

Premixes and Protein Vitamin-Mineral Concentrates in Livestock and Poultry Breeding: Technological Properties



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Abstract: It is known that today in the field of feeding animals and poultry, the use of dietary supplements, or premixes, is relevant. However, it should be noted that the premix quality mainly depends on the filler. Due to the above, the authors have performed comprehensive studies of the possibility to use fodder concentrate and the Sarepta vegetable raw material as a filler in the composition of premixes for cattle and poultry diets. In studying the nutritional value and the technological properties, the new filler was favorably different from the one traditionally used (sunflower meal). In the course of the research of using premixes and protein vitamin-mineral concentrates with the new filler in the composition of the fodder for agricultural animals and poultry, the following positive results were obtained: during the main period of experiment, milk yield of the dairy cows increased by 7.40 %; milk quality also improved, the value of byproducts from a single animal amounted to 4,928 rubles; the live weight of the dairy calves increased by the age of six months by 1.7 %, which amounted to 7,560 rubles of additional growth; during the period of experiment, egg productivity of the laying hens increased by up to 1.73 %, and the economic effect was 1,142.73 rubles; the live weight of the broiler chickens increased by 10.2 %, the slaughter yield of carcasses increased by 1.9 %, with that, the additional profit per animal was about 55.51 rubles. Based on the comprehensive research, one can recommend introducing the premix with the Sarepta concentrate to the diets of cattle and poultry to increase their productivity, improving product quality and economic efficiency of the livestock breeding industry and poultry production.

Keywords : premixes, filler, productivity, product quality, dairy cows, calves, laying hens, broiler chickens.

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I. INTRODUCTION

An important factor for improving the productivity of agricultural animals and poultry and the products obtained from them is the organization of complete feeding [1, 2].

Optimization of diets for modern breeds of cattle and poultry crosses allows obtaining high-quality products in the shortest time to satisfy the needs of the Russian population for ecologically pure food products [3, 4].

One of the priorities for the successful development of livestock and poultry breeding is increasing the efficiency of using combined feeds as the main source of increasing production in this industry [5, 6].

This is why it is so important to use well-balanced feed for livestock and poultry growing, since the lack of various elements in the diet may cause metabolic disorders in the organism, deteriorate the physiological condition, which will have an adverse effect on the productivity and the quality of the obtained products [7, 8].

For more complete commercialization of the genetic potential of agricultural animals and poultry, the use of biologically active additives (BAA) in the composition of combined feed plays an important role [9, 10]. Domestic and foreign experience proves that the use of certain BAA in the combined feed is less efficient than introducing them in the form of premixes and protein vitamin-mineral concentrates [11, 12]. Adding premixes and protein vitamin-mineral concentrates into the diets of agricultural animals and poultry will help to satisfy the need of the organism for essential nutrients [13, 14]. The authors have developed recipes of premixes and protein vitamin-mineral concentrates based on the Sarepta feed concentrate for cattle and egg-and-meat hens.

The purpose of the comprehensive studies was increasing the livestock and poultry production through the use of premixes and protein vitamin-mineral concentrates based on the Sarepta concentrate for feeding agricultural animals and poultry.

II. METHODS

A. General description

Before the scientific and economic experiments in studying the effect of these new premixes and protein vitamin-mineral concentrates on the quantitative and qualitative indicators of animals and poultry productivity, the forage base of the farms was analyzed. Next, with regard to the missing elements in the diet, targeted formulations of the premixes and protein vitamin-mineral concentrates were made, given the productive and physiological periods of animals and poultry.

Premixes and protein vitamin-mineral concentrates both with the new and the traditional filler were manufactured at a factory of the MegaMix group of companies.

After that, a series of experiments were organized for determining the efficiency of using premixes and protein vitamin-mineral concentrates in the diets of cattle and poultry. In 2012 – 2017, the studies were performed at the leading livestock and poultry breeding companies of the Volgograd region, such as Zavety Lenina collective farm in the Oktyabrsky district, JV Donskoe in the Kalachevsky district, ZAO Agrofirma Vostok in the Nikolaevsky district, and ZAO Kumylzhenskaya poultry farm in the Kumylzhensky district.

B. Algorithm

During the scientific and economic experiments, animals were selected to the group by the method of analog pairs, and poultry — by the method of analogs, with regard to the age, productivity, and other indicators.

For the scientific and economic experiments with dairy black-motley cows, two groups (reference and experimental) of 10 animals were formed. The duration of the experiment was 210 days.

For the scientific and economic experiments with black-motley calves, two groups (reference and experimental) of 10 animals were formed. The duration of the experiment was 180 days.

