

# Vermiculax drug effect on blood parameters, immune response, calcium and phosphorus, and weight of laying hens

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**Abstract.** This paper presents the experiment on 160 laying hens of the white Leghorn breed divided into 4 groups. Group I (taken as a control group) was given a basic diet (OR). Group II had OR + Vermiculax at a dosage of 30 mg per 1 kg of the laying hen weight. Group III had OR + Vermiculax at a dosage of 37 mg per 1 kg of the laying hen weight. Group IV consumed OR + Vermiculax at a dosage of 44 mg per 1 kg of the laying hen weight. According to the results of the study, we came to the following conclusions. The drug Vermiculax increases the content of erythrocytes (by 21.45%) and hemoglobin (by 4.94%), which indicates the prevention of anemia, increases the index of total protein by 30.57%, calcium by 0.7% and inorganic phosphorus in the blood by 4.16%. Thus, it affects phagocytic processes, increases the immune response and absorption processes; increases the activity of macrophages and affects the process of degranulation of polymorphonuclear neutrophils, which in turn increases lysozyme activity by 3.9%. This is a sign of strengthening the natural antibacterial barrier. There is an increase in the retention of calcium in the body by 115.32% and phosphorus by 107.94% (on the 30th day of the study). In addition, increased retention of calcium by 8.3% and phosphorus by 8.5% (on the 180th day of the study) was observed. There is an increase in the deposition of calcium in the body by 132.8% and phosphorus by 133.45% (on the 30th day of the study), and increased retention of calcium by 66.36% and phosphorus by 66.4% (on the 180th day of the study). There is a high dynamic in weight gain by the second month of the study (increased by 21.88%), as well as a decrease in the level of feed consumption per weight gain of 1 kilogram by 13.33%.

## 1 Introduction

To date, the question of finding the most effective schemes for raising laying hens is relevant in poultry farming. One of the most promising and science-intensive directions is the introduction of mineral supplements into the diet. In addition, this direction is relevant because now the search is underway for more effective drugs able to replace antibiotics in the production process. This issue is actively discussed in the scientific field.

The work of Kovalevsky V.V. and Kislyakova E.M. (2013) describes the use of Calcium-MCG supplements in the diet of laying hens who have reached the age of one year. This additive was a modified form of calcium gluconate and was added in an amount of 770 grams per 1 ton of feed. In this experiment, the intensity of egg production improved (increased by 5.5%), the weight of the shell increased by 7.4%, feed costs per 10 eggs

decreased by 7%, the yield of eggs suitable for incubation increased to 82.6% and the digestibility of feed increased by 2% [1].

The invention of Hongxin W. (2013) reveals a feed additive for broilers. The prepared feed additive for broilers is formed by mixing a mixed extract of Daurian lespedeza and quail lespedeza and inulin in a mass ratio, while the content of the mixed extract of Daurian lespedeza and quail lespedeza is 80%, and the inulin content is 20%. In accordance with the broiler feed additive described in the invention, 3% of the broiler feed additive is added to the main daily feed in order to have an obvious effect on the growth of broilers. The average daily increase increased by 2.62%, antioxidant protection, (serum index (U.mL<sup>-1</sup>) increased by 1.42%. This component was determined by T-SOD; this indicator increased in the heart (by 6.39%), liver (by 4.36%) and kidneys (by 2.99%), increased immunity (mortality decreased by 50.32%), etc. And the effect of

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the feed additive for broilers is better than that of the market feed additive [2].

The S. Ganjigohari experiment (2017) was conducted to assess the effect of calcium nanocarbonate (HC) instead of calcium carbonate (CC) on egg production, egg weight, egg mass, FCR, calcium in the blood and egg quality characteristics in laying hens. A total of 120 laying hens aged 23 to 33 weeks were used in the 10-week trial. Laying hens were randomly distributed into six treatments with four repetitions, five chickens each. Experimental treatments included the replacement of 50% CC in the diet with a decrease in the amount of HC and were a group 1 Basic Diet (BD) with 8.06% CC. Group 2 had 6.045% CC as negative control; group 3 had 4.03% CC replaced by 2.015% NC. Group 4 had 4.03% CC replaced by 1.01% NC; group 5 had 4.03% CC replaced by 0.252% NC, and group 6 amounted to 4.03% CC replaced by 0.126% NC. The egg weight did not affect the dietary treatment ( $p > .05$ ). However, the percentage of egg production and egg weight in group 6 was lower than that with other treatment options ( $p < 0.05$ ). Laying hens in the control group had the best average feed conversion rate ( $p < 0.05$ ). Also, the lowest concentration of calcium in the blood of chickens was recorded in birds treated with group 6 ( $p < 0.05$ ). The best eggshell quality (relative eggshell weight and eggshell weight/surface) was observed in group 1 ( $p < 0.05$ ). Taken together, our results showed that NCC can replace CC at a lower inclusion level, but a sharp decrease in the concentration of calcium in the diet (up to 1.43% Ca in group 6) reduces productivity, egg quality characteristics, tibial thickness and calcium content in the blood, laying hens [3].

