The effect of the mineral supplement "Permait" and vitamin B$_{13}$ on the productivity of broiler chickens

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Abstract. The article presents the materials obtained in experiments to study the feasibility of using a zeolite-containing additive “Permait” and poorly studied vitamin B$_{13}$. The results of the experiments showed that the optimal dose of using a zeolite-containing additive in compound feeds is 2% of the dry matter of the feed. At this level, compared with the control, the growth energy of broiler chickens increased by 9.1-10.7 % compared to the control groups. The feeding of this drug contributed to an increase in slaughter of meat in the first experiment by 3.1%, in the second experiment - by 4.6%. Per 1 kg gain in live weight of experimental birds was spent from 2.02 to 2.56 kg of feed. The use of potassium orotate in the composition of complete feed contributed to an increase in the average daily growth of broiler chickens from the experimental groups only by 0.8 - 2.5% relative to the control (p <0.05). Higher rates are obtained with a dose of 10 mg. The slaughter yield of the half-gutted carcass of broiler chickens ranged from 78.1 to 81.2%, and the gutted - 64.7-66.8%.

1. Introduction

Poultry farming is the most intensively developing branch of the agro-industrial complex for the production of such valuable food products as egg and meat. Under optimal conditions of maintenance and full feeding from laying hens, it is possible to get at least 300 eggs per year and about 50 g of the average daily increase in broiler chickens. In the technology of their cultivation, balanced feeding in accordance with detailed norms is important [1]. They take into account more than 40 essential nutrition factors. Calcium, phosphorus, sodium, manganese, zinc, copper, iron, cobalt, iodine, selenium are taken into account in the detailed feeding rates. However, the set of basic feeds that are present in the composition of mixed feeds does not meet the poultry demand for these substances. In order to eliminate this deficiency, various mineral additives are introduced in them: fodder chalk, bone meal, precipitates, trace element salts, as well as non-traditional sources of mineral substances [1-6].

Highly productive poultry farming requires the availability of high-quality feed both in the presence of nutritional components and in the absence or minimum content of harmful and toxic substances. The higher the productivity of animals, the more sensitive they are to the presence of mycotoxins in the feed, which pose a real threat to farm animals [7, 8].

Agrominerals and zeolites occurring in the form of tuffaceous sedimentary rocks in various regions of the country, including in the territories of the Ulyanovsk region, the Republic of Tatarstan, the Mordovia and Chuvash Republics, have been established in the production of mixed feeds and feeding
of agricultural poultry trace elements, and they are able to adsorb harmful gases formed in the digestive tract of animals and birds. Zeolites in compound feeds are supposed to stabilize amino acids by the nitrogen “tail” of some amino acids with a simple structure. This leads to a decrease in energy consumption for the growth of live body weight of birds [8].

In recent years, local agromineral powers have been widely used in experiments as sources of macro- and microelements for farm animals and birds [9, 10]. In the Chuvash Republic, prospecting and exploration works of Cretaceous sediments, zeolite-containing tripoli in the Alatyr and Shemurshinsky districts have been conducted and their resources are estimated at more than 700 million m³ [2]. Zeolite-containing tripoli of the Alatyr (Pervomaisky) field contains 24–30% zeolite, 18% calcite, 20% opal cristobalite, 63.9% silica, and various oxides. The drug "Permit" is produced from this raw material. It consists of (%): silicon oxide – 60.3–70.5; zeolite – 20–25; quartz – 10–15; calcium – 1.0–1.5; iron oxide – 2.8–4.2; calcium oxide – 2.6–12.3 and other oxides up to 3.3 [11].

G. I. Ivanov and T.E. Grigoreva successfully worked for many years on the development of a prescription for the drug "Permit" and the study of the feasibility and effectiveness of its use in animal husbandry. They and other researchers proved that it should be used in feeding cattle, pigs and poultry as a source of calcium, phosphorus and some trace elements, within 2-3 % of dry matter feed [12].

It should be noted that most studies have been conducted on chickens and few of them on young birds. While there is some disagreement on the dose of the introduction of zeolite into animal feed. Apparently, this is due to the significant difference in the chemical composition of its different deposits.

