ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

The Effect of Microelement Agents on the Ruminal Digestion and Metabolism of Cows.

Sergey Yu. Smolentsev[1]*, Firaya K Akhmetzyanova[2], Alizade S Gasanov[2], Elena L Kuznetsova[2], Aliya R Kashaeva[2], Delius R Sharipov[2], and Ramil N Fayzrakhmanov[2].

[1]Mari State University, Lenin Square1, Yoshkar-Ola city, 424000, Russia
[2]Kazan State Academy of Veterinary Medicine named after E.N. Bauman, Sibirsky tract, 35, Kazan city, 420029, Russia

ABSTRACT

The results of the research serve as a basis for replacing biogenic metal sulfates to their citrates in lactating cow premixes, which improves the bioavailability of feed nutrients, enhances ruminal fermentation, has a positive effect on milk production and milk quality. Blood values responsible for major metabolic processes in the body of cows of the experimental group which received mineraland vitamin premix differ slightly from those in the control group. The introduction of this agent into the cows' diet increases the content of mineral substances in milk.

Keywords: cows, milk production, chemical composition, microelements, ruminal fermentation, volatile fatty acids.

Corresponding author

ISSN: 0975-8585

INTRODUCTION

The problem of increasing agricultural production is one of the most important in modern animal farming, which is conditioned, on the one hand, by a significant reduction in the number of cattle, and, on the other hand, by a sharp reduction in farm animals productivity, so provision of a person with full-fledged farm animal products remains the greatest task of the