The nutritional value of limestone, oyster shells and extruded eggshells was evaluated by Mohammad Aminul Islam and Masahide Nishibori (2021) using various methods. A total of 120 18-week-old laying hens ISA Brown were divided into six dietary groups, namely D 1 (4% limestone)-calcium content 3.03%, D 2 (8% limestone)-calcium content of 3.39%, D 3 (4% of oyster shell) -calcium content of 2.95%, D 4 (8% oyster shell) -calcium content of 3.25%, D 5 (4% eggshell) -calcium content of 2.97%, and D 6 (8% eggshell) - calcium content of 2.97% to assess the effect of calcium sources on egg production, egg quality, dry matter content and cholesterol in the egg. Egg extruded shells contained 98.52, 4.24, 29.75 and 14.82% DM, CP, Ca and P, while egg extruded shells contained 99.20, 13.80, 25.53 and 13.87% DM, CP, Ca and P, respectively. Limestone and oyster shells contained 99.60, 99.51% CB, 37.12 and 35.20% Ca, respectively. Live weight (increased by 6.75% in the group with a calcium content of 3.03%), egg production (increased by 8.19% in the group with a calcium content of 2.97%), productivity per day of laying hens and egg mass, as well as FCR did not differ between diets ( $p > 0.05$ ). Egg production tended to increase with the increase in egg production from laying hens ( $p < 0.001$ ) in D 6, followed by D 2, D 5, D 3, D 4 and D.1, respectively. The lowest production costs and

the highest net profit were noted in D 6, followed by D 2, D 4, D 5, D 1 and D 3, respectively [4].

In his work, Nikolaev S. I. (2017) draws attention to the fact that most of the feeds used in poultry farming suffer from a deficiency of mineral, energy and amino acid components. In this regard, the authors introduced several components into the diet of poultry to set up the experiment, namely: sorghum and chickpea grains with the addition of pumpkin and sunflower phosphatides with bischofite. During the study, the indicators of egg weight (which increased by 2.7, 0.9 and 1.4 g), yolk weight (increased by 15.93, 11.89 and 22.17%) were evaluated [5].

Considering the rather versatile activity of the scientific community in the creation and application of additives to the diet of laying hens. Our goal was to conduct an experiment with the introduction of the mineral-vitamin preparation "Vermiculax" into the diet of laying hens and to establish its effect on the indicators of natural resistance, haematological and biochemical. The purpose was to assess the effect on the parameters of the weight gain, feed consumption, retention and deposition of trace elements in the body of laying hens [6, 7, 8, 9].

## 2 Materials and methods

The experiment was conducted on 160 laying hens of the white Leghorn breed selected according to the principle of pairs of analogues. All laying hens were randomly distributed into 4 groups in equal numbers. The scheme of the experience is presented in Table 1. The main diet consisted of flour of 54%; oat flour of 11%; yeast (dry, baked) – 14.3%; Flour (fish, meat-bone, hay) -8.2%; %; rutabaga - 7.3%; fat (animal, fish)-3.8%; nettle (ground) - 1.2%; salt 0.2%. All indicators of the content of laying hens met regulatory requirements.

The air temperature was determined using a mercury thermometer TTM from 0 to 200 TU 25-2021.010-89. Humidity of the air was measured using a psychometric hygrometer VIT-2. The air velocity was measured using the Testo 440 anemometer. Illumination was determined using a luxmeter Yu-116. The concentration of NH<sup>3</sup> and H<sub>2</sub>S in the air was determined by the universal gas analyser UG-2.

The water was given free rein, and was provided with a central water supply. Two valve-type micro-cup drinkers were installed in each cell. All laying hens were housed in BKM-3b cell batteries with 10 heads each.