An important role in feeding poultry belongs to vitamins, including water-soluble, not taken into account in the norms of feeding poultry. They are part of many enzymes and participate actively in digestion nutrients feed. Their lack in the diets of birds leads to a decrease in productivity, safety, poor use of nutrients for the synthesis of products [13]. B vitamins play an important role in the feeding of agricultural birds and monogastric animals. So no wonder the norms of their feeding counts 6-9 of the 17 vitamins known. Preparations of these biologically active substances are used in the production of feed for birds.

One of them is vitamin B₁₃ or orotic acid salt - potassium orotate. According to its physiological properties, this vitamin is close to cyanocobalamin and favorably affects the body's nitrogen metabolism, protein synthesis and the activity of enzymes associated with these processes, as well as erythropoiesis. Currently, it is of interest to use it in diets in combination with other water-soluble vitamins, in particular, ascorbic and folic acids. This is necessary to identify synergism and antagonism of its action with them in the physiological processes occurring in the body, and the development of new recipes for premixes for poultry. According to its physiological properties, this vitamin comes close to cyanocobalamin (B₁₂) and has a beneficial effect on nitrogen metabolism, protein synthesis and on the activity of enzymes associated with these processes. And also it takes part in carbohydrate metabolism by stimulating enzyme functions.

Vitamin B₁₃ is found only in the milk of cows, poorly soluble in water and therefore produced by the industry in the form of orotic acid salt – potassium orotate, better soluble in one liquid. The question of the use of this drug as part of animal feed in the cultivation of young birds, especially broiler chickens, has not been studied.

All this was the reason for research in the field of technology of growing broiler chickens. In this regard, we conducted a series of scientific and economic experiments on broiler chickens.

The aim of the research was to study the effect of feeding different doses of zeolite-containing additives "Permit" and vitamin B₁₃ (potassium orotate) in the feed on growth energy, safety, meat productivity of broiler chickens and digestibility of nutrients feed.

2. Materials and methods
A series of scientific and economic and balance (physiological) experiments on broiler chickens of the cross "Competitor" and "Change 2" were conducted by conventional zootechnical methods. The
effectiveness of the use of additives "Permait" and vitamin B₁₃ (potassium orotate) in animal feed and diets was studied. We conducted two scientific and economic experiments, where the broiler chickens from experimental groups were fed different doses of zeolite-containing drug "Permait" according to the following scheme (table 1).

Table 1. Scheme of feeding broiler chickens on the use of the drug "Permait".

| Group          | Livestock of chickens | Main diet         | Dose "Permait" from dry matter of feed, % |
|----------------|-----------------------|-------------------|------------------------------------------|
|                |                       |                   |                                          |
| Initial experiment |                       |                   |                                          |
| I control       | 40                    | Mixed fodder: PC 5-0 PC | —                                       |
| II experimental | 40                    | 5-1 PC 3          | 0.5                                      |
| III experimental| 40                    | — —               | 1.0                                      |
| IV experimental | 40                    | — —               | 1.5                                      |
| V experimental  | 40                    | — —               | 2.0                                      |
| VI experimental | 40                    | — —               | 2.5                                      |
| Second experiment |                       |                   |                                          |
| I control       | 40                    | Mixed fodder: PC 5-0 PC | —                                       |
| II experimental | 40                    | 5-1 PC 3          | 2.0                                      |
| III experimental| 40                    | — —               | 3.0                                      |
| IV experimental | 40                    | — —               | 4.0                                      |

In scientific and economic experiments 4-6 groups of 5-10 daily chickens with 40 heads each were formed. Birds of experimental groups from 11 days of age were fed compound feeds with the addition of different doses of the drug "Permait", namely from 0.5 to 4.0 % of the dry matter of the feed. Chickens of control groups did not receive it.

In two scientific and economic experiments conducted by the method of balanced groups, different doses of vitamin B₁₃ of the studied drug were fed as part of feed. Four groups of day-old chicks with 100 heads in each group were formed in these studies. In this case, one group was the control, and the rest – experimental. The scheme of these experiments is shown in table 2.