For experiments with Hisex Brown hens, reference and experimental groups with 54 hens in each group were formed. The experiment was performed with the hens from the age of 120 days, and its duration was 52 weeks.

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

C. Flow Chart

The general scheme is shown in Figure 1.

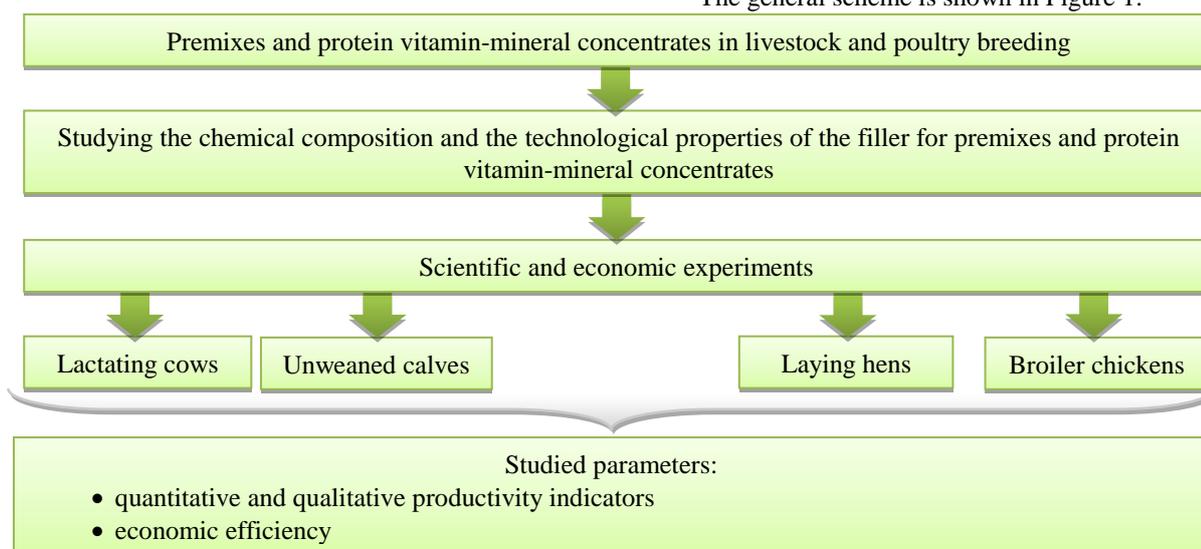


Fig. 1: General scheme of the research

Throughout the scientific research, milk production of the cows, growth, and development of the unweaned calves, meat productivity of the broiler chickens, and egg productivity and egg quality of the laying hens were studied. At the end of the experiments, the economic efficiency of the premixes and protein vitamin-mineral concentrates based on the Sarepta concentrate for feeding animals and poultry was calculated.

The obtained data were processed biometrically according to the method of Plokhinsky N. A. using Microsoft Excel. The significance of the differences between the traits was determined by comparing to the Student's criterion; three significance thresholds were determined (* $P > 0.05$, ** $P > 0.01$, *** $P > 0.001$).

III. RESULTS

The oilseed crop Saperda mustard (*Brassica juncea*) is grown

in the Volgograd region in large amounts. By pressing the seeds, mustard oil is obtained, which is known for its high taste properties, and the product of processing is mustard oil cake. However, this waste contains anti-nutritional substances that have a negative effect on the health of animals and poultry. Scientists of the Volgograd State Agrarian University suggested a method of mustard cake neutralization by thermal processing, where decomposition of anti-nutritive substances occurs. This feed product was called Sarepta feed concentrate, which has no negative effect on the health of living organisms, in particular, agricultural animals and poultry [15].

Before the research with animals and poultry, chemical compositions of sunflower cake and the Sarepta feed vegetable concentrate were studied. The results of these studies are shown in Table 1.

Table 1: Comparison of the chemical composition of sunflower cake and the Sarepta feed concentrate, %

Value	Sunflower cake	Feed concentrate Sarepta
Crude fat	7.9	8.0
Crude fiber	12.9	11.5
Crude ash	6.7	6.5
Crude protein	30.5	39.0
Nitrogen-free extractive substances	21.0	27.2
Total amino acids	19.46	25.12

The Sarepta feed concentrate and sunflower cake meet the requirements to premix fillers. The water content of the studied fodders was within the norm for concentrated feeds. The content of crude protein in sunflower cake was 30.5 %, in the Sarepta concentrate – 39.0 %, the content of crude fat was 7.9 and 8.0 %, and the content of amino acids was 19.46 and 25.12 %, respectively.

