

Modern Energy Supplements for Correction of Physiological and Biochemical Status of Cattle

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Abstract—Energy supplements are often used to normalize the physiological and biochemical status of cattle during milking; to increase the yield and make up for the energy lack in the diet. The objective of this research was the practical justification for the use of modern energy supplements in the diets of highly productive cows during milking. The scientific novelty lies in the fact that the effect of energy feed supplements “Lacto S” and “Extima 100” on productive, physiological and biochemical parameters of Black Pied cattle during milking has been studied for the first time. We used generally accepted zootechnical biochemical and statistical research methods. The results showed that the use of 200 g per animal per day (the 1st experimental group) of the energy feed supplement “Lacto S” in the diets of highly productive cows increased their milk productivity by 8.88% ($P < 0.05$), compared with the analogues of the control group. In this case, the service period of cows of this group was 9 days shorter, and duration of the calving interval was 15 days shorter, than of the analogous to the control group. The glucose level in the blood serum of cattle of the 1st experimental group was 41.38% ($P < 0.05$) higher than in the control group. The lowest urea content was in the blood serum of the 1st experimental group – 4.10 mmol/l, which is 15.37% lesser when compared to the control group. The creatinine content in animals of the 1st experimental group was 8.13 mmol/l, or 10.48% more than in the control group. These energy supplements contributed to a decrease in alkaline phosphatase in blood serum in the 1st experimental group by 8.62% and in the 2nd experimental – by 5.94%, compared with the control group.

Keywords—modern energy supplements for correction of physiological and biochemical status of cattle.

I. INTRODUCTION

An integral part in solving country’s food security is to provide the population with milk and dairy products. In recent years, there has been a qualitative increase in the agricultural production, in particular, of milk and dairy products, and there is a tendency to decrease their imports [1-2].

Increasing the milk yield of cows and their productive longevity is one of the priority areas in the development of dairy cattle breeding in Russia. Constraining factors in the growth of animal productivity include an insufficiently effective system for the production and preparation of feed, managing and milking technologies, as well as veterinary and hygienic measures aimed at improving the physiological state of animals. The most important is the issue of organizing

proper feeding of highly productive cows, since the metabolic processes in their body are very intense, which determines the high requirements for balancing diets in energy, nutrients and biologically active substances [3-5].

A solid feed base, based on modern highly efficient technologies of harvesting, proper storage of feed and preparing it for feeding, is of paramount importance in organizing biologically complete feeding, which determines the level of cattle productivity [6].

To normalize the physiological and biochemical status of cattle during milking and to increase their productivity and immune resistance – energy feed additives are often used in diets. These feed supplements contribute to better digestion and use of nutrient and biologically active substances in diets, normalization of metabolic processes [7-8].

At the same time, the influence of energy feed supplements on the intensity of physiological and biochemical processes in cattle during the milking season has not been adequately studied, taking into account their productivity, physiological state, feeding conditions and managing, which requires further study of this issue [9-10].

The objective was the practical justification for the use of modern energy supplements in the diets of highly productive cows during the milking period in order to correct their physiological and biochemical status.

II. RESEARCH METHODOLOGY

The studies were conducted at “Glinki” farm in the Kurgan region (Russia). Scientific experiment was carried out on the basis of analogues taking into account genetic and paratypic factors – three groups of adult cows of Black Pied breed were formed.

In the main period of the experiment, the conditions for feeding were the same. The main diet consisted of 34.5 kg of feed mixture; 4.0 – brome hay; 1.7 – rapeseed meal; 1.0 – crushed corn grain; 5.0 – draff; 0.5 – PVMC-60-10 (protein-vitamin-mineral concentrates) and 0.5 kg of molasses. In the first 30 days after calving, the cows of the first experimental group were fed with “Lacto S” energy supplement (Uralbiovet, Russia) of 200 g per animal per day in addition to the main diet, and the second experimental group – with Extima 100 (Malaysia) of 200 g per animal per day. The feeding level was normalized taking into account the

nutritional and biological value of the feed according to the standards recommended by the Russian Academy of Sciences. Animal conditions and microclimate parameters did not differ.

“Lacto S” energy supplement is a white loose powder that is thermostable during production of premixes and animal feed; compatible with all feed ingredients, medications and other feed additives; as the active substance contains propylene glycol (1,2-propanediol), glycerin, biotin (vitamin H), nicotinic acid (vitamin B3), flavoring and silicon dioxide; 1 kg of feed additive contains at least 9.8 MJ of metabolic energy.

