The effect of phytobiotic preparations on the digestibility of macronutrients by laying hens

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Abstract. Currently, intensive industrial use of poultry facilities and a large concentration of livestock negatively affect the bacterial background and, consequently, the microflora of the bird body. Due to the settlement of opportunistic and pathogenic microflora in the microbiocenosis of the chicken gastrointestinal tract, after 10-11 months of productivity, laying hens either weaken in egg production or in egg quality. The article describes the results of the absorption of calcium and phosphorus macronutrients by the body of laying hens when phytobiotics are introduced into the feed. According to the research results, it was determined that in birds receiving phytopreparations, the absorption of calcium and phosphorus increased by 10.13 and 10.31% compared with the control, and the content of these elements in the tibia increased by 2.30 and 1.54%, respectively, on average during the experiment. During the studies, the egg weight of the experimental chickens exceeded the control by 1.03-5.26%, while the shell strength was higher by 0.72-1.73%.

1 Introduction

The main condition for the manifestation of high productivity by chickens and the effective conversion of nutrients given with feed into the products obtained, which are genetically determined, is full-fledged feeding of poultry. It is based on a well-thought-out and verified feed composition as a primary indicator of nutritional value, functional anatomical and physiological characteristics of the gastrointestinal tract, absorption of feed nutrients and their biochemical metamorphoses in metabolic processes [1, 2].

High-tech and intensive modern poultry farming entails many positive changes, but also quite unfavorable factors of feeding and keeping poultry, therefore, the need to use feed additives is determined by preventing the negative effects of stress factors [3]. The consequence of constant exposure to the latter is the suppression of the body immune functions, which significantly increases the susceptibility of animals and birds to diseases of various etiologies. Also, due to the violation and distortion of the actions of most physiological systems, it inevitably leads to a deterioration in the product quality [4].

Currently, scientists pay quite a lot of attention to poultry farming methods (technologies), which are based on a comprehensive account of significant biofactors, borrowings from wildlife. The study of plant properties, essential oils, and their symbiotic

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effect makes it possible to create phytobiotics — biologically active substances of plant origin that have antibiotic properties and can become an alternative to synthetic feed antibiotics [5]. Modern literature sources define phytobiotics (phytogenic feed additives or herbal preparations) as natural additives obtained from the plant world, which have a wide range of effects on the body (immunomodulatory, antimicrobial, anti-inflammatory, antiviral, antifungal). Phytobiotics are used to support the body of animals and poultry by introducing them into ready-made compound feeds, or added to water to improve production indicators (productivity, safety, quality of food products of animal origin, and other zootechnical traits) [6, 7, 8, 9, 10].

Calcium and phosphorus macronutrients play an important role in the body of an egg laying bird, they are involved in many vital processes, including metabolism, bone formation, functioning of the nervous system, and egg formation.

The purpose of our research was to determine the effect of new phytobiotic preparations – "Activo" (a microcapsulated complex including essential oils of oregano, rosemary, thyme extracts, as well as chili pepper extract) and "Activo Liquid" (an emulsified preparation in which cinnamon and oregano oil and citric acid are used as active ingredients) on the metabolism of calcium and phosphorus macronutrients, on the mineralization of bone tissue in the body of laying hens, as well as on the quality of eggs.

2 Materials and Methods

The experiment was conducted in the conditions of buildings (poultry houses) of cage housing on the basis of JSC "Poultry Farm "Borovskaya". For the experiment, the repair young and laying hens of the High-Line brown cross were used. The keeping and feeding conditions were applied to the poultry of the control and experimental groups in accordance with the technological parameters of the recommendations for the tested cross adopted at the poultry farm.

The scientific and economic experiment was carried out on two groups of birds formed according to the principle of analogues. According to the experimental scheme, the control and experimental groups were staffed with a 14-week-old bird, in the amount of 2,100 heads each (Table 1). The experiment was carried out up to 42 weeks of age of chickens. Feeding of birds was organized within 2 periods: 1) from the 14th to the 24th week - a pre-peak recipe; 2) from the 25th week to the end of the experiment – a recipe for the first phase of egg productivity.

Recommendations on the methods of the SRC All-Russian Research and Technological Institute of Poultry Farming of the Russian Academy of Sciences (2013) were used as a basis for scientific research [11].

Table 1. Experiment scheme

Control group (2,100 heads)	Experiment group (2,100 heads)
Conditions of feeding technology	
The main diet (MD) is compound feed with a nutritional value corresponding to the recommendations for cross	MD + "Activo" in the amount of 0.1 kg per 1 ton of compound feed during the period of 16-21 weeks of life (42 days) + "Activo Liquid" in 3 stages, at each stage the preparation was drunk for 5 days in the following amount: the first stage – 0.5 l/1000 l of water from the 21st week of age, the second stage is 0.5 l/1000 l of water from 24 weeks of age, 3) 0.2 l/1000 l of water from 30 weeks of age.