The studied safety parameters (the content of nitrates, nitrites, metal foreign matter) of these feed products met the veterinary and sanitary requirements. The Sarepta feed concentrate is a loose powder with the particle size of about 0.98 mm; it does not produce dust, is nonhygroscopic, and retains the stability of properties within five months of storing, its pH is close to neutral (6.7 – 6.9).

Thus, by the studied parameters, the Sarepta feed concentrate is not inferior to sunflower cake, which is the traditional filler for premixes and protein vitamin-mineral concentrates.

The first scientific and economic experiment was made with lactating motley-black cows in the conditions of the Zavety Lenina collective farm; its duration was 210 days. For the experiment, two groups of cows were formed. The keeping conditions for all cows in the experimental groups were the same during the entire experience. The cows were milked twice a day. The cows were kept loose.

The quantitative and qualitative indicators of milk productivity of the cows are shown in Table 2.

Table 2: The quantitative and qualitative indicators of milk productivity of the experimental cows (M ± m)

Value	Group	
	reference	experimental
Milk yield over the main period of the experiment, kg	3,393 ± 104.7	3,644 ± 134.2
Average daily milk yield, kg	18.85 ± 1.69	20.24 ± 1.73
Content in the milk of:		
fat, %	4.03 ± 0.13	4.04 ± 0.13
protein, %	3.11 ± 0.03	3.14 ± 0.04
milk fat, kg	136.74 ±	147.22 ± 6.33

	5.64	
milk protein, kg	105.52 ± 4.26	114.42 ± 5.03
nonfat milk solids, %	8.46 ± 0.08	8.53 ± 0.06
lactose, %	4.60 ± 0.10	4.63 ± 0.09
ash, %	0.73 ± 0.01	0.75 ± 0.01
calcium, %	0.125 ± 0.001	0.130 ± 0.001*
phosphorus, %	0.097 ± 0.001	0.102 ± 0.001*

Here and further, * P>0.95, ** P>0.99, ***P>0.999

The milk yield of the cows during the main period of the experiment increased in the experimental groups. For instance, in the experimental group where the premix based on the Sarepta feed concentrate was used, the increase in the milk yield over the main period of the experiment was 7.40 %, or 251 kg. According to the obtained data, by the average daily yield of natural milk, cows in the experimental group surpassed those in the reference group by 1.39 kg (7.37 %).

At the same time, along with the increase in milk production, the cows' milk quality indicators also improved. By the content of fat in the milk in the experimental animals, no significant changes were found. Compared to the reference group, the cows in the experimental group had higher content of dry matter in the milk by 0.09 %, of protein – by 0.03 %, of nonfat milk solids – by 0.07 %, of milk sugar – by 0.03 %, and of ash – by 0.02 %. However, it should be noted that the content of calcium and phosphorus in the milk of the cows in the experimental group was 0.130 % and 0.102 %, respectively, while in the reference group – 0.125 % and 0.097 %.

The density of the milk from the cows in the experimental groups almost did not vary and was in the range between 29.1 and 29.5 Ao, and the average milk acidity was 17.0 oT.

The amino acid composition of the milk from the cows in the experimental group was 3.093 %, which was higher than in the reference group by 0.032 %. In the reference group of cows, this indicator was 3.061 %.

Additional products from a single cow in the experimental group in monetary terms amounted to 4,928 rubles. Due to the increased milk productivity of the animals, the profit from the sale of milk from the cows in the experimental group was higher by 4,719.93 rubles than in the reference group, which contributed to increasing the profitability of milk production in the experimental group to 48.86 %.

The second scientific and economic experiment was performed with the motley-black calves at the age of up to six months at JV Donskoye in the Kalachevsky district of the Volgograd region. The duration of the experiment was 180 days. A reference and an experimental group were formed for the experiment, 15 animals in each group. At the age of one month, the average live weight of one animal was about 45 – 50 kg. The calves were kept loose in group quarters and fed three times a day. The animals were watered from automatic drinkers.

To satisfy the need of the experimental calves in vitamins, minerals, and amino acids, premixes were introduced into all diets. For instance, the calves in the reference group received a premix with the sunflower meal filler. The animals in the experimental group received a premix based on the Sarepta feed concentrate.

The use of the premix based on the Sarepta vegetable concentrate for feeding the calves had a positive effect on their growth and development. The data obtained in the course of monthly weighing during the experiment showed

that the average daily gain of 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 respective groups weighed 144.10 kg and 146.61 kg.

The introduction of the premix based on the Sarepta feed concentrate into the diets of the unweaned calves ensured a relatively high average daily gain. A veterinary inspection of the calves did not reveal any deviations from the norm (Table 3).

