

INFLUENCE OF DIFFERENT LEVELS OF VITAMIN AND MINERAL NUTRITION OF DAIRY COWS ON MORPHOLOGICAL AND BIOCHEMICAL INDICATORS OF BLOOD AND THEIR PRODUCTIVITY

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Abstract

Successful animal husbandry is impossible without the organization of a balanced feeding system, and in particular is providing rations with optimal level of mineral elements and vitamins, which serve as a guarantee of the intensity of metabolic processes in the body as well as assimilation of feed nutrients and their conversion into products. Multi-ingredient feed supplements are the best source of replenishing the rations of dairy cows with nutrients. The morphological and biochemical composition of blood is a symptomatic reflection of the metabolism intensity. Feeding cattle an improved vitamin and mineral supplement (VMS), as part of the improved compound feed K 60-32-89, makes it possible to ensure a sufficient level of vitamin and mineral nutrition in the Pre-Carpathia zone. The balanced ration of dairy cows with biologically active substances (BAS) enhances the redox reactions of the body (probably a higher level of erythrocytes, hemoglobin, total protein, nitrogen fractions) while simultaneously accumulating energy in the cell (increasing total acid-soluble phosphorus and nucleic acids (NA)) and the growth of the level of milk productivity by 9.8%.

Key words: blood, dairy cows, milk, premix, vitamin and mineral supplement.

INTRODUCTION

The food security of the state and the improvement of the population's well-being are largely determined by the effective management of agriculture. Cattle breeding, as an extremely perspective branch of agriculture, is the most important indicator of the state of the livestock industry, as it provides mankind with irreplaceable food products, while the food and processing industry with valuable raw materials (Kukhar, 2013; Antoshchenkova, 2020). In particular, the population consumes with livestock products more than 2/3 of animal protein, while milk accounts for 50% (Bozhydarnik, 2010). According to FAO data, 16% of the human energy comes from food of animal origin, namely milk. Every Ukrainian on average consumes less than 200 kg of milk and dairy products during the year, while norm is 380 kg (Antoschenkova, 2020). Thus, the priority task of agricultural science is to increase the volume of production, which is achieved by increasing the intensity of metabolic processes in the body.

An important link in achieving the genetic maximum of productivity, reproductive capacity, preserving the health of animals and extending productive longevity, the birth of strong offspring, as well as the prevention of alimentary diseases is the organization of rational complete feeding of cows (Spears, 2011; Sawant et al., 2013; Keshri et al., 2021). The level of livestock nutrition is determined by the amount of energy, protein, essential amino acids, fats, carbohydrates and a wide range of biologically active substances, including mineral elements and vitamins (Farionik, 2020; Spears & Weiss, 2014). The optimal ratio of these substances determines the full functioning of the animal organism, the rational use of feed resources and the effective transformation of nutrients into products (Yanovych & Sologub, 2000; Vorobel & Pivtorak, 2011; Weiss, 2017).

Based on the analysis of scientific literature, it is known that mineral elements and vitamins play a leading role, both in the formation of milk and in building muscle mass. It is also known that the provision of the ration with these nutrients is

reflected in the composition of the blood, since ontogenetic hematological changes are closely related to the feeding factor and the health of the organism (Kozlovskiy, 2013; Dovhii et al., 2019). According to the researches of a number of scientists, it was established that the lack of one or more nutrients contributes not only to a lower level of productivity corresponding to their deficiency, but also negatively affects the body's use of other feed elements and causes metabolic disorders in the animal's body (Kozlovskiy, 2013; Yattoo et al., 2013). To ensure of vitamin and mineral nutrition of ruminants, it is advisable to use complex feed supplements in the rations, which would have the optimal amount of vitamins and mineral elements in their composition, which act as a catalyst-regulating factor of this or that metabolic link in the body (Sawant et al., 2013; Dovhii et al., 2019). The use of feed supplements in livestock rations makes it possible to improve the digestibility of nutrients, which thereby leads to an increase in protein, carbohydrate and lipid metabolism, and as a result, an increase in the volume of production at a lower cost (Sawant et al., 2013; Kotets et al., 2020).

The analysis of literary sources shows that there are a number of geochemical zones on the territory of Ukraine, which are characterized by a deficiency of certain mineral elements in soils, fodder, as well as in animal rations (Kravtsiv et al., 2001; Doletskiy, 2010; Sachuk et al., 2019). Research by scientists confirms the impossibility of using a single recipe for a feed supplement without taking into account the zonal aspect of the region, since the needs of animals in each nutrient are not fully met (Mc Dowell, 1985; Sachuk et al., 2019; Farionik, 2020).