The analysis, based on the results of balance (physiological) studies conducted within the framework of scientific and economic experience, allowed us to determine the use of calcium and phosphorus macronutrients in the body of the experimental bird. The studies were conducted on three heads selected by average body weight from each group at 24 and 32 weeks of age. The samples of manure and compound feed selected during the experiment were examined in the analytical laboratory "Ural Research Institute" – a branch of the FSBSI Ural Federal Agrarian Research Center Ural Branch of the Russian Academy of Sciences according to generally accepted methods: calcium content – by atomic absorption method, GOST 26570-95 (%); phosphorus content - by photometric method, GOST 26657-97 (%).

For greater objectivity of the results of the digestibility of macronutrients, the chemical composition of the tibia of laying hens for the content of crude ash, calcium, and phosphorus was determined in parallel. The research material was selected from 5 birds from each group at the ages of 24 and 32 weeks.

During the research, the main morphological parameters of 30 eggs from each group were studied. The analysis was performed every productive month.

The data obtained as a result of the experiments were processed by the variation statistics method using the Microsoft Excel program. The statistical significance of the differences between the groups was assessed using the Student's t-test.

3 Results

Mineral metabolism in the poultry body and all the physiological functions associated with it is an important process, as it has an effect on many zootechnical indicators of chickens and directly affects the quality of products, in particular eggs. The lack or imbalance of calcium and/or phosphorus negatively affects the mineral composition of the backbone of birds. Since the bones of laying hens are a kind of mineral depot, the calcium-phosphorus imbalance negatively affects their productivity and herd safety, therefore, this negatively affects the financial and economic results of the enterprise.

The calculations shown in Table 2 indicate that the calcium balance in the body of laying hens at the ages of 24 and 32 weeks was positive.

Table 2. Calcium balance in the body of laying hens, (n = 3).

Indicator	Control group	Experiment group
	Age of 24 weeks	
Taken with food, g/head/day		3,70
Excreted in the litter, g/head/day		1,21
Deposited in the body, g/head/day		2,48
Digested from the taken, %		67,16
	Age of 32 weeks	
Taken with food, g/head/day	4,11	3,98
Excreted in the litter, g/head/day	1,81	1,98
Deposited in the body, g/head/day	2,30	2,00
Digested from the taken, %	55,87	50,25

Losses of the macronutrient isolated in the droppings of experimental birds at 24 weeks of age, compared with the control group, were 0.5 g lower, therefore, its deposition in the body of chickens receiving the studied phytobiotic additives exceeded the control by 10.13%. The higher use of calcium by experiment chickens is consistent and confirmed by the results of morphological values of eggs, indicating an increase in shell strength and

thickness, compared with the control.

Calcium absorption in chickens of the experimental group was lower, compared with the control, by 5.62% at 32 weeks of age.

According to the results of calculating the phosphorus balance in the body of the studied chickens, presented in Table 3, it was found that both in the control and in the experimental groups, at the age of 24 weeks, the studied macronutrient was used ineffectively from the amount obtained. Nevertheless, it should be noted that the experimental birds had a better phosphorus uptake of 0.06% compared to the analogues of the control group. The most effective use of this macronutrient in the experimental group was demonstrated by repeated results of phosphorus balance in the chicken body obtained at 32 weeks of age, where the value in experimental chickens was 10.31% higher than the control ones.

Table 3. Phosphorus balance in the body of laying hens, (n = 3).

Indicator	Control group	Experiment group
	Age of 24 weeks	
Taken with food, g/head/day	0,621	0,578
Excreted in the litter, g/head/day	0,616	0,573
Deposited in the body, g/head/day	0,005	0,005
Digested from the taken, %	0,80	0,86
	Age of 32 weeks	
Taken with food, g/head/day	0,56	0,55
Excreted in the litter, g/head/day	0,46	0,40
Deposited in the body, g/head/day	0,09	0,15
Digested from the taken, %	17,20	27,51

The skeleton of chickens during their intensive operation is caused by significant changes in it and, in principle, indicates the potential productive capabilities of the laying hen, which is closely related to the metabolism in bone tissue. The state of bone reserves, feed intake, the level of egg production, egg weight, and shell quality are criteria for the usefulness and balance of phosphorus-calcium nutrition of laying hens. The shell strength depends on the process of calcium metabolism in the laying hen's body, which is a dynamic flow from feed calcium and bone moving into the shell formation department. First of all, the necessary amount of calcium is provided from the feed consumed, but the calcium reserves of the medullary bone can also be used. These reserves are relatively small, but they are of great importance for maintaining a sufficient amount of calcium in the body obtained from feed; no more than 5% of calcium is used to form the shell.

The chemical composition of the tibia of experimental birds is shown in Table 4.

At the age of 24 weeks, a predominantly higher content of ash, calcium, and phosphorus in the tibia was observed in the poultry of the experimental group. Thus, the amount of ash, calcium, and phosphorus exceeded the control values by 0.18%, 2.40%, and 1.59%, respectively.