Table 2. Scheme of scientific and economic experiments on the use of vitamin B₁₃.

| Group | Number of broiler chickens | The dose of potassium orotate in 1 kg of feed, mg |
|-------|---------------------------|--------------------------------------------------|
|       |                           |                                                  |
| Initial experiment |                       |                                                  |
| I – C | 100                       | -                                                |
| II – E | 100                     | 5                                                |
| III – E | 100                     | 7.5                                              |
| IV – E | 100                      | 10.0                                             |
| Second experiment |                       |                                                  |
| I – C | 100                       | -                                                |
| II – E | 100                     | 15                                               |
| III – E | 100                     | 17.5                                             |
| IV – E | 100                      | 20.0                                             |

The experiments were divided into two periods: preparatory – the first 6 days and the main – 50 days, during which the chickens of the experimental groups were fed complete feed with the addition of potassium orotate in doses of 5 to 20 mg per 1 kg. 100 g of feed contained 1.22 – 1.19 MJ OE (metabolic energy), 20.5-19.2 g of crude protein, 0.94-0.76 g of calcium, 0.79-0.66 g of phosphorus and fed them to chickens according to the accepted feeding scheme.
During the experiments, the experimental birds were kept in cellular batteries with the same parameters of the microclimate. The studies took into account the dynamics of live weight of broiler chickens, their safety, meat productivity and physiological state. The dynamics of changes in live weight of birds was established by individual weighing at the beginning and at the end of the experiment, and the safety of the chickens by daily accounting of mortality and culling. In all experiments, we kept daily records of given feeds and their residues. Upon completion of the experiments, the total feed consumption was determined by groups and their costs were calculated for obtaining 1 kg of a live weight gain. The growth rate was characterized by absolute and relative indicators. The absolute gain for the entire experiment was calculated by subtracting the live weight at the end and at the beginning of the growing period. The average daily gain was estimated as the absolute increase in live weight in one day.

Balance experiments were conducted in order to determine the use of the studied additives for nutrient digestibility and the balance of nitrogen, calcium and phosphorus in the body of birds.

3. Results and discussion
In all experiments to establish the effect of feeding broiler chickens of the drug "Permait" on their growth at the age of 10 and 30 days and at the end of the growing period, individual weighing was carried out. The results of changes in live weight of experimental birds for the accounting period of experiments are shown in table 3.

Table 3. The effect of different levels of the drug "Permait" in compound feeds on growth of broiler chickens (on average).

| Group       | Live weight of 1 head, g | % over control |
|-------------|-------------------------|----------------|
|             | in the beginning of the experiment | at the end of experiment |
| Initial experiment |                      |                  |
| I control   | 139.7±0.2               | 1450.7±20.6     | 100.0          |
| II experimental | 140.0±0.2               | 1450.8±18.3     | 100.0          |
| III experimental | 139.9±0.2               | 1476.8±20.3     | 101.9          |
| IV experimental | 139.7±0.1               | 1538.1±9.2*     | 106.6          |
| V experimental | 139.9±0.2               | 1591.7±9.4*     | 110.7          |
| VI experimental | 139.8±0.22              | 1541.1±9.6*     | 107.0          |
| Second experiment |                      |                  |
| I control   | 159.4±0.2               | 1677.0±20.4     | 100.0          |
| II experimental | 158.2±0.3               | 1813.0±27.2*    | 109.1          |
| III experimental | 159.0±0.2               | 1780.0±24.6*    | 106.9          |
| IV experimental | 158.2±0.2               | 1723.0±23.1     | 103.3          |

* - p<0.05

In both experiments, the best results were obtained by feeding poultry feed with 2 % of the studied drug "Permait". Their average live weight of 1 head was higher by 9.1 – 10.7 % (p<0.05) compared to the control groups.

In order to establish the effect of feeding the studied additives on meat productivity a control slaughter of 5 heads from each group was carried out. At the same time, the pre-slaughter live mass, the mass of half-gutted and gutted carcass, edible and inedible parts in them were taken into account. The data obtained are given in table 4. The control slaughter showed that the use of the studied mineral additives in the compound feeds did not significantly lead to the output of meat, the morphological composition of the carcasses of
broiler chickens. The obtained numerical data of all groups of experimental birds were similar and the discrepancy between them ranged from 0.1 – 0.8 %.