**Table 1.** Scheme of experience.

Groups	Diets
I group (taken as a control group)	Basic diet
II group	The main diet + Vermiculax in a dosage of 30 mg per 1 kg of weight of laying hens
III group	The main diet + Vermiculax in a dosage of 37 mg per 1 kg of weight of laying

	hens
IV group	The main diet + Vermiculax in a dosage of 44 mg per 1 kg of weight of laying hens

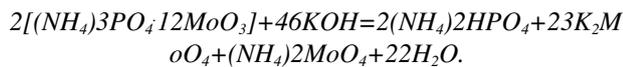
III group	120	100.3±11.68	3.0±0.94	27.2±1.73
	180	118.9±8.62	3.68±0.37	33.2±1.54
IV group	120	98.7±14.76	2.66±0.11	26.7±1.87
	180	111.1±21.84	2.95±0.40	29.8±1.88

Monthly records of calcium and phosphorus retained in the body were kept. Morphofunctional blood tests were carried out on the 4th and 6th month, which were carried out on an automatic hemoanalyzer BC-2800 Vet Mindray (Mindray, China). Biochemical parameters were studied using an automatic biochemical analyser Mindray BS-380 (Mindray, China) using commercial kits. From each group, 5 laying hens were sent monthly for slaughter, which was carried out externally. The amount of calcium and phosphorus was determined in the carcasses of laying hens.

Calcium was determined by a method based on the ability of calcium to precipitate under the action of ammonium oxalate according to the formula:  $CaC_2O_4 + H_2SO_4 \rightarrow CaSO_4 + H_2C_2O_4$ .

Phosphorus was determined by the Pemberton method based on the ability of phosphorous compounds with ammonium molybdenum to form a yellow phosphorous-molybdenum-ammonium salt that precipitates.

The determination took place by reaction:



Statistical processing of the received data was performed on a PC using the Microsoft Office Excel 2010 application. The obtained results were analyzed in accordance with the norms of variation statistics.

### 3 Results and discussion

In the course of the study of the haematology of laying hens, we found that the administration of the drug Vermiculax at a dosage of 37 mg per 1 kg of weight of laying hens favourably affects the red blood cell count. Thus, the content of erythrocytes on day 180 in group III was 21.45% higher than in group I, 21% higher than in group II and 24.74% higher than in group IV. The data obtained during the study allow us to assume that the introduction of Vermiculax into the body stimulates the immune response by increasing the number of red blood cells, which in turn adsorb various poisons on their surface and then these substances are destroyed by tissue macrophages (reticuloendothelial system).

**Table 2.** Haematological parameters of laying hens for the 6th and 8th month of the study.

Group	Age, days	Hemoglobin, g/l	Erythrocytes 10 <sup>12</sup> /l	Hemoglobin content in erythrocyte, pg
I group	120	99.7±6.77	2.76±0.43	27.0±1.63
	180	113.3±3.95	3.03±0.52	30.6±1.32
II group	120	99.6±8.69	2.73±0.63	27.1±1.93
	180	113.3±9.21	3.04±0.62	30.6±1.46

Also, you can see that the introduction of Vermiculax at a dosage of 37 mg per 1 kg of weight of laying hens affected the amount of hemoglobin (increased by 4.94%), which indicates the prevention of anemia with Vermiculax.

**Table 3.** Biochemical parameters of laying hens for the 6th and 8th month of the study.

Groups	Age, days	Total protein, g/l	Calcium mmol/l	Inorganic phosphorus, mmol/l
I group	120	57.9±1.56	3.41±1.64	1.46±1.75
	180	66.0±1.92	4.27±1.84	1.92±1.46
II group	120	58.5±0.65	3.50±1.48	1.50±1.76
	180	70.0±1.39	4.27±1.93	1.91±1.00
III group	120	58.5±1.55	3.49±1.34	1.52±1.63
	180	75.6±1.32	4.30±1.87	2.00±1.74
IV group	120	57.6±1.06	3.38±1.99	1.40±1.71
	180	65.2±1.37	4.22±1.56	1.88±1.55

During the analysis of biochemical data, we found that in comparison with the control and experimental groups, the data of group III were higher. The total protein in the blood of group III on the 180th day of the experiment was 30.57% higher than that in group I, 8% higher than that in group II and 15.95% higher than that in group IV. This phenomenon indicates a direct effect on phagocytic processes and an increase in the immune response. This indicator is consistent with high levels of calcium in the blood (the 180 day indicator of group III was 0.7% higher than the indicators of groups I and II, group IV by 1.86%) because the total protein directly affects the transfer of organic and inorganic substances in the blood and the binding of trace elements. We connect that the increase in the index of total protein, which in turn affected the immune response and absorption processes (this effect is also confirmed by an increase in the index of inorganic phosphorus by 4.16%) is due to the ingestion of laying hens of one of the components of the drug "Vermiculax" - monocalciphosphate.

