



# Changes in the Physiological Status of Agricultural Animals and Poultry under the Influence of Biologically Active Additives

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**Abstract** | The article presents and describes the results of using biologically active additives in the diets of farm animals and poultry. During the experiments, a positive effect of introducing a protein vitamin-mineral concentrate (PVMC) and a premix based on the Sarepta feed concentrate obtained from vegetable raw materials into the diets of calves, young chickens, and broiler chickens was discovered. The use of the developed premix allowed increasing the content of erythrocytes in the blood of calves by 0.35 %, of hemoglobin – by 3.28 %, of protein – by 1.77 %, of calcium – by 2.22 %, and of phosphorus – by 1.68 %. It should be noted that the average daily live weight gain of the unweaned calves increased by 3.36 %; the live weight at the end of the experiment with the unweaned calves in the experimental group was higher by 2.24 % than that in the reference group. During the second experiment with young laying hens, positive results have also been obtained. With the introduction of the premix based on the feed concentrate obtained from the Sarepta vegetable raw material, the content of erythrocytes in the blood of the young hens increased by 1.3 %, of total protein – by 6.34 %, of glucose – by 4.93 %, and of calcium and phosphorus – by 12.5 %. It should be noted that the average daily live weight gain of the young chickens in the experimental group was higher than that in the reference group by 6.93 %, and the total live weight gain – by 7.0 %. During the third experiment with broiler chickens, the following positive results have been obtained. The use of the PVMC based on the Sarepta concentrate developed by the authors resulted in the increase in erythrocytes in the blood of broiler chickens by 8.67 %, total protein – by 1.75 %, calcium – by 5.82 %, and phosphorus – by 7.74 %. With that, the average daily live weight gain of the broiler chickens in the experimental group was higher than that in the reference group by 10.27 %, and the total live weight gain was higher by 10.37 %. Based on the performed research, it is possible to recommend introducing the premix and the PVMC based on the Sarepta concentrate as filler into the diets of farm animals and poultry with the aim of intensifying the metabolic processes in their organism, as confirmed by the provided data about productivity and proven in hematological studies.

**Keywords** | Calves, Young chickens, Broiler chickens, Combined feed, Premix, Protein vitamin-mineral concentrate (PVMC), Live weight

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## INTRODUCTION

The problem of providing high-quality and safe food for the population of Russia has been a priority in recent years. Improving the quality of combined feeds and improving their biological value is one of the main ways to

materialize the productive potential of agricultural animals and poultry (Brukhno et al., 2014; Lipova et al., 2014).

First of all, ensuring normal vital functioning and high productivity of agricultural animals and poultry requires high standards on the feed (Khosravinia, 2016). Meeting

this requirement is possible through providing combined feed for the poultry, which is balanced in nutrients and bioactive substances, with the use of highly efficient special additives (premixes and PVMC), which will allow improving the digestibility and assimilation of nutrients, improving the productivity, and reducing feed consumption per unit of product (Sherstyugina and Lipova, 2015; Ahmadipour et al., 2015). They also have a positive effect on the process of animals and poultry reproduction, contribute to preventing the diseases associated with vitamins and minerals deficiency (Vodyannikov and Shkalkenko, 2017; Karapetyan et al., 2014). Due to the activation of the enzyme, hormonal and immune systems, the productivity of livestock increases, the preservation rate of young animals improves as well as the health of agricultural animals and poultry (Tancharoenrat and Ravindran, 2017).

The research is aimed at studying the effect of the premixes and the PVMC on the physiological status of farm animals and poultry through the use of the Sarepta fodder concentrate for feeding young cattle and poultry.

## MATERIALS AND METHODS

Before a series of scientific and economic experiments on animals and poultry, the authors studied the chemical composition and the technological properties of sunflower cake and the Sarepta fodder concentrate.

After that, a series of experiments were performed that were aimed at determining the efficiency of using premixes and the PVMC in the diets of young farm animals and poultry. In 2012–2017, the studies were performed at the leading livestock and poultry-breeding farms in the Volgograd region.