Taking into account the above, it should be noted that physiologically, the body of animals cannot fully function without providing an optimal amount of BAS, which is reflected in the composition of the blood, and therefore in the level of productivity. Thus, ensuring the livestock's need for vitamins, macro- and microelements through the use of multi-ingredient feed supplements, developed taking into account the geochemical zone and clarifying their effect on blood indicators and productivity, remains a promising direction of research.

The purpose of the research was to establish the effectiveness of the use of various variants of vitamin and mineral supplements in the feeding

of dairy cows on the morphological and biochemical indicators of the blood, their productivity in the Pre-Carpathia region.

MATERIALS AND METHODS

In order to find out the influence of different levels of vitamin and mineral nutrition on the morphological and biochemical indicators of dairy cows and their productivity, an experiment was conducted at the PAC «Berezhnytsia» of the Lviv Region. The experimental part of the research lasted 120 days (equalization period - 30 days, main - 90 days) on a grass-concentrate ration in the summer-pasture period. The study was conducted on 20 dairy cows of the Simmental breed, from which two groups were formed: I - control, II - experimental, 10 cows in each. Selection of animals into groups was carried out according to the method of analogues, taking into account origin (Simmental breed), age (4.0-4.5 years, second lactation), live weight (515-530 kg), productivity (third month of lactation, average daily yield was at level of 19-20 kg).

Cows were fed in accordance with scientifically based norms (Bohdanov et al., 2012). The main ration of the experimental animals was represented by pasture grass, green mass of cereal-legume mixtures of the green conveyor (75% cereals, 25% legumes), cereal-various grass hay and molasses. The concentrate group of the cow's ration included control and experimental compound feed K 60-32-89, premix P 60-5M and an improved vitamin and mineral supplement. Grains - wheat, barley, oats and their processing products - wheat bran served as constituent components of both experimental and control feed. The macroelement composition of the combined feed was represented by monocalcium phosphate, magnesium oxide and common salt. Premix P 60-5M contains fat-soluble vitamins (A, D), trace elements (zinc, cobalt, iodine) and a filler - wheat bran. Experimental animals were fodder twice a day with 50% of the total nutritional value of the ration: in the morning and in the evening. Cows were milked twice by machine.

Experimental animals of both groups were fodder control combined feed K 60-32-89 and premix P 60-5M at the same time as the main ration feed during the equalization period.

During the main period, dairy cows of the control group received an identical ration. The animals of the experimental group were fed similar fodder with the only difference that the compound feed K 60-32-89 (improved in terms of phosphorus and sulfur) to replace the premix P 60-5M included VMS in the amount of 1%. The supplement additionally included copper and selenium and is adjusted according to the level (according to need) of microelements (zinc, cobalt, iodine) that are limited in the Pre-Carpathia zone as well as the scientifically based level of fat-soluble vitamins: A, D. Wheat bran acts as a filler. The experimental compound feed, unlike the control feed, is characterized by a larger amount of monocalcium phosphate and the additional inclusion of glauber salt, which enriches the latter with phosphorus and sulfur and, accordingly, has a positive effect on the content of these macroelements in the ration of cows.

The material for research was fodder, blood and milk. In the course of the experiment, fodder samples were taken for full zootechnical analysis – nutrition and chemical composition. For studies of morphological and biochemical indicators, blood was collected in the morning before feeding from the jugular vein of 3 animals from each group. The following indicators were determined in the blood: the number of erythrocytes and the level of hemoglobin, the content of total protein in the blood serum, fractions of nitrogen (amine, total, protein and residual) and phosphorus (total acid-soluble, inorganic and organic, ribonucleic acid (RNA) and deoxyribonucleic acid (DNA)), urea according to generally accepted methods (Vlizlo et al., 2012).

The digital material was processed by the methods of variational statistics using the standard package of *Microsoft Excel* and *AtteStat* application programs using Student's t-test. Arithmetic mean values (M) and arithmetic mean errors (m) were calculated. Differences between mean arithmetic values were considered statistically significant by: * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

RESULTS AND DISCUSSIONS

The analysis of the actually consumed amount of fodder by dairy cows shows a slight

difference between the control and experimental groups only in the green mass of cereal-legume mixtures of the green conveyor, which in percentage is 0.7%. As for the consumption of other components of the grass-concentrate ration - hay, pasture grass, compound feed, and molasses - it was 100% in both groups of animals. In the experiment, fodder was used that met the requirements of the standard and was noted for its good taste, based on the percentage of its consumption, therefore, it was of high quality. The productive effect of the rations, that is, the level of metabolism in the body of dairy cows of both groups, is determined by the use in the structure of compound feed K 60-32-89 of premix P 60-5M and optimized VMS in the composition of (improved in terms of phosphorus and sulfur) compound feed K 60-32-89.