“Extima 100” is a dry highly stable refined palm oil that does not contain trans fats. 1 kg of feed additive contains 37.7 MJ of metabolic energy.

Once a decade, experimental cows were monitored for milk yield using the control milking method. The resulting milk was converted to 4% fat content, the chemical composition and technological properties of milk were determined according to generally accepted methods.

Biochemical blood tests were carried out in an accredited laboratory of the Federal State Budgetary Scientific Institution “Ural Scientific Research Veterinary Institute” according to standardized methods.

The digital material obtained during the research was processed by the method of variation statistics according to N.A. To Plokhinsky [11], the reliability was determined by Student-Fisher t-test.

III. RESULTS AND DISCUSSION

During our studies we discovered that additional feeding of high-yielding cows with energy supplements had a positive effect on their milk productivity (Fig. 1).

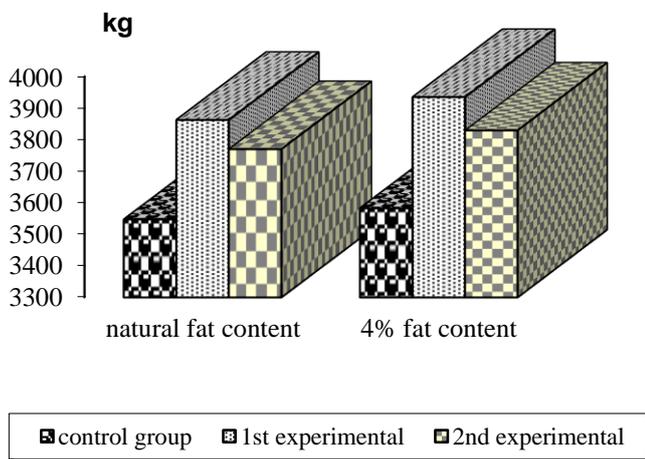


Fig. 1. Milk yield for the first 100 days of lactation, kg

Studies shows that cows of the 1st experimental group, which were additionally fed the “Lacto S” energy supplement, gave more milk during the first 100 days of lactation than the analogues of the control group. So, the milk yield with the natural fat content increased by 8.88% ($P < 0.05$), compared with the control group, and 2.46% compared with the 2nd experimental group. Cows of the 1st experimental group, gave 3934.2 kg of milk of 4% fat content, which is 9.82% ($P < 0.05$)

and 2.76% more than the animals of the control and the 2nd experimental groups, respectively.

The use of energy supplements in cattle feeding during milking has a positive effect on the composition and properties of milk. So, the highest energy value was obtained from cow milk of the 1st experimental group – 2.96 MJ, which is 0.07 MJ (2.42%) more than from analogues of the control group, and by 0.05 MJ (1.73%) more than from analogues of the 2nd experimental group. The milk density in the cows of the experimental groups did not have significant differences, while this indicator was within the normal range (1.027-1.032 g/cm³) (Table I).

TABLE I. COMPOSITION AND PROPERTIES OF MILK OF EXPERIMENTAL COWS ($\bar{x} \pm S_x$)

Indicator	Group		
	Control	1st experimental	2nd experimental
Energy value, MJ	2.89±0.03	2.96±0.02	2.94±0.04
Milk solids residue, %	12.61±0.19	12.84±0.10	12.77±0.07
Density, °A	27.98±0.52	28.39±0.54	28.28±0.20
Milk fat, %	4.05±0.05	4.15±0.03	4.12±0.06
Total protein, %	3.29±0.05	3.40±0.09	3.36±0.08
Lactose, %	4.45±0.07	4.52±0.07	4.50±0.03
Skimmed milk solids residue, %	8.57±0.14	8.69±0.13	8.65±0.05
Ash, %	0.71±0.01	0.75±0.01	0.73±0.01

The fat content in milk, first of all, depends on the complex microbiological cicatricial cleavage of fiber with the formation of organic volatile fatty acids, primarily acetic acid, which is a precursor to the synthesis of milk fat. Lack of energy in the diet leads not only to a decrease in milk yield, but also to the decrease of fat content in milk. So, the cow milk of the 1st experimental group contained 4.15% of milk fat, which is 0.10% and 0.03% more than that of the analogues of the control and the 2nd experimental group, respectively.