Experimental groups were formed according to the method of zootechnical experiments (calves by the method of analog pairs, poultry by the method of analogs); the age, the physiological condition, the productivity, the health status, the live weight, etc. were taken into account.

In the scientific-economic experiment on broiler chickens of Cobb 500 cross, two groups (control and experimental) of one-day chickens were formed, 50 chickens in each group. The duration of the experiment was 42 days.

For the experiment with young chickens of Hisex brown cross, reference and experimental groups were formed, 54 chickens in each. The experiment was performed in the age of the chickens from one day to 120 days.

To study the effect of the premix based on the Sarepta fodder concentrate on the hematological parameters of

black-motley unweaned calves, two groups (reference and experimental) were formed, 15 animals in each group.

The morphological indicators of blood were determined by counting the erythrocytes and leukocytes in the Goryaev's camera, biochemical indicators in the blood serum, and the content of total protein, glucose, albumin, calcium, phosphorus by spectrophotometry on KFK-3-01.

Over the period of the research, in addition to the hematological parameters, productive qualities of the unweaned calves, broiler chickens and laying hens were taken into account.

The obtained data were processed biometrically according to the method of N.A. Plokhinsky with the use of Microsoft Excel. The veracity of the differences between the attributes was determined by matching with the Student's t-criterion, with that, three confidence thresholds were identified (\*  $R > 0.95$ , \*\*  $P > 0.99$  and \*\*\*  $P > 0.999$ ).

The general scheme of the research is shown in Figure 1.

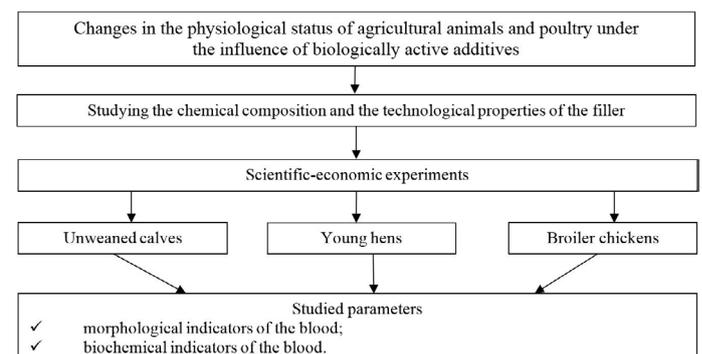


Figure 1: General scheme of the research.

## RESULTS AND DISCUSSION

In the Volgograd region, Sarepta mustard variety is grown. By pressing its seeds, mustard oil is obtained, which is known for its high taste qualities. The product of processing the seeds is mustard cake. However, this waste product contains anti-nutritional substances that affect the health and productivity of farm animals and poultry. Scientists of the Volgograd State Agrarian University proposed a method of neutralizing mustard cake by hydrobarothermal processing, whereby the anti-nutritive substances decomposed.

Thus, the processed mustard cake was named Sarepta Feed Concentrate from Vegetable Raw Materials. This fodder product is a loose powder. It is nonhygroscopic, does not fume, and retains the stability of its properties within six months of storage, its pH being close to neutral (6.7–6.9).

Thus, Sarepta concentrate by the pH level, the moisture, the content of fiber and fat, by the availability of fodder properties, flowability, caking ability and absence of tendency to fuming is not inferior to the traditionally used fillers.

After analyzing the chemical composition of the Sarepta fodder concentrate, the authors came to the conclusion that this fodder product has high feeding value (Table 1).

Based on the data shown in Table 1, fodder concentrate Sarepta is superior to sunflower cake in terms of the content of crude protein by 8.5 %, and of crude fat by 0.1 %. The sum of amino acids in sunflower cake is 19.13 %, while in fodder concentrate Sarepta 25.54 %, which is higher than in sunflower cake by 6.41 %.