In the process of conducting the research, no difference between the groups was also found in a number of nutrients – exchangeable energy, dry matter, crude and digestible protein, crude fat, crude fiber, sugar. The optimal ratios were observed in ruminant's rations: sugar to protein - 0.9: 1.0, carbohydrates to protein - 2.0: 1.0, calcium to phosphorus - 1.8-2.0: 1.0, nitrogen to sulfur - 11.1-11.9: 1.0, potassium to sodium - 5.4-5.9: 1.0. Simultaneously with the optimum of the above mentioned nutritional indicators, the analysis of the feeding of dairy cows of the two groups shows the different supply of BAS level in rations.

As a result of the assessment of the chemical composition of the , that were included in the structure of the grass-concentrate ration of the experimental animals of the control group, it was established that the standard compound feed K 60-32-89 in a complex with the premix P 60-5M does not provide scientifically justified needs for a number of macro-(phosphorus, sulfur) and trace elements (copper, zinc, cobalt, iodine, selenium) and requires correction by the content of fat-soluble vitamins (A, D). It should be noted that, in contrast to the control group, improved VMS as a component of the experimental compound feed K 60-32-89 (improved in terms of phosphorus and sulfur) eliminates BAS deficiency, i.e. brings the level of vitamin and mineral nutrition of dairy cows to the recommended norm.

Correction of rations for deficient mineral elements and vitamins is one of the ways to improve hematopoietic processes in tissues, and in this way – to activate metabolism in the animal's body.

The obtained experimental data show that the consumption of experimental cows in the summer-pasture period of K 60-32-89

combined feed, improved in terms of phosphorus and sulfur, improved VMS, corrected for mineral elements and fat-soluble vitamins in the Pre-Carpathia zone, had a positive effect on the investigated morphological and biochemical indicators of blood (Table 1).

Table 1. Morphological and biochemical parameters of the blood of dairy cows (M±m, n=3)

The investigated indicator and unit of measurement	Groups of animals	
	I (control)	II (experimental)
Erythrocytes, T/l	6.61±0.13	6.91±0.10
Hemoglobin, g/l	95.87±2.98	114.7±2.52**
Total protein, g/l	80.00±0.50	82.90±0.43*
Nitrogen, mmol/l:		
amine	3.36±0.08	3.73±0.06*
total	1842.3±12.0	1894.0±6.62*
protein	1804.2±13.7	1856.0±6.50*
residual	38.10±1.70	38.00±0.58
Urea, mmol/l	4.14±0.07	3.72±0.07*
Phosphorus, mmol/l:		
total acid-soluble	2.61±0.04	2.92±0.05**
Inorganic	1.56±0.01	1.66±0.02**
Organic	1.05±0.04	1.26±0.04*
RNA	597.9±16.8	660.3±5.6*
DNA	275.7±11.4	317.2±7.9*

Note. The difference is probable comparing to the control: *P<0.05; **P<0.01; ***P<0.001.

According to the results of the research, it was found that on the background of improved VMS in the blood of ruminants of the research group, the intensity of redox processes in the body increases. This is confirmed by the increase in the number of erythrocytes in the blood of dairy cows of group II, compared to group I. In percentage terms, the difference between the groups is 4.5%. In this plane, in the animals of the experimental variant, relative to the control, a significantly higher degree of saturation of erythrocytes with hemoglobin is observed. The percentage advantage of the former over the latter is 19.6%. The intergroup difference is within the limits of high probability (P<0.01). Erythrocytes and hemoglobin participate in the metabolism, which is the basis of the vital activity of the body. So, in particular, red blood cells adsorb amino acids and distribute them with blood throughout the body, which ensures the creation of conditions for the intensification of synthesis processes. Free amino acids are used for the formation of proteins of organs and tissues, and their balance is replenished due to the desorption of amino acids bound by erythrocytes (Yanovych & Sologub, 2000; Luz

et al., 2005). At the same time, it should be noted that a high level of free amino acids, i.e., amino nitrogen, is an indicator that determines the intensity of protein synthesis, which is observed in the blood of dairy cows of the research group of this experiment fed with optimized VMS. In particular, in the blood of experimental animals of the II group, a higher level of amino nitrogen is observed, compared to the control analogues by 11.0%. The probability criterion is P<0.05. Confirmation of the intensive course of synthetic processes, simultaneously with the growth of amino nitrogen, is an increase in the content of total protein. In particular, the advantage of this indicator in the blood of dairy cows of the experimental variant, in contrast to the control, in percentage terms is 6%. The intergroup difference is within the limits of probability (P<0.05). The analysis of the conducted studies shows that when feeding test animals of the II group with improved VMS there is an increase in total nitrogen in the blood of animals by 2.8%, compared to premix P 60-5M. According to the statistical calculation, the difference is within the limits of probability (P<0.05). As for the content of

protein nitrogen in the blood of dairy cows of the experimental variant, the intergroup difference in percentage terms is 2.9%, compared to the control variant. The probability criterion is $P < 0.05$. Such a studied indicator as the level of residual nitrogen in the blood of experimental animals of both groups is almost at the same level, however, in a statistical sense, the difference is improbable ($P > 0.05$).