Table 3: Changes in the live weight of the experimental animals

Age in months	reference group		experimental group	
	Live weight, kg	Average daily weight gain, g	Live weight, kg	Average daily weight gain, g
1	45.90 ± 3.11		45.60 ± 2.94	
2	64.83 ± 4.12	631 ± 30.87	64.86 ± 3.67	642.30 ± 32.81
3	83.91 ± 4.84	636 ± 40.52	84.21 ± 4.25	645.00 ± 38.41
4	103.70 ± 5.67	660 ± 41.84	104.40 ± 4.84	674.30 ± 40.56
5	123.70 ± 6.45	665 ± 52.37	124.71 ± 4.55	676.00 ± 41.81
6	144.10 ± 8.13	680 ± 47.61	146.61 ± 5.86	730.00 ± 45.55
Total over the experiment	144.10 ± 8.13	633.50 ± 52.85	146.61 ± 5.86	651.67 ± 40.37

During the research, the authors studied the basic measurements of the experimental calves. For instance, the height at the withers of the calves in the reference group was 105.60 cm, in the experimental animals — 107.60 cm. Chest depth of the animals of the reference group was 49.60 cm, that of the calves in the experimental group — 52.70 cm; chest width behind the shoulders — 32.00 cm and 35.00 cm; chest girth behind the shoulders — 139.00 cm and 140.00 cm, metacarpus girth — 16.80 cm and 17.60 cm, slope body length — 127.30 cm and 128.00 cm, and quarters half-girth — 69.20 cm and 71.10 cm, respectively. In the calves in the experimental group, the basic measurements were larger than those in the reference group due to the positive effect of the premix based on the Sarepta feed concentrate in their diet.

Throughout the research, the gross live weight gain of a single animal in the experimental group on average was 101.00 kg, in the reference group – 98.20 kg. The livestock preservation rate in the groups in the experiment was 100 %. In the experimental group of calves, the cost of the additional weight gain was 7,560 rubles. Laying hens of the Hisex brown cross were used for the third scientific and economic experiment in the conditions of ZAO Agrofirma Vostok in the Volgograd region. The experimental hens were grouped by the method of analogs with regard to the age, the live weight, and other indicators. The keeping, feeding and watering conditions, the microclimate parameters in all groups were identical and corresponded to the recommendations of the All-Russia Research Institute of Poultry Breeding (VNITIP). The experimental hens were kept in Big Dutchman cage batteries, seven hens in each cage. The hens in the reference

group received complete feed used at the farm, which included protein vitamin-mineral concentrate (P) based on sunflower cake; the hens in the experimental group received the protein vitamin-mineral concentrate (S) with the Sarepta feed concentrate as the filler.

The results of the scientific and economic experiment showed that throughout the experiment, the average egg productivity of a single laying hen in the reference group was 323 eggs, in the experimental group – 329 eggs, which was higher by 1.86 % than in the reference group (Table 4).

Table 4: Egg productivity of the laying hens in the experiment

Value	Group	
	reference	experimental
The number of hens	54	54
Total eggs obtained, pcs.	17,442	17,766
per laying hen	323	329
% of egg production	88.49	90.14
The average weight of eggs, g	63.3	65.7
Obtained egg mass, kg	1,105.10	1,166.87
Feed cost, kg		
per 1 kg of egg mass	2.05	1.94
per 10 eggs	1.30	1.27



The hens in the experimental group showed high intensity of egg-laying, which was 90.14 %, or by 1.65 % higher than in the reference group. The average egg weight in the experimental group was higher by 3.79 % than in the reference group. In the experimental group, the feed used per one kg of egg mass was lower by 0.11 kg than in the reference group, the feed used per 10 eggs – by 0.03 kg lower than in the reference group. In studying the chemical composition of table eggs, it was found that in the eggs from hens in the experimental group, the content of dry matter both in the white and the yolk was higher than those in the reference group.

For instance, the content of dry matter in the white of eggs in the experimental group exceeded that in the reference group by 0.53 %, and in the yolk – by 0.79 %, respectively.

In the world community, the content of essential amino acids in the egg white is adopted as the standard [16]. The total amount of amino acids in the white and yolk of the eggs of the hens of the experimental group was 76.15 % and 79.48 %, respectively, which was higher than in the reference group by 3.34 % and 7.07 %. With that, the content of carotenoids in the eggs of the hens of the experimental group was higher than in the reference group by 0.2 µg/g; of vitamin A in the yolk – by 0.71 µg/g; of vitamin E – by 0.41 µg/g; and of vitamin B2 in the yolk – by 0.41 µg/g. The difference was not reliable.