**Table 4.** Results of studies of meat productivity of broiler chickens.

| Indicators                          | Control Main diet | Experimental 2% "Permait" |
|------------------------------------|-------------------|---------------------------|
| Live weight of 1 head, g           | 2090±17.9         | 2280±15.8                 |
| The percentage of output:          |                   |                           |
| half-gutted carcass                | 78.9              | 78.5                      |
| gutted carcass                     | 62.2              | 63.5                      |
| Morphological composition of the   |                   |                           |
| carcass, %                         |                   |                           |
| skin                               | 11.6              | 12.3                      |
| muscles                            | 65.4              | 64.6                      |
| fat                                | 2.5               | 2.3                       |
| bones                              | 20.5              | 19.8                      |
| Energy value of 100 g of meat, kJ  | 688.0             | 713.1                     |

The use of the additive "Permait" in poultry diets did not have a significant impact on the development of internal organs. Thus, the mass of the muscle stomach ranged from 63.6 to 66.9 g, liver – from 45.0 to 49.6 g.

To determine the influence of the studied factors on the energy nutritional value of broiler chicken meat, the chemical composition of the femoral muscle was studied (table 5).

**Table 5.** Chemical composition and energy value of the femoral muscle.

| Indicators, %                  | Group                   |
|-------------------------------|-------------------------|
|                               | I - control Main diet   | II - experimental 2% chalk | III experimental 2% "Permait" |
| Moisture                       | 74.9                    | 74.1                      | 73.9                   |
| Dry matter                     | 25.1                    | 25.9                      | 26.1                   |
| including: protein             | 16.6                    | 17.1                      | 17.3                   |
| fat                            | 7.4                     | 7.7                       | 7.6                    |
| ash                            | 1.1                     | 1.1                       | 1.2                    |
| Calcium, mg/kg                 | 9.7                     | 13.0                      | 14.8                   |
| Phosphorus, mg/kg              | 26.9                    | 27.3                      | 30.8                   |
| Caloric value of 100 g of meat:|                         |                           |
| kcal                           | 164.6                   | 170.2                     | 170.6                  |
| kJ                             | 688.0                   | 711.4                     | 713.1                  |

Feeding a mineral supplement did not noticeably affect the chemical composition of the femoral muscle. Its water content was 73.9-74.9 %, protein – 25.1-26 %, fat – 7.4-7.7 %, ash – 1.1-1.2 %. However, it should be noted that when added to the diet of mineral supplements, the concentration of calcium increases by 34.0-52.6 %, phosphorus – 1.5-14.6 % compared to the control. In 100 g of muscle energy content varied within 688 – 713 kJ. This figure was slightly higher in broiler chickens of experimental groups.

In the balance (physiological) experiments it was found that the enrichment of animal feed preparation "Permait" contributes to some improvement of digestibility of all nutrients, especially
"raw" protein. The coefficient of digestibility of this substance in broiler chickens, receiving 2% of this additive in the feed, was higher by 2.5 - 4.2% compared with the control groups and amounted to 66.1-66.9%. Feeding broiler chickens with zeolite-containing additives from 1 to 2.0% in the composition of mixed feed had a positive effect on the balance of nitrogen, calcium and phosphorus. They had nitrogen retention in the body by 0.3-2.0%, calcium — 0.3-2.4%, phosphorus — 0.3-4.1% relative to the control. With a further increase in the concentration of this additive in diets, there is a tendency to decrease this indicator.

Chickens of all groups received a similar amount of feed and on average their consumption per head per day was 77-79 g. Rations on the content of energy, nutrients and biologically active substances corresponded to the accepted norms of feeding. The use of 2% of the studied mineral additives in animal feed contributed to a decrease in feed consumption per 1 kg of live weight gain of broiler chickens in the experimental groups by 0.11-0.12 kg compared to the indicator of birds in the control group.

The efficiency of using vitamin B_{13} (potassium orotate) in growing broiler chickens depends on the usefulness of the rations. In the experiments, first of all, the intensity of growth of experimental birds was determined by periodic weighing. Table 6 summarizes the average changes in the live weight of one head of broiler chickens by groups during the accounting period of the experiments.

