Based on the above, it can be concluded that the inclusion of various doses of Cellobacterin-T in the diet does not significantly affect the morphological and biochemical parameters of the blood of experimental chickens.

4. Conclusions

According to the obtained results on the effectiveness of the use of the enzymatic Cellobacterin-T probiotic in the diet of young Brown Nick cross, it can be concluded that the optimal dose of its introduction into the diets is 100 mg per 100 g of compound feed, which contributes to an increase in live weight by 48.03 g or 3.87%, compared to the control group. The introduction of the optimal dose of the Cellobacterin-T probiotic into the feed has a positive effect on the indicators of digestibility and use of nutrients in diets, the development of internal organs, and hematological indicators. Hematological parameters of the experimental chickens when using Cellobacterin-T at a dosage of 100 mg/100 g of compound feed were within acceptable physiological norms.

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