**Table 1: Comparative chemical composition of sunflower cake and the Sarepta fodder concentrate, %.**

| Indicator                  | Content, % |             |           |               |                                     |
|----------------------------|------------|-------------|-----------|---------------|-------------------------------------|
|                            | Crude fat  | Crude fiber | Crude ash | Crude protein | Nitrogen-free extractive substances |
| Sunflower cake             | 7.9        | 12.9        | 6.7       | 30.5          | 31.0                                |
| Fodder concentrate Sarepta | 8.0        | 11.5        | 6.5       | 39.0          | 27.2                                |

During the laboratory research it has been found that sunflower cake and fodder concentrate Sarepta meet the basic requirements for fillers in premixes and PVMC.

Employees of the Department of Feeding and Breeding Agricultural Animals of the Volgograd State Agricultural University, together with the Megamix company have developed a recipe of new PVMC (S) and premix (S) based on the Sarepta fodder concentrate obtained from vegetable raw materials for calves, young chickens, and broiler chickens.

The first scientific and economic experiment was performed with unweaned calves. Two groups of one-month-old calves with the average live weight of 45–50 kg, 15 calves in each, were formed.

The experimental animals received premixes in the main diet: e.g., the calves in the reference group received standard premix (P) (with sunflower meal as the filler), in the experimental group, the calves received premix (S) based on the Sarepta fodder concentrate.

The adequacy of feeding may be determined not only by the zootechnical indicators but also by more specific biochemical and morphological indicators, such as the content of erythrocytes, leukocytes, total protein, glucose, calcium, and phosphorus in the blood of the animals.

Changes in the protein, carbohydrate, mineral exchanges that occur in poultry may be determined by studying the biochemical and morphological parameters of the blood (Mutucumarana et al., 2014). It is known that the mediator between the cells of the organism and the external environment is blood. It delivers nutrients to the cells and carries away the products of metabolism (decomposition). The hematological parameters of the experimental animals are shown in Table 2.

**Table 2: Hematological parameters of the experimental calves (M±m).**

| Indicator                         | Group         |                |
|-----------------------------------|---------------|----------------|
|                                   | Reference     | Experimental   |
| Erythrocytes, 10 <sup>12</sup> /l | 5.77 ± 0.52   | 5.79 ± 0.051   |
| Leukocytes, 10 <sup>9</sup> /l    | 7.80 ± 0.40   | 7.90 ± 0.30    |
| Hemoglobin, g/l                   | 112.80 ± 1.30 | 116.50 ± 1.45* |
| Total protein, g/l                | 67.70 ± 0.43  | 68.90 ± 0.53*  |
| Calcium, mmol/l                   | 2.25 ± 0.03   | 2.30 ± 0.05    |
| Phosphorus, mmol/l                | 1.79 ± 0.06   | 1.82 ± 0.10    |

Note: \*P > 0.95.

The erythrocytes count in the reference group of calves was 5.77\*10<sup>12</sup>/l, and in the experimental group 5.79\*10<sup>12</sup>/l, which was more by 0.02\*10<sup>12</sup>/l (0.35 %). The level of total protein in the calves in the reference group was 67.7 g/l, in the experimental 68.9 g/l, which was more by 1.2 g/l (1.77 %) than in the reference group. Hemoglobin in the blood of calves in both groups was within the physiological norm; in the reference group it amounted to 112.80 g/l, and in the experimental group to 116.5 g/l, which was higher than in the reference group by 3.28 %. The content of calcium in the experimental group was higher by 2.22 % than in the reference group, and that of phosphorus in the reference group by 1.68 % lower than in the experimental group.

The use of the premix based on the Sarepta feed concentrate obtained from vegetable raw materials in feeding the calves had a positive effect on their live weight gain. The data of monthly weighing over the six months of calves rearing showed that the average daily gain in the calves in the reference group was 633.50 g; in the experimental group 651.67 g. At the end of the experiment, the animals in the groups weighed 144.10 kg and 146.61 kg, respectively.