Table 6. Change of live weight of broiler chickens with the inclusion of potassium orotate in the composition of complete feed (on average by groups).

| Groups | Live weight of 1 head, g | Average daily growth | % over control |
|--------|-------------------------|----------------------|---------------|
|        | in the beginning of the experiment | at the end of experiment | g |               |
| Initial experiment | | | | |
| I – C | 82.0 | 1696.4 | 37.0 | 100 |
| II – E | 82.3 | 1912.7 | 37.2 | 100.8 |
| III – E | 81.8 | 1933.9 | 37.8 | 102.0 |
| IV – E | 81.6 | 1944.0 | 38.0 | 102.5 |
| Second experiment | | | | |
| I – C | 87.6 | 1878.2 | 36.5 | 100 |
| II – E | 87.4 | 1891.0 | 36.8 | 101.4 |
| III – E | 87.3 | 1895.6 | 36.9 | 101.7 |
| IV - E | 89.3 | 1905.6 | 37.1 | 102.2 |

The data of the table 6 show that the inclusion of potassium orotate in the composition of complete feed did not significantly affect the growth energy of broiler chickens in the experimental groups and the difference in the average daily growth between the control and experimental groups ranged from 0.8 to 2.5%, which is statistically unreliable. However, at the same time a clear pattern of a small increase in both the live weight of one head and the average daily increase in the dose of the studied drug in animal feed was revealed.

It should be noted that in all experiments and groups there was a high safety of broiler chickens and it was 96-99%.

To determine the effect of different doses of vitamin B_{13} in animal feed on meat productivity of broiler chickens, a control slaughter of 4 birds from each group was carried out. At the same time, it was revealed that the addition of vitamin B_{13} to the feed had little effect on the carcass output, and it amounted to half-gutted 78.1-80.5%, gutted - 63.4-66.9%. The best indicators were in the first scientific and economic experiment.

The results of balance (physiological) experiments are shown in table 7. In both experiments the digestibility coefficient was (%): "raw" protein of 63.7 compared to 68.1; raw fat – 63.7-68.1; "raw"
fiber is 19.2 to 20.3; NFE (nitrogen-free extractive substances) -77.1-79.8. At the same time, there is a slight tendency to increase the digestibility coefficient of all nutrients as the dose of the studied drug in feed increases. According to S. M. Bremen [2] vitamin B13 has a positive effect on the activity of enzymes taking in the digestion of feed nutrients.

| Table 7. Nutrient digestibility coefficients of diets (average by group, %). |
|------------------|------------------|------------------|------------------|------------------|
| Group            | Raw protein      | Raw fat          | Raw fiber        | Nitrogen-free extractive substances |
| I – C            | 64.3             | 65.5             | 19.6             | 78.2             |
| II – E           | 65.9             | 66.7             | 19.7             | 78.8             |
| III – E          | 67.9             | 68.7             | 20.3             | 79.9             |
| IV – E           | 66.6             | 68.1             | 20.1             | 79.5             |

In all experiments similar results were obtained on the balance of nitrogen, calcium and phosphorus in the body of experimental birds. Thus, nitrogen retention in the body of broiler chickens in the first experiment ranged from 1.47 to 1.53 g, and in the second – from 1.38 to 1.47 g and there was no big difference in this indicator between the control and experimental groups. The balance of calcium in both experiments varied within 0.72-0.81 g, and phosphorus – 0.33-0.47 g and it was taken from 61.4-64.7% and 41.2-46.2%, respectively.

The full value of feeding broiler chickens was estimated also by hematological indicators. The content of hemoglobin, total protein and cholesterol was determined. It was revealed hemoglobin concentration varied within 99.5-106.8 g/l, total protein – 33.2-38.0 g/l, cholesterol – 2.6-3.2 mmol/l, i.e. within physiological norms.

Calculations showed that 1.73-1.87 kg of compound feed (i.e. within zootechnical norms) were spent in experiments to obtain 1 kg of live weight gain of broiler chickens. For 1 ruble of expenses only 0.6-1.2 rubles of additional production were received.

Conclusion
1. The addition of “Permait” preparation to the feed at a dose of 2% of the dry matter of the feed contributes to an increase in the growth rate of the experimental birds by 9.1 - 10.7% (p<0.05) with a slight increase in the slaughter of meat and a decrease in the cost of feed for unit of increase in live weight compared with the indicators of the control groups. This dose is recommended to be used in compound feeds used in the technology of growing broiler chickens.

2. The use of the preparation of vitamin B13 from 5 to 20 mg per 1 kg of complete feed does not noticeably affect the growth rate. The meat productivity of broiler chickens is not economically justified. The question of the advisability of using potassium orotate in poultry production requires further research.

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