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## Calcium And Phosphorus Feed Supplement FAX-2 In The Feeding Of Laying Hens Of Industrial HERD.

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### ABSTRACT

The effectiveness of new mineral supplement FAX-2 in the feeding of laying hens is studied, its optimal dose of inclusion in complete feed is determined. The influence of FAX-2 on the egg production of hens, their safety and payment for feed with products was studied. It is established that it promotes increase of use of calcium and phosphorus, improves a physiological condition of an organism of hens; reduces expenses of a forage for eggs production. At the same time their quality improves. It is shown that when it is included in the standard feed at a dose of 6 % from weight of the diet, the safety is increased by 6 %, the feed costs are reduced by 1.8 %; egg production increases by 3 %. The use of this additive in the feed increases the economic performance of the poultry industry, in particular the level of profitability increases by 8.3 %.

**Keywords:** laying hens, FAX 2, feed supplement, livestock preservation, feed costs, blood parameters, egg production, economic efficiency.

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## RELEVANCE OF THE THEME

Numerous studies conducted in our country and abroad in different years proved the need for additional implementation into the diets of farm animals and poultry, as individual micronutrients and their complexes [17]. However doses of the guaranteed additives of microelements which are now applied in poultry farming are uniform for a bird of different types, age, type of productivity, and also for various natural zones of the country and are made without the maintenance of microelements in the main components of forages [3, 4, 5, 8, 10, 19]. Therefore, scientists are faced with the objective to clarify the norms of micronutrients in the diet, depending on the climatic zone, species, age, physiological state and productivity of birds.

The objective of finding new sources of mineral nutrition cheap and containing elements in a more accessible form is also relevant. At present, carbonates, sulfates and oxides of micronutrients are the most widely used in poultry farming. But due to the growing need of the industry for rare metals, it becomes difficult to provide agricultural production with these compounds of micronutrients. With this in mind, in recent years, the attention of scientists is directed to the use of unconventional sources of minerals in poultry feeding [14]: various geological deposits, industrial waste, etc. One of these additives is the phosphorus-calcium supplement FAX-2 – waste in the production of inorganic acids from local mineral raw materials [1, 2, 7, 12, 13, 16,].

**The aim of the research:** The aim of our research was to study the impact of the supplement FAX-2 on the zootechnical indicators of laying hens, such as live weight, safety and feed costs, the study of the blood picture, as well as the egg production of birds and economic indicators of the industry.

## MATERIAL AND METHODS OF RESEARCH

Studies were conducted on laying hens of cross “Highsex brown” with 151 to 450 days of age in the conditions of the poultry farm CJSC “Bekhtevskoe” (Agrofirm “Rus”) Koroichansky district of Belgorod region. The bird was kept in three-tier cell batteries of the CBN type in accordance with the established by RSRIPIF standards for density of placement. Groups of birds were formed on the principle of analogues taking into account age, live weight and clinical condition.

As the main diet, dry complete feed was used, the nutritional value of which corresponded to the recommendations of RSRIPIF on feeding of agricultural poultry. Vitamins and microelements were dosed according to recommendations on vitamin nutrition of farm animals and poultry. The diet of laying hens of the control (first) group fully corresponded to the above recommendations, in the diets of hens of the experimental (second, third, fourth and fifth) groups a mineral supplement FAX-2 in the amount of 2, 4, 6 and 8 % of the diet weight was additionally included.

FAX-2-feed mineral supplement-is a complex of minerals, the main of which are phosphorus and calcium. It is a by-product in the production of inorganic acids (phosphoric and hydrochloric) from local raw materials – natural zeolites and bentonite clays. FAX-2 is a fine-grained flowing powder of light gray color. The chemical composition of the new additive is as follows: phosphorus (P) – 3.9 %, calcium (Ca) – 17.5, nitrogen (N<sub>2</sub>) – 3.5, sulfur (SO<sub>4</sub><sup>2-</sup>) – 14.0 %. Total organic minerals contain 38.9 %; pH of 1% solution-4; mass fraction of moisture-2 %.