Thus, the premix based on the Sarepta feed concentrate obtained from vegetable raw materials introduced into the diet of calves had a positive effect on their live weight and physiological state.

Next, the authors performed the research with young chickens of the Hisex brown cross. Two groups of one-day-old chickens were formed for the scientific-economic

experiment, 54 chickens in each. The conditions of keeping, feeding and watering, the microclimate in the experimental groups were identical and corresponded to the recommendations for the cross.

During the experiment, the young chickens in the reference group received the standard diet used at the poultry farm, where sunflower cake was used as the filler for the premix, and the chickens in the experimental group received the combined feed with premix (S) based on the Sarepta fodder concentrate.

The biochemical and morphological blood indicators indicate the overall state of the organism, and its physiological processes (Sherstyugina, 2016; Yun et al., 2017). In the organisms of poultry, blood performs various functions, delivering the necessary substances to the cells and carrying away the products of metabolism, thus implementing the key process of metabolism in a living organism. Studying the biochemical parameters of the blood when testing various fodders and feed additives is of great importance since changes in the metabolic processes primarily result in changes in the blood composition (Gopinger et al., 2014). The biochemical and morphological indicators of blood in the experimental young hens are shown in Table 3.

**Table 3:** Morphological and biochemical composition of the young hens' blood (M± m).

| Indicator                         | Group        |              |
|-----------------------------------|--------------|--------------|
|                                   | Reference    | Experimental |
| Erythrocytes, 10 <sup>12</sup> /l | 3.08 ± 0.04  | 3.12 ± 0.06  |
| Leukocytes, 10 <sup>9</sup> /l    | 27.11 ± 0.51 | 27.59 ± 0.72 |
| Total protein, g/l                | 47.3 ± 0.82  | 50.3 ± 2.02  |
| Glucose, mmol/l                   | 14.2 ± 1.02  | 14.9 ± 0.26  |
| Calcium, mmol/l                   | 2.6 ± 0.24   | 2.8 ± 0.073  |
| Phosphorus, mmol/l                | 1.6 ± 0.2    | 1.8 ± 0.06   |
| Albumin, g/l                      | 18.5 ± 0.93  | 20.0 ± 0.97  |
| Cholesterol mmol/l                | 3.3 ± 0.18   | 3.8 ± 0.22   |

The results of these studies of the blood of the experimental young hens show that the indicators were within the physiological norm.

However, the erythrocytes count in the blood of the young chickens in the experimental group was higher by 0.04\*10<sup>12</sup> l (1.3 %) compared to the reference. The content of calcium in the blood of the young hens in the reference group was 2.6 mmol/l, in the experimental group 2.8 mmol/l, which was higher by 0.2 mmol/l; the content of phosphorus in the blood of the young hens in the experimental group exceeded the reference value by 0.2 mmol/l. Thus, no violations were found in the metabolism of the young hens,

which indicated the adequacy of their feeding.

By the results of the experimental weighing of the young hens by the age of 120 days in the reference group, the live weight amounted to 1,453 g, and in the experimental group to 1,551 g, which was higher by 6.74 % than in the reference group. The average daily live weight gain of the poultry in the experimental group was higher by 6.93 % than in the reference group. With that, the population preservation rate was 100 %.

Next, the authors performed the scientific-economical experiment with broiler chickens of the Cobb 500 cross. The poultry in the reference group received the combined feed used at the farm, which contained PVMC (P) with standard filler (sunflower cake), and the poultry in the experimental group received the PVMC (S) with the Sarepta filler.

The introduction of the PVMC (S) into the composition of the feed had a positive effect on the hematological parameters of the broiler chickens' blood (Table 4).