**Table 4.** Indicators of natural resistance of laying hens for the 6th and 8th month of the study.

Group	Age, days	Glycoproteins, mg%	Bactericidal activity, %	Lysozyme activity, %
I group	180	124.0±11.96	47.5±1.46	18.0±1.26
II group		135.8±12.39**	55.9±2.22*	21.9±1.90*
III group		159.4±11.75**	61.0±1.27**	25.3±1.48**
IV group		122.51±5.09	45.1±1.57**	17.1±0.13

The administration of the drug Vermiculax at a dosage of 37 mg per 1 kg of laying hens increases lysozyme activity by 3.9%. More precisely, it increases the activity of macrophages, cells that secrete lysozyme, and it is also possible that Vermiculax affected the process of degranulation of polymorphonuclear neutrophils, which is a sign of strengthening of the natural antibacterial barrier. An increase in lysozyme activity has a stimulating effect on bacterial activity (as confirmed by Table 4). Bacterial activity increased by 13.5%. Moreover, we found that there is also a stimulating effect on the content of glycoproteins (increased by 35.4%), which have an antiviral effect, protective function, and so on.

In the course of the study, we saw a certain relationship between the retention rates in the body of

laying hens, the deposition of calcium and phosphorus in the body of laying hens and age-related changes. Thus, in group I, in comparison with the first month of studies, the retention rate of calcium in the body decreased by 18.7% on day 180. At the same time, the average monthly decline was 3.11%. In terms of phosphorus, the difference between the indicators of the first and sixth month was 21.6%, while the average monthly decline was 3.6%. In the indicators obtained after slaughter in group I, the difference between the calcium indicators at the beginning of the study and the final stage was 14%, while the average monthly decrease was 2.33%. In terms of phosphorus, the difference between the first month and the 180th day was 16.5%, while the average monthly decrease was 2.75%.

**Table 5.** Retention and deposition by the body of laying hens of calcium and phosphorus (without administration of the drug Vermiculax).

		Age, days					
		30 days	60 days	90 days	120 days	150 days	180 days
Retained by the body, %	Ca	35.9 ±1.73-2.99	32.5 ±0.85-0.72	27.8 ±1.65-2.72	26.0 ±1.68-2.82	17.3 ±1.74-3.02	17.2±1.67-2.79
	Ph	40.3± 1.93-2.30	36.5 ±1.64-2.69	28.8 ±1.40-1.96	27.2 ±1.14-1.3	18.7 ±1.99-3.96	18.7±1.20-1.44
Deposited in the body (based on the results of slaughter), %	Ca	25.0 ±1.13-1.27	23.25±1.10-1.21	19.3 ±1.05-1.1	19.4 ±1.00	11.2 ±1.02-1.04	11.0±1.65-2.72
	Ph	29.3 ±1.67-2.79	27.7 ±1.19-1.41	19.9 ±1.64-2.68	20.9 ±1.48-2.19	12.9 ±1.64-2.68	12.8±1.88-3.53

In group II, there was also a decrease in indicators with the age of laying hens. In comparison with the 30th day of studies, the retention rate of calcium in the body decreased by 36.2% on the 180th day. At the same time, the average monthly decline was 6.03%. In terms of phosphorus, the difference between the indicators of 30 and 180 days was 40.3%, while the average monthly

decline was 6.71%. In the indicators obtained after slaughter in group II, the difference between the calcium indicators of the first month of the study and the final one was 27.3%, while the average monthly decrease was 4.55%. In phosphorus indicators, the difference between the first month and the fifth was 33.1%, while the average monthly decrease was 5.51%.

**Table 6.** Retention and deposition by the body of laying hens of calcium and phosphorus (with the introduction of Vermiculax at a dosage of 30 mg per 1 kg of the weight of laying hens).