An indicator characterizing the quality of milk is milk protein, which affects its purchase price, alike the milk fat. Its content depends not only on the protein nutritional value of the feed, but also on the level of energy nutrition, which is necessary for the synthesis of microbial protein in the cattle rumen.

It is quite difficult to provide the necessary amount of energy during the milking of highly productive cows, which reduces the amount of protein in milk. So, in the cow milk of the control group, the protein content was 3.40%, which is 0.11% and 0.04% less than in the 1st and 2nd experimental groups, respectively.

The amount of lactose in the milk of cows of the 1st experimental group was the highest – 4.52%, which is 0.07% more compared to the analogues of the control group.

A higher level of fat, protein and lactose in the milk of the cows of the experimental groups in total increased the dry milk residue content. So, milk of the 1st experimental group contained 0.23% and 0.07% more than the control and 2nd experimental groups, respectively.

The skimmed milk solids residue of the 1st experimental group was 0.12% and 0.04% higher than of the control and 2nd experimental groups, respectively. The same trend was observed in the amount of ash. Its level in the 1st experimental group is the highest – 0.75%, which is 0.04% and 0.02% more than the same indicator in the milk of cows of the control and 2nd experimental groups, respectively.

The high level of milk yield in the conditions of modern industrial technologies affects the metabolism as a whole, and also changing the reproductive system. Scientific research and practical experience indicate that the reproduction issue of highly productive cows directly correlates with feeding conditions. Our studies have proved that the additional feeding of energy supplements of highly productive cows during the milking period has a positive effect on their reproductive functions.

The most important condition for the realization of the genetic potential of high milk productivity of cows, increasing the economic efficiency of milk production, is to optimize the service period, which is a determining factor in restoring the physiological function of reproduction; that is, the animal must replenish the necessary supply of nutrient and biologically active substances. Analysis of the studies showed that, this indicator was 9 days lesser in cows of the 1st experimental group, than in the control group, and 5 days lesser than in the 2nd experimental group.

The optimal duration of calving interval of highly productive cows is not only the physiological basis of effective reproduction, but also the economic basis of dairy cattle breeding, due to an increase in the productivity and yield of calves. We found that the calving interval duration was 411 days in cows that were fed the “Lacto S” energy supplement in the amount of 200 g per animal per day, which is 15 days lesser than in the control group.

Intensive fetus development occurs in the last two months before calving, so the main goal of the dry period is to provide the healthy fetus with necessary nutrients to complete the development. A pregnant cow restores the necessary amount of nutrients and biologically active substances during this period, and the mammary gland also develops. In this period, metabolic processes increase by 30-40%. The physiological duration of the dry period is 60 days. Our studies have established that length of the dry period of the experimental groups’ cattle was within physiological values. It should be noted that this indicator of cows of the 1st experimental group was 64 days, which is 7 days lesser than of animals of the control group.

One of the key parameters of the cattle reproductive ability is the number of inseminations per one fertilization. The insemination index of the 1st experimental group was 2.07; which is 0.15 sperm doses lesser than in the control group.

One of the important indicators characterizing the fecundity of the brood stock and the regularity of calving during the calendar year is the reproductive rate. Our research has established that the level of reproductive ability of cows fed with the “Lacto C” was 0.89 units, which is 0.03 units more than in the control group.

Under the influence of a number of factors, not only the chemical composition changes, but also the technological properties of milk. The analysis showed that the use of energy

supplements did not significantly affect the change in milk density in the experimental groups (Table II).

TABLE II. TECHNOLOGICAL PROPERTIES OF COW MILK ($\bar{X} \pm S_x$)

Indicator	Group		
	Control	Experimental	
		1st	2nd
Density, g/cm ³	1027.98±0.52	1028.39±0.54	1028.28±0.20
Acidity, °T	16.81±0.23	16.52±0.21	16.60±0.26
Thermal stability group	II	I	II
Rennet coagulation time, minutes	14.45±0.35	13.88±0.37	14.19±0.36

Studies have established that the acidity of cow milk of the 1st experimental group was the lowest – 16.52 °T, which is 0.29 °T less than of the control group. The ability of milk to maintain the initial colloidal-dispersed properties of proteins under the influence of high temperatures (115-140 °C) determines its thermal stability. Milk of the first experimental group, corresponded to group I, in terms of thermal stability. It is likely that the changes in the thermal stability index are due to the optimization of the energy supply of cows.