During the experiment, the following parameters were studied: clinical-physiological state of the bird– by its daily inspection; attention was paid to the general behavior, feed eatability, mobility, plumage, pigmentation of the legs, development of the crest; safety of the livestock – on the basis of data of daily accounting of the fallen and selected birds; live weight of laying hens–by individual weighing; feed costs for the formation of 10 eggs–by daily accounting of feed eatability and for the entire period of experience.

At the age of 151 days the slaughter of birds with 5 heads from each group is carried out. The blood was investigated, in which the following was determined: the number of red blood cells and white blood cells – by counting method in the Goryaev camera; hemoglobin – by hemiglobincyanide method; total protein – by biuret reaction; calcium – by titrometric method according to de Waard; phosphorus – by colorimetric method

with vanadate and molybdenum reagent; glucose – by color reaction with ortho-toluidine; total lipids – with sulfopropylaniline reaction (according to Zolner and Kirsch).

**RESEARCH RESULTS AND THEIR DISCUSSION**

In the course of studies it was found that the clinical and physiological state of the experimental birds is normal. They are well developed, moderately mobile, eat up actively food, and respond adequately to external stimuli. As the term of keeping of laying hens increased, their live weight grew (table 1).

**Table 1 – Dynamics of live weight of laying hens, g**

Bird age, months	Control group - 1	Experimental groups			
		2	3	4	5
7-8	1887,5±1,8	1903,0±2,1	1908,4±1,2	1917,5±1,6	1892,5±1,6
9-10	1945,2±2,6	1967,8±2,4	1968,4±1,8	1983,3±2,4	1951,3±1,6
11-12	2012,3±2,3	2032,2±2,3	2036,2±2,6	2034,2±1,2	2022,0±2,1
15-16	2081,5±2,4	2112,7±3,2	2117,5±2,8	2097,4±2,8	2103,4±3,1

In all age periods, the live weight of hens in the experimental groups is higher than in the control group; at the same time, the difference increases with age. Thus, at the age of 7-8 months the live weight of laying hens of experimental (second, third, fourth and fifth) groups is higher by 15.5 g, 20.9, 30 and 5 g, respectively, than in the control group. At 15-16 months these differences were respectively 31.2 g, 36, 15.9 and 21.9 g. Interesting dynamics was observed in live weight of hens of the experimental groups. At the age of 7-8 months the greatest live weight (1917.5 g) is characteristic of the bird of the fourth experimental group (6% FAX-2), the smallest – 1892.5 g – the fifth experimental group (8 %). The same tendency is observed at the age of 9-10 months. At the age of 11-12 months, the live weight of laying hens of the second, third and fourth groups is practically equalized-2032.2, 2036.2 and 2034.2 g. This is, respectively, 10.2, 14.2 and 12.2 g higher than that of hens of the fifth experimental group; however, the difference between the first three groups and the fourth is not much less than in the first age periods. By the end of oviposition, at the age of 15-16 months, the highest live weight (2117.5 g) is characteristic of the hens of the third experimental group (4% FAX 2), somewhat less – 2112.7 g in hens of the second experimental group (2 % FAX-2); indicators of the fourth (6 %) and fifth (8 %) groups (2097.4 g and 2103.4 g) are lower than in the birds of the first two experimental groups. It should also be noted that the live weight of laying hens of the fifth experimental group exceeds the fourth, which was not observed in the early age periods.

Thus, the inclusion in the diet of laying hens a new mineral supplement FAX-2 contributes to the increase in live weight of birds. This trend is evident in all experimental groups. The best indicators on live weight in laying hens are in the third experimental group (4% FAX-2).

It should also be noted that in the early stages of egg production (the age of hens 7-10 months), a greater influence is exerted by the average doses of supplement (4 and 6 %), after passing the peak of egg production and before its end – smaller doses of 2 and 4 %, and the live weight of birds receiving additionally 8% FAX-2 sharply increases. This trend can be used at using second-year hens in the second year of production.