		Age, days					
		30 days	60 days	90 days	120 days	150 days	180 days
Retained by the body, %	Ca	60.3 ±1.95***	52.4 ±1.31***	47.5 ±1.60***	38.3 ±1.52***	24.1 ±1.66***	24.1±1.85
	Ph	65.6 ±1.74***	57.3 ±1.94***	49.3 ±1.46***	38.8 ±1.46***	25.2 ±1.45***	25.3±1.50
Deposited in the body (based on the results of slaughter), %	Ca	45.5 ±0.51***	40.6 ±1.70***	33.1 ±1.30***	30.5 ±1.03***	17.9 ±1.07***	18.2±1.03
	Ph	53.3 ±1.26***	47.7 ±1.79***	34.0 ±2.5***	32.7 ±1.25***	20.2 ±1.41***	20.2±1.36

Comparing the indicators of group I and II, we see that the retention rate of calcium after reaching 180 days was higher in group III by 6.9%, phosphorus by 6.6%. At the same time, based on the data of the control slaughter, the indicator of calcium deposited in the body was higher in II by 7.2%, phosphorus by 7.4%. Analysing the indicators of reduced retention of calcium

and phosphorus in the body of laying hens, this indicator was higher in group II (the average monthly decrease in group II was higher by 2.92% and 3.11%, respectively). A similar pattern was observed in the indicators of calcium and phosphorus deposited in the body, the indicators of the average monthly decrease in calcium were higher in group II by 2.22% and 2.76, respectively

In group III, there was also a decrease in indicators with the age of laying hens. In comparison with the 30th day of studies, the retention rate of calcium in the body decreased by 51.8% on the 180th day. At the same time, the average monthly decline was 8.63%. In terms of phosphorus, the difference between the indicators of 30 and 180 days was 56.3%, while the average monthly

decline was 9.38%. In the indicators obtained after slaughter in group III, the difference between the calcium indicators of the first month of the study and the final one was 39.4%, while the average monthly decrease was 6.65%. In phosphorus indicators, the difference between the first month and the fifth was 47.1%, while the average monthly decrease was 7.85%.

**Table 7.** Retention and deposition by the body of laying hens of calcium and phosphorus (with the introduction of Vermiculax at a dosage of 37 mg per 1 kg of the weight of laying hens).

		Age, days					
		30 days	60 days	90 days	120 days	150 days	180 days
Retained by the body, %	Ca	77.3 ±0.67***	55.2 ±1.52***	50.1 ±0.74***	40.5 ±1.55***	25.7 ±1.13***	25.5±1.46** *
	Ph	83.8 ±1.96***	60.6 ±1.45***	52.3 ±1.67***	41.0 ±2.96***	27.6 ±1.66***	27.5±1.77** *
Deposited in the body (based on the results of slaughter),%	Ca	58.2 ±1.17***	42.9 ±1.29***	35.0 ±1.36***	33.3 ±1.23***	18.7 ±1.98***	18.3±1.75** *
	Ph	68.4 ±1.34***	49.0 ±1.53***	36.9 ±1.74***	35.2 ±1.58***	21.6 ±1.64***	21.3±1.53** *

Comparing the indicators of groups I and II, we see that the retention rate of calcium after reaching 180 days was higher in group III by 8.3%, phosphorus by 8.5%. At the same time, based on the data of the control slaughter, the indicator of calcium deposited in the body was higher in III by 7.3%, phosphorus by 8.5%. Analysing the indicators of reduced retention of calcium and phosphorus in the body of laying hens, this indicator was higher in group III (the average monthly decrease in group III was higher by 5.52% and 5.78%, respectively). A similar pattern was observed in the indicators of calcium and phosphorus deposited in the body, the indicators of the average monthly decrease in calcium were higher in group III by 4.32% and 5.1, respectively.

day of studies, the retention rate of calcium in the body decreased by 20.2% on the 180th day. At the same time, the average monthly decline was 3.36%. In terms of phosphorus, the difference between the indicators of 30 and 180 days was 22.4%, while the average monthly decline was 3.73%. In the indicators obtained after slaughter in group IV, the difference between the calcium indicators of the first month of the study and the final one was 12.4%, while the average monthly decrease was 2.06%. It should be noted that the decrease in calcium and phosphorus indicators was observed only from the 60th day of the study. In terms of phosphorus, the difference between the first month and the fifth was 16.5%, while the average monthly decrease was 2.75%.

In group IV, there was also a decrease in indicators with the age of laying hens. In comparison with the 30th

**Table 8.** Retention and deposition by the body of laying hens of calcium and phosphorus (with the introduction of Vermiculax at a dosage of 44 mg per 1 kg of the weight of laying hens).