An indirect indicator of the intensity of protein metabolism in the body of ruminants in general is the level of urea in blood serum. In the course of research, it was established that the urea content in the blood of dairy cows on the background of the use of optimized VMS is lower, compared to the control analogue (premix P 60-5M). The percentage advantage in favor of the control is 10.1%. According to the data of statistical processing, the intergroup difference is probable ($P < 0.05$). In the context of the above, a decrease in the level of urea in the blood of animals of the experimental variant, and probably in the rumen of ammonia, indicates a high level of anabolic processes in the pre-stomachs.

Correction of vitamin and mineral nutrition of experimental animals by feeding a new VMS results in significant changes in the fractions of phosphorus metabolism in the blood. An element like phosphorus plays a key role in energy processes. It is a component of the redox buffer system of blood and exists in two forms: acid-soluble (organic and inorganic fractions) and acid-insoluble (nucleoproteins and lipids) (Demydiuk et al., 2011). Analyzing the indicators of phosphorus metabolism in the blood of dairy cows, it should be noted that the difference in the content of total acid-soluble phosphorus in percentage terms is 11.9% in favor of the II group. According to the statistical calculation, the advantage is probable ($P < 0.01$). Such a studied indicator as inorganic phosphorus in the blood of animals of the experimental variant in percentage terms increases by 6.4% in contrast to the control. The probability criterion is $P < 0.01$. At the same time, the amount of such a fraction as organic phosphorus increases by 20.0% when consumed by dairy cows of the II group of improved VMS. The difference between the groups in statistical terms is within the limits of probability ($P < 0.05$).

At the same time, the leading role in the anabolic chain belongs to nucleic acids. In the studies of many scientists, there is a direct correlation between the synthesis of protein molecules and the level of NA. Thus, the number of NAs in animal tissues can to some extent be used as a test of the intensive course of protein metabolism. In the blood of ruminants of the II group, with the use of optimized VMS, there is an increase in the level of NA Phosphorus. In particular, in the blood of dairy cows of the experimental variant, a higher concentration of RNA phosphorus was noted relative to the similar indicator of the control, which in percentage terms is 10.4%. The degree of probability is equal to $P < 0.05$. The advantage in the content of DNA phosphorus in the blood of ruminants of the II group compared to the I group is 15.1%. According to the statistical calculation, the intergroup difference is probable ($P < 0.05$). A higher level of NA phosphorus, as well as total protein in the blood of dairy cows of the experimental variant, indicates the intensification of synthesis processes in the body as a whole.

The above changes in the morphological and biochemical indicators of blood, which were noted in experimental animals of the II group on the background of improved VMS, are consistent with the results of similar studies (Dovhii et al., 2019; Kropyvka & Bomko, 2020; Farionik, 2020). Thus, the introduction of a complex of mineral elements (copper, cobalt, zinc, manganese, iodine) and the vitamin drug "Solvimin Selen" into the ration of lactating cows led to an increase in the level of productivity and an improvement in morphological indicators (number of erythrocytes, hemoglobin), which indicates the activation of hematopoiesis. The researches of Farionik (2020) established the positive effect of using both sulfuric acid salts of trace elements (zinc, copper and manganese) and mixed ligand complexes in the rations of cows on hematological parameters, live weight, productivity and chemical composition of milk. Other scientists have also found a positive effect of different levels of mineral elements – zinc, manganese and cobalt in the feeding of highly productive Holstein cows on morphological and biochemical indicators of blood, their productivity and reproductive functions (Kropyvka & Bomko, 2020).

Taking into account the above, it should be noted that the correction of vitamin and mineral nutrition of dairy cows due to the inclusion in the structure of the improved compound feed K 60-32-89 of the improved VMS provides the rations with the optimal amount of mineral elements and vitamins, which thereby activates redox and synthetic processes in the blood, contributes to a higher level of productivity by 9.8% and improvement of the chemical composition of milk (fat, protein, milk sugar, calcium).

CONCLUSIONS

The perspective of using in the feeding of dairy cows in the summer-pasture period of maintenance in the structure of the improved compound feed of the optimized VMS has been experimentally established and scientifically substantiated. Feeding VMS to cattle stimulates hematopoietic processes. In particular, it helps to increase the level of erythrocytes, hemoglobin, total protein, fractions of nitrogen (amine, total, protein) and phosphorus (total acid-soluble, organic, NA) and conditions the growth of quantitative and qualitative indicators of milk.

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