**Table 4:** Morphological and biochemical composition of the broiler chickens' blood, (M±m).

| Indicator                         | Group        |                 |
|-----------------------------------|--------------|-----------------|
|                                   | Reference    | Experimental    |
| Erythrocytes, 10 <sup>12</sup> /l | 3.00 ± 0.16  | 3.26 ± 0.12     |
| Leukocytes, 10 <sup>9</sup> /l    | 32.30 ± 0.66 | 32.69 ± 0.51    |
| Total protein, g/l                | 53.23 ± 0.73 | 54.16 ± 0.53    |
| Albumin, g/l                      | 24.07 ± 0.24 | 24.41 ± 0.31    |
| Glucose, mmol/l                   | 11.30 ± 0.15 | 12.40 ± 0.32*** |
| Calcium, mmol/l                   | 3.95 ± 0.07  | 4.18 ± 0.07*    |
| Phosphorus, mmol/l                | 1.68 ± 0.01  | 1.81 ± 0.09     |

Note: \*P > 0.95; \*\*\*P > 0.999.

Erythrocytes count in the blood of the broiler chickens in the experimental group was greater by 0.26\*10<sup>12</sup> l (8.67 %) than in the reference group.

The content of total protein in the blood of the chickens in the reference group was 53.23 g/l, in the experimental group 54.16 g/l, which was higher than in the reference group by 0.93 g/l (1.75 %). The content of calcium in the blood of the broiler chickens in the reference group was 3.95 mmol/l, and in the experimental group this indicator exceeded that in the reference group by 0.23 mmol/l (5.82 %), and amounted to 4.18 mmol/l; the content of phosphorus in the blood of the broiler chickens in the experimental group was higher than in the reference group by 0.13 mmol/l (7.74 %).

The average daily live weight gain of the broiler chickens in

the experimental group was higher, compared to the reference group, by 10.27 %, which resulted in higher indicators of the total live weight gain in the experimental group, which was by 10.37 % higher than in the reference group.

Thus, the hematological studies did not reveal any disruptions in the metabolism, which showed the adequacy of feeding the broiler chickens.

## CONCLUSION

The study has shown that in terms of the nutritional value and the technological properties the developed filler for premixes and the PVMC the Sarepta fodder concentrate compares favorably with the traditionally used sunflower cake. A series of scientific studies of using the premix (S) and the PVMC (S) in the composition of the feed for agricultural animals and poultry have revealed the following positive results.

During the first experiment with the unweaned calves, the content of erythrocytes in the blood of the animals increased by 0.35 %, total protein by 1.77 %, hemoglobin by 3.28 %, calcium by 2.22 %, and phosphorus by 1.68 %. It should be noted that at the end of the experiment, the live weight of the unweaned calves in the experimental group was higher than that in the reference group by 2.24 %.

At the end of the second experiment with young hens, the hematological parameters were studied. For instance, the erythrocytes count in the blood of the young hens in the experimental group was higher by 1.3 %, the leukocytes count by 1.77 %, and calcium and phosphorus by 12.5 %, compared to the reference group. The average daily live weight gain of the poultry in the experimental group was higher than that in the reference group by 6.93 %, and the total live weight gain by 7.0 %.

During the third experiment with the broiler chickens, the following positive results have been obtained. The use of the PVMC (S) in the composition of combined feed resulted in an increased erythrocytes count in the blood of broiler chickens by 8.67 %, total protein by 1.75 %, calcium by 5.82 %, and phosphorus by 7.74 %, compared to the reference group. Check weighing of broiler chickens during the experiment has shown that the average daily live weight gain in the experimental group was higher than that in the reference group by 10.27 %, and the total live weight gain by 10.37 %.

Thus, using the premixes and PVMC based on the Sarepta concentrate for feeding unweaned calves, young hens and broiler chickens has a positive effect on the physiological state and the metabolic processes in the organism, and on

the dynamics of the live weight gain, which allows making a conclusion about efficiency of their use.

## AUTHORS CONTRIBUTION

All authors contributed equally.

## CONFLICT OF INTEREST

The authors declare no conflicts of interest.

## ETHICAL CLERANCE

The ethical permission for the studies was obtained from the methodical Commission of the Department of Biotechnology and Veterinary Medicine of the Volgograd State Agrarian University.

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