At the age of 32 weeks (Table 4) in the experimental group, the ash content in the tibia corresponded to the level of the indicator at 24 weeks, while it was less than the control by 5.71% ($P \leq 0.05$). It should be noted that the amount of ash in the composition of bones may change due to resorption, and not due to demineralization of bone tissue, therefore, it does not always convey the actual picture of the state of bone reserves [18].

Table 4. Chemical composition of the tibia of laying hens, % (n = 5).

Indicator	Control group	Experiment group
	Age of 24 weeks	
Ash	41,14 ± 0,79	41,32 ± 0,51
Calcium	29,20 ± 0,49	31,60 ± 1,17
Phosphorus	14,21 ± 1,16	15,80 ± 1,01
	Age of 32 weeks	
Ash	47,06 ± 1,47	41,35 ± 0,74**
Calcium	28,40 ± 1,17	30,60 ± 1,33
Phosphorus	16,70 ± 0,46	18,20 ± 0,56

The results presented in Table 4 showed that the presence of calcium and phosphorus in the tibia of chickens of the experimental group was higher than in the control group by 2.20 and 1.50%, respectively.

To assess the usefulness of eggs morphological studies of eggs in the amount of 30 pieces from each group of chickens were carried out monthly, starting from the age of 24 weeks and then every productive month (Table 5).

The main and initial feature of classifying eggs according to the standard and determining the price is the egg weight. The final cost at the output and the economic result are calculated by the amount of egg mass, which may be different with a single egg production level. In addition, the egg weight, along with the live weight of the bird, is a criterion for the uniformity of the adult herd.

It was revealed that at 24, 28, and 36 weeks of age, the egg weight of individuals from the experimental group exceeded the control by 5.26 ($P \leq 0.01$), 3.32, and 3.10%, respectively.

It is difficult to overestimate the importance of eggshell quality, since reducing these products with open (cracked) and surface - without damaging the subcortical shells (notches) shell transformations, during their production due to violations in mineral metabolism, reduces economic losses [12-18]. The eggshell thickness of the experimental chickens at 24 weeks of age was 2.9% ahead of the control, and in the remaining periods it was at the same level as the control group. Nevertheless, measuring the thickness of the shell cannot be considered as the only indicator of its quality or a priority characteristic. The shell is proteoceramic, and its functional properties do not necessarily depend on its thickness. The shell that retains the ability to absorb and, at the same time, can withstand physical or other external influences without cracking can be considered more elastic. In production, when evaluating eggs, the predominant indicator is the shell strength, since it is from this indicator that the level of damage and the percentage of non-standard eggs depend. The poor quality of the egg shell leads to a decrease in its grade and food safety [19,20]. The shell strength primarily depends on its structure and the organization model of calcium minerals (i.e., the size of the crystals and the way they combine), which form the different layers of the egg shell.

Table 5. Morphological parameters of eggs of laying hens, $M \pm m$ (n = 30).

Indicator	Control group	Experiment group
Age of 24 weeks		
Egg weight, grams	56,06 ± 0,65	59,01 ± 0,67**
Shell strength, N	47,03 ± 1,13	47,37 ± 1,38
Shell thickness, mm	0,35 ± 0,00	0,36 ± 0,00
Age of 28 weeks		
Egg weight, grams	58,16 ± 0,70	60,09 ± 0,79

Shell strength, N	48,48 ± 1,46	49,32 ± 1,96
Shell thickness, mm	0,37 ± 0,00	0,36 ± 0,00
Age of 32 weeks		
Egg weight, grams	60,57 ± 0,69	60,05 ± 0,76
Shell strength, N	47,63 ± 0,98	45,60 ± 1,18
Shell thickness, mm	0,36 ± 0,00	0,36 ± 0,00
Age of 36 weeks		
Egg weight, grams	59,44 ± 0,80	61,28 ± 0,61
Shell strength, N	49,23 ± 1,04	49,77 ± 0,98
Shell thickness, mm	0,37 ± 0,00	0,37 ± 0,00

The determination of the shell strength limit is the actual measurement of the amount of force or resistance required to disrupt the eggshell integrity. The results (Table 5) showed that the egg strength of the experimental group of hens at 24, 28, and 36 weeks of age exceeded the control peers by 0.72, 1.73, and 1.10%, respectively. An increase in the strength of eggshells in chickens under the effect of phytobiotics during the study period contributed to a decrease in the number of eggs with shell damage (cracks and notch) by 0.21%.

4 Conclusion

As a result of the conducted research, it was found that the use of feed additives "Activo" and "Activo Liquid", due to the active phytocomponents included in their composition, contributes to the activation of the absorption and assimilation of calcium and phosphorus in the body of laying hens, accompanied by a higher reserve of them in bone tissue, an increase in egg weight and shell strength. These effects, providing a high categorization of eggs, are important arguments for increasing the profitability of production at an egg-producing poultry farm.

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