The use of mineral supplements contributes to the viability of laying hens and, as a consequence, its safety (table 2).

**Table 2 – Safety of laying hens, %**

Period	Control group - 1	Experimental groups			
		2	3	4	5
The beginning of oviposition	98,0	98,5	99	99	99
The peak of oviposition	92,7	94,3	98,3	98,3	95,7
Final oviposition period	86,2	87,8	92,4	95,0	90,2
In average	90,5	91,9	95,5	96,8	93,6

It should be noted that in all studied periods the safety of hens of the experimental groups receiving the supplement FAX-2 is higher than the safety of hens of the control group. Thus, at the beginning of oviposition, the difference was 0.5 %, 1.1 and 1%, respectively, for the second, third, fourth and fifth experimental groups. At the peak of egg production, the difference increases to 1.6 %, 5.6, 5.6 and 3.0 %, respectively, and even more in the final oviposition period – to 1.3%, 6.2, 8.8 and 4%, respectively. In general, during the study period, the safety of laying hens of the experimental groups is higher than the control, respectively, for the second, third, fourth and fifth by 1.4%, 5, 6.3 and 3.1 %. Comparing with each other indicators of safety of birds of experimental groups it should be noted that throughout the cycle of oviposition it is higher in the third (4% FAX-2) and fourth (6% FAX-2) groups. The lowest safety of the experimental groups is typical for the second, the birds of which were received the lowest dose of FAX-2 – 2 %.

Thus, the use of a new mineral supplement FAX-2 in the diets of laying hens contributes to the viability and safety of livestock.

The indicator of the effectiveness of the new supplement FAX-2 is data on feed costs for the production of ten eggs. Some contradictory data were obtained (table 3).

**Table 3 – Feed consumption per 10 eggs formation, g**

Period	Control group - 1	Experimental groups			
		2	3	4	5
The beginning of oviposition	1,55	1,55	1,55	1,55	1,55
The peak of oviposition	1,65	1,65	1,63	1,63	1,66
Final oviposition period	1,70	1,69	1,68	1,67	1,72
In average	1,633	1,630	1,620	1,616	1,643

At the beginning of the cycle of oviposition, the indicator remained at the same level in all the experimental groups of laying hens at 1.55 kg. With the peak of egg production, these indicators vary slightly depending on the dose of supplement FAX-2. Thus, the lowest feed costs for the production of 10 eggs (1.63 kg) were observed in hens of the third and fourth experimental groups, which received additionally 4 and 6% of supplement, respectively. This is by 20 g (1.2 %) less than in the control group and in the second experimental group (2% FAX-2). The highest feed costs (1.66 kg) are typical for hens of the fifth experimental group, whose rations additionally included 8% FAX-2. This trend continues until the end of the oviposition cycle. The lowest feed costs are in laying hens of the fourth experimental group (6% FAX-2) – 1.67 kg and the third (4% FAX -2) – 1.68 kg. This is 20 and 10 g less than in the second experimental group (2% FAX-2), 30 and 20 g less than in the control group and 27 and 23 g than in the fifth experimental group (8% FAX-2).

Thus, the data obtained by us show that the inclusion of a new mineral supplement in the diet of laying hens helps to reduce the cost of feed for egg production. At the same time, the best results are given by the average doses of the additive – 4 and 6%, while low (2 %) and high (8 %) have the opposite effect, and feed consumption increases slightly.

The noted positive trends can probably be linked: firstly, with the increase in the biological availability of calcium from FAX-2; secondly, with the stimulating effect of nitrogen, which is part of FAX-2, on the digestion processes due to the activation of a number of hydrolytic enzymes; thirdly, with a more effective transformation of feed nutrients into eggs. Our opinion is consistent with the data of a number of authors, who note the positive effect of mineral compounds together with protein on the processes of digestion and use of nutrients feed as a whole. At the same time, moderate dosages have a greater effect. As conducting studies show the level of calcium in the diet of laying hens is of great importance for efficient use of forage. It is with this we associate the reduction in feed costs in the fourth and third experimental groups; the level of calcium in the diet of the second experimental group was insufficient, and the fifth experimental group was overestimated for more efficient use of feed.