One of the main technological properties of milk is its ability to coagulate with rennet ferment. In the process of rennet coagulation of milk, its composition and properties, soluble calcium content, clotting temperature and other factors play an important role. Our studies have established a decrease in the time of rennet coagulation of milk of animals of the 1st experimental group by 0.57 min, compared with the control group, and by 0.31 min, compared with the 2nd experimental group.

The use of energy supplement as a part of highly productive cows’ diets had a positive effect on the biochemical blood composition of the experimental cows (Table III).

TABLE III. BIOCHEMICAL BLOOD PARAMETERS OF EXPERIMENTAL ANIMALS ($\bar{X} \pm S_x$)

Indicator	Standard	Group		
		Control	Experimental	
			1st	2nd
Glucose, mmol/l	2.5-5.0	2.90±0.17	4.10±0.36*	3.87±0.35
Urea, mmol/l	2.0-5.5	4.73±0.35	4.10±0.42	4.33±0.32
Creatinine, mmol/l	56.0-162.0	77.57±5.46	85.70±4.61	79.10±4.31
Total bilirubin, μmol / l	0.0-8.5	4.73±0.38	1.33±0.78*	2.50±0.72
Alkaline phosphatase, units/l	20.0-100.0	71.33±4.06	65.67±2.33	67.33±2.33
Cholesterol, mmol/l	2.0-5.0	4.40±0.38	4.47±0.30	4.53±0.38

Note * P < 0.05.

Thus, the glucose concentration was within the physiological norm in the experimental animals, however, the glucose level was 41.38% (P < 0.05) higher in the blood serum of cattle in the 1st experimental group, than in the control group, which suggests that that feeding the “Lacto S” energy supplement improves liver function during gluconeogenesis.

The functional state of the liver can also be estimated by the concentration of urea in the blood serum, since this is the

final product of protein hydrolysis with the subsequent formation of ammonia, which is absorbed into the blood and, when it enters the liver, is converted into urea. We found that energy supplements reduce the level of urea in the blood serum. Its concentration was 4.10 mmol/l in the blood serum of cows in the 1st experimental group, which is 15.37% less than in the control group. A decrease in the level of urea is also likely to contribute to the creation of favorable conditions for the rumen microbiota activity.

Creatinine is the final product of the conversion of creatine phosphate, which serves as an energy source for muscle tissue. Its concentration in blood serum, as a rule, has a constant value, which depends on the balance of metabolic processes in the muscle tissue and excretory function of the kidneys. Therefore, an increase in its level, most often, indicates a violation of filtration in the renal glomeruli. So, the creatinine content in the blood serum of cows of the experimental groups corresponds to the physiological standards for healthy cows. It should be noted that its level in the blood serum of cows of the 1st experimental group was 10.48% higher than in the control group and amounted up to 8.13 mmol/l.

The main component of bile is the total bilirubin. Its formation in the blood is primarily associated with the destruction of old red blood cells. A significant decrease in the bilirubin content in the blood serum of cows of the 1st experimental group by 3.6 times, compared with the control group, is probably associated with the restoration of the function of damaged liver cells.

One of the catalysts for the decomposition of phosphoric acid is the alkaline phosphatase enzyme, which plays a protective role in the normalization of intestinal microbiota. The use of energy supplements contributed to a decrease of alkaline phosphatase in the blood serum by 8.62% in the 1st experimental group and by 5.94% in the 2nd experimental, compared with the control group. The decrease in the content of alkaline phosphatase in the blood serum of the experimental groups is probably due to the normalization of the liver during energy supplements feeding, despite the concentrate type of feeding.

The proteolytic cholesterol enzyme performs a hormone-producing building function, participates in the absorption of vitamin D, and also improves digestion and takes part in the work of the serotonin receptor system. An analysis of the results showed that the level of cholesterol in the blood serum of the experimental animals did not differ significantly; so the use of energy supplements did not affect the concentration of cholesterol in the blood serum.

IV. CONCLUSION

Supplementary feeding of highly productive cows of Black Pied cattle breed with the "Lacto S" energy supplement at a dose of 200 g per animal per day increases the level of milk yield, improves the physicochemical and technological properties of milk, and also balances the physiological status and reproductive performance of animals.

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