		Age, days					
		30 days	60 days	90 days	120 days	150 days	180 days
Retained by the body, %	Ca	40.2 ±0.32**	36.3 ±1.25***	30.3 ±1.48***	30.2 ±1.90***	20.1 ±1.36**	20.0±1.64** *
	Ph	43.5 ±1.36***	41.0 ±1.43***	31.5 ±1.93	30.8 ±0.04***	21.5 ±1.47***	21.1±1.05** *
Deposited in the body (based on the results of slaughter),%	Ca	24.3 ±1.91	35.0 ±1.54***	29.5 ±1.69***	28.9 ±1.66***	12.9 ±1.95	11.9±1.76
	Ph	29.0 ±1.62	40.1 ±1.45***	29.7 ±1.11***	30.2 ±1.65***	13.7 ±1.50	12.5±1.44

**Table 9.** Indicators of the weight of laying hens and feed consumption for the first 2 months of the study.

III	455 ±26	1610 ±30***	2.10 ±0.39
IV	389 ±6*	1311 ±24	2.59 ±0.66

Groups	Weight, gr.		Feed consumption per 1 kg of weight gain
	30 days	60 days	
I	413 ±12	1321 ±27	2.38 ±0.76
II	424 ±31	1476 ±54**	2.29 ±0.57

Comparing the indicators of group I and IV, we see that the retention rate of calcium after reaching 180 days was 2.8% higher in group IV, phosphorus was 0.3% lower. At the same time, based on the data of the control

slaughter, the indicator of calcium deposited in the body was 8.2% higher in IV, phosphorus was 2.3% lower. Analyzing the indicators of a decrease in the retention of calcium and phosphorus in the body of laying hens, this indicator was higher in group IV (the average monthly decrease in group IV was 0.25% and 0.13% higher, respectively). A similar pattern was observed in the indicators of calcium and phosphorus deposited in the body, the indicators of the average monthly decrease in calcium were lower in group IV by 0.27% and were identical in changes in phosphorus.

Analyzing the data of mass indicators, we see that when Vermiculax was introduced into the diet at a dosage of 37 mg per 1 kg of weight of laying hens (group III) by the second month of the study. The highest results of weight gain were achieved: 1610 grams ( $P < 0.001$ ), which is 21.88% higher than that in the control group, 9.07% higher than that in group II and 22.81% than that in group IV. At the same time, a higher rate of the weight gain between the first and second months of studies was also observed in group III (the mass index increased by 253.85% compared to the first month of the study), which is 33.99% (the mass index of group I increased by 219.85% compared to the first month of the study). Also, group III had the lowest amount of feed consumption per 1 kilogram of weight gain. This indicator was lower than that in group I by 13.33%, by 9.04% than that in group II and by 23.33% than that in group IV. These phenomena of a higher level of the weight gain are explained by the amount of deposited calcium in the body of laying hens of group III. This phenomenon has affected a large number of enzymatic processes that affect the growth and development of the body of laying hens.

## Conclusion

In the course of the study, we concluded that the drug Vermiculax has the most beneficial effect on the body when introduced into the diet of laying hens at a dosage of 37 mg per 1 kg of weight of laying hens. According to the results of the study, we came to the following conclusions. The drug Vermiculax:

- increases the content of erythrocytes (by 21.45%) and hemoglobin (by 4.94%), which indicates the prevention of anemia;
- increases the index of total protein by 30.57%, calcium by 0.7% and inorganic phosphorus in the blood by 4.16%. Thus, it has an effect on phagocytic processes, an increase in the immune response and absorption processes;
- increases the activity of macrophages and affects the process of degranulation of polymorphonuclear neutrophils, which in turn increases lysozyme activity by 3.9%, which is a sign of strengthening the natural antibacterial barrier;
- increases the retention of calcium in the body by 115.32% and phosphorus by 107.94% (on the 30th day of the study), retention of calcium

by 8.3% and phosphorus by 8.5% (on the 180th day of the study);

- increases the deposition of calcium in the body by 132.8% and phosphorus by 133.45% (on the 30th day of the study), retention of calcium by 66.36% and phosphorus by 66.4% (on the 180th day of the study);
- shows a high dynamics of weight gain by the second month of the study (increased by 21.88%), as well as a decrease in the level of feed consumption for weight gain of 1 kilogram by 13.33% (Kovalevsky V.V. Achievements of science and technology of agriculture, 43-48 (2013)).

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