The efficiency of using the protein vitamin-mineral concentrate based on the Sarepta feed concentrate in the production of edible eggs resulted in a positive economic effect, which in the experimental group amounted to 1,142.73 rubles.

The fourth scientific and economic experiment was performed with broiler chickens in the conditions of poultry farms of OOO Kumylzhenskaya in the Kumylzhenskiy district of the Volgograd region. Following the methodology of VNITIP, two groups of broiler chickens were formed in the experiment, 50 chickens in each group (reference and experimental). The broiler chickens used in the experiment were kept and fed equally.

The chickens in the reference group received complete feed used at the farm, which included protein vitamin-mineral concentrate (P) based on sunflower cake, the hens in the experimental group received the protein vitamin-mineral concentrate (S) with the Sarepta feed concentrate as the filler.

The results of weighing broiler chickens throughout the experiment showed that the overall weight gain in the reference group was 2,330.14 g, and the average daily weight gain was 55.5 g. The total weight gain of the chickens in the experimental group was 2,571.74 g, and the average daily weight gain was 61.2 g, which was higher than that in the reference group by 10.4 %, respectively; the difference is reliable.

For the final assessment of the meat productivity of the broiler chickens in the experiment, check slaughtering was performed (Table 5).

Table 5: Meat productivity of the broiler chickens in the experiment (M ± m)

Value	Group	
	reference	experimental
Pre-slaughter live weight, g	2,342.30 ± 4.25	2,497.09 ± 1.56***
Weight of eviscerated carcass, g	1,691.14 ± 2.56	1,850.34 ± 1.94***
Slaughter yield, %	72.20 ± 0.12	74.10 ± 0.15***
Total weight of the muscles, g including breast muscles, g	1,009.40 ± 1.22	1,105.22 ± 2.82***
	521.41 ± 0.68	574.00 ± 0.67***
Edible parts of the carcass, g	1,127.62 ± 1.33	1,243.24 ± 3.02***
Inedible parts of the carcass, g	563.52 ± 0.21	607.10 ± 0.31***
Edible to inedible parts of the carcass ratio	2.00	2.10

***P>0.999

The slaughter yield in the reference group was 72.2 %, in the experimental group – 74.10 %, which was higher by 1.9 % than that in the reference group. The yield of the breast muscles in the reference group was 521.41 g, and in the experimental group – 574.0 g, which was higher than that in the reference group by 52.6 g.

The content of dry matter in the breast muscles of the broiler chickens in the reference group was 24.86 %, in the experimental group – 28.95 %, which was higher by 4.09 % than that in the reference group. The content of dry matter in the thigh muscles of the chickens in the reference group was 23.61 %, in the broiler chickens in the experimental group – 27.69 %, which was higher than that in the reference group by 4.08 %. The content of protein in the breast muscles of the broiler chickens in the reference group was 20.29 %, in the experimental group – 24.65 %, which was higher by 4.36 % than that in the reference group. The content of protein in the thigh muscles of the chickens in the reference group was 20.16 %, in the broiler chickens in the experimental group – 23.36 %, which was higher than that in the reference group by 3.2 %. The total amount of amino acids in the breast and thigh muscles of the chickens in the experimental group was higher than that in the reference group by 7.7 % and 7.9 %, respectively.

Economic calculations as the final indicators of the tested protein vitamin-mineral concentrate based on the Sarepta feed concentrate are the evidence of the practicability of using it for feeding broiler chickens. With that, the additional profit per 50 chickens increased up to 2,775.71 rubles.

IV. CONCLUSION

Today, in the field of feeding animals and poultry, the search for nontraditional food products that are not inferior by their nutritional value, or are even superior to the ones traditionally used remains relevant. It is also known that the use of premixes and protein vitamin-mineral concentrates in the diets of agricultural animals and poultry allows increasing both the efficiency and the quality of the products obtained from them. The use of premixes and protein vitamin-mineral concentrates (S) based on the Sarepta feed concentrate in the diets has helped to increase the milk productivity of cows by 7.40 %, the live weight of the unweaned cows by 1.74 %, the number of the eggs obtained from a single hen by 1.86 %, and the meat productivity of broiler chickens – by 10.2 %. With that, a positive economic effect was reached during the scientific and economic experiments with agricultural animals and poultry.

Thus, in order to improve the efficiency of livestock and poultry breeding, it is advisable to use for feeding animals and poultry premixes and protein vitamin-mineral concentrates based on local sources.

V. ETHICAL CLEARANCE

Ethical permission for the studies was obtained from the Methodical Commission of the Faculty of Biotechnology and Veterinary Medicine of the Volgograd State Agrarian University.

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