The methods that allow giving an objective assessment of the physiological state and level of metabolic processes in animals and birds include blood tests. Blood takes a direct part in specific and non-specific reactions of the body, affects its resistance and reactivity, while sensitively reacting to the various

effects to which the body is exposed. Blood is a liquid tissue of the body, which reflects its physiological state as in a mirror. In violation of the functions of any organs and tissues, poisoning, infectious diseases, the development of local or general pathological conditions the morphological and biochemical composition of the blood is changed. Changes in the blood picture occur at changing or violations of the conditions of maintenance and feeding of farm animals and birds [6, 9, 11, 15, 17, 18]. Improved feeding of birds should also affect the blood picture.

In the conducted researches it is established that inclusion in a diet of laying hens additionally a new mineral supplement FAX-2 does not cause sharp deviations during exchange processes in a bird (table 4).

**Table 4 - Blood parameters of laying hens**

Parameter, mmol/l	Groups				
	control - 1	experimental			
		2	3	4	5
Total calcium	4,75±1,12	4,82±0,84	5,32±1,16	6,03±1,12	5,49±0,86
Inorganic phosphorus	1,34±0,04	1,36±0,02	1,44±0,06	1,68±0,04	1,35±0,06
Glucose	10,45±1,24	10,52±0,84	10,54±0,76	10,73±1,14	10,29±0,74
Total lipids	4,02±0,46	3,86±0,22	3,92±0,34	4,44±0,54	4,31±0,62
Total protein, g/l	46,80±2,54	48,20±1,44	49,60±1,58	50,20±1,68	52,50±1,02

The concentration of total protein in serum is a very stable value and varies significantly only with deep metabolic disorders. In this regard, there were no significant differences in the total protein content in the blood of experimental hens. In the blood of laying hens of the experimental groups compared to the control total protein content increases: in the second – by 3 %, in the third – by 6, in the fourth – by 7.3 and in the fifth – by 12.2 % ( $p \leq 0.05$ ). There was a trend of increasing total protein level depending on a dose FAX-2 supplement in the diet. Perhaps this can be explained by the presence of nitrogen in it, which is involved in the metabolism of nutrients, and if it is higher in the supplement, the better the metabolism of proteins is, and increased its content in blood of experimental birds.

The state of protein metabolism can also be judged by the ratio of albumin and globulin fractions of total protein. On average, globulins are by 10-40% more. In our experiment, the albumin / globulin ratio is almost the same in all experimental groups (0.41-0.44 / 1). At the same time, there were minor changes in the globulin fraction of the total protein. Thus, in the blood of hens of experimental groups receiving additionally FAX-2  $\alpha$ - and  $\beta$ -globulins were slightly more (the difference is unreliable). At the same time, the concentration of  $\gamma$ -globulins is higher in the blood of hens of the control group (the difference is also unreliable). The total content of globulins in the blood of birds is almost the same in all groups.

An interesting trend can be seen in the content of total lipids and glucose in blood. So, at including in the diet small doses of supplement (2 and 4% FAX-2) there is a decrease (by 4.1% and 2.5%) of level of total lipids in the blood. Their highest concentration – 4.44 mmol/l – is typical for the fourth experimental group, laying hens of which received additionally 6% FAX-2; the maximum dose of the supplement (8 %) contributes to an increase in the level of total lipids compared to the control, second and third experimental groups, but is inferior to the fourth experimental group (6% FAX-2). Obviously, the lipid metabolism is most influenced by the average (5-7 %) doses of the supplement, and small and large are critical.

Fat metabolism is closely related to carbohydrate one. Increasing the concentration of glucose in adipose tissue and increasing the rate of glycolysis inhibit lipolysis. Increasing the concentration of glucose in the blood stimulates insulin secretion, which also leads to inhibition of lipolysis. Thus, when the body receives a sufficient amount of carbohydrates and the rate of their cleavage is high, the mobilization of NEFA and their oxidation go at a reduced rate. As soon as the carbohydrate reserves are depleted and the intensity of glycolysis decreases, there is an increase in lipolysis, as a result of which tissues receive increased amounts of fatty acids for oxidation. However, an increase in the content of long-chain fatty acids in the blood causes a decrease in the intensity of glucose utilization and oxidation, for example, in muscles. All this indicates that the

fat and carbohydrate metabolism, which are the main energy-forming processes in the living body, so closely related to each other that many factors affecting one type of exchange, directly or indirectly affect the other.

Thus, in our studies, the highest level of glucose is characteristic of the fourth experimental group, the birds of which received additionally 6% of FAX-2 supplement. It is by 0.28 mmol/l (2.7 %), 0.21 (2), 0.19 (2) and 0.44 mmol / l (4.3 %) higher than, respectively, in the control and in the second, third and fifth experimental groups. The lowest blood glucose content was observed in laying hens of the fifth experimental group, receiving additionally maximum number of FAX-2 – 8 % of all the experimental groups. It should also be noted that the level of glucose in the blood of all experimental groups exceeds the value of the control group, which indicates a positive effect of the new mineral supplement FAX-2 on carbohydrate metabolism.

In the study of blood, we were more interested in the indicators of calcium and inorganic phosphorus, as the main components of the supplement. In all experimental groups they are higher than in control. At the same time, the increase in the dosage of the supplement FAX-2 contributes to a gradual increase in the concentration of calcium and inorganic phosphorus in the serum of laying hens. However, this occurs only at small and medium doses of the supplement (2-6 %); with the inclusion in the diet an increased amount of FAX-2 (8%), the content of calcium and especially inorganic phosphorus is significantly reduced. The best results were observed in the fourth experimental group, in which in the diet of hens 6% FAX-2 was additionally included. Total calcium is higher by 1.28 mmol/l (27 %), 1.21 (25.1), 0.71 (13.3) and 0.54 mmol / l (9.8 %), than respectively in the control and in the second, third and fifth experimental groups; inorganic phosphorus – by 0.34 mmol/ l (25.4 %), 0.32 (23.5), 0.24 (16.7) and 0.33 mmol / l (24.4%), respectively.

The data obtained by us are comparable with the results of studies that investigating natural mineral substances found that they have a positive effect on blood parameters and the absorption of feed minerals. The advantage of such complexes is due to their greater biological availability. Also according to the literature, the content of calcium in the blood of birds during the egg-laying period is increased due to the fractions associated with organic components, in particular, such as serum vitellin. At the same time, calcium fractions associated with albumins and globulins necessary for the synthesis of egg components can play a certain role in increasing calcium. An indirect confirmation of this in our experiment is a parallel increase in the total protein content in the blood of experimental hens compared with the control.

In general, a higher level of mineral elements in the blood serum and, in particular, calcium, in laying hens of the experimental group receiving FAX-2, can be associated with greater productivity of birds. Thus, in numerous studies there was a close positive correlation between the content of calcium, phosphorus in the blood of hens and their productivity.

Analyzing the content of mineral elements in the blood, it is necessary to take into account that the blood, which provides a humoral connection between the organs, has a relatively constant composition. In maintaining a certain level of serum mineral composition, along with the activity of the intestinal mucosa and renal tubules, an important role belongs to the processes of mineralization and resorption of bone tissue. Regulation of bone resorption in physiological conditions should provide two functions, namely: the preservation of the skeleton as a structural system, which is constantly being rebuilt, and the performance of the metabolic role in mineral homeostasis.

The use of the new supplement FAX-2 in the diet of laying hens had a positive impact on their productivity (table 5). The highest egg production (90.47 %) during the study period is typical for the hens of the third experimental group, which in addition to the diet received 4% of the supplement “FAX-2”. This is 2.22 % higher than in the control group and 0.44 %, 1.19% and 2.49%, respectively, than in the fourth, second and fifth experimental groups. At the same time, the egg production of hens of the fifth experimental group, receiving 8 % “FAX-2” additionally is lower than that of other groups.

**Table 5 – Egg production of laying hens, %**

Period	Control group - 1	Experimental groups			
		2	3	4	5
The beginning of oviposition	84,1	84,2	85,2	85,2	84,9
The peak of oviposition	95,4	95,3	96,2	96,3	93,8
Final oviposition period	85,5	87,6	89,1	88,1	85,7
In average	88,2	89,3	90,5	90,0	88,0

Laying hens of the third experimental group is characterized by a more stable egg production. They have the smallest difference in periods.

Thus it can be stated that the use of mineral preparation “FAX-2” for laying hens has a positive effect on their productivity. According to the results of the studies, the best indicators are typical for laying hens of the third and fourth experimental groups, which additionally received 4 and 6% of the mineral supplement “FAX-2” in the diet.

Any technological method is considered economically feasible if the income received from the sale of products not only reimburses the costs associated with the production of goods, but also provides additional net income.

Taking into account the egg laying capacity of laying hens, the cost of egg production and the cost of supplement, the greatest economic efficiency was noted in the third and fourth experimental groups, the bird of which in addition to the diet received respectively 4 and 6% of FAX-2 supplement. The profitability level in these groups was 39.6% and 39.4%, respectively. This is 1.2 and 1.0 % higher than in the control group, 1.9 and 1.7% higher than in the first group and 6.5 and 6.3% higher than in the fifth experimental group.

Thus, the most optimal dose of the supplement FAX-2 is 4-6 %. The use of such doses increases the egg production of birds, the gross production of eggs and, as a consequence, the economic efficiency of the poultry industry. Small doses (2 %) and especially high (8 %) do not have the desired effect. Egg production is reduced, the total number of eggs is reduced, costs increase (especially at high doses of supplement) and the economic performance of the industry is sharply reduced.

**CONCLUSIONS**

On the basis of the conducted research, the following conclusions can be drawn:

1. The inclusion of a new mineral supplement FAX-2 in the diet of laying hens contributes to the increase of live weight of birds. This tendency is observed in all experimental groups. The best indicators on live weight in laying hens are in the third experimental group (4% FAX-2).

2. Safety of laying hens of experimental groups is higher than control by 1.4-6.3 %. It is the highest (95.5% and 96.8%, respectively) in the third (4% FAX-2) and fourth (6% FAX-2) groups; the lowest (91.9%) – in the second (2% FAX-2).

3. The lowest feed costs for the production of 10 eggs (1.616 kg) in hens of the fourth experimental group, receiving additionally 6% of the supplement. This is 17 g (1.1 %) less than in the control group. The highest feed costs are in the second (1.63 kg) and especially the fifth (1.643 kg)

4. In the blood of laying hens of experimental groups the total protein content increases (respectively by 3-12.2 %); glucose– by 2-4.3 % . The highest concentration of total lipids – 4.44 mmol/l – is in the blood of birds of the fourth experimental group, where they received 6% of FAX-2 additionally.

5. The best results on the content of calcium and phosphorus are in the fourth experimental group, hens in which additionally received 6% FAX-2 in the diet. Total calcium is higher by 0.54-1.28 mmol/l (9.8-27%) than in the control and experimental groups; inorganic phosphorus – by 0.24-0.34 mmol / l (16.7-25.4 %).

6. When feeding with FAX-2 the content of red blood cells increases by 0.9-4.9% and hemoglobin – by 0.5-3.6 % in the blood of hens of experimental groups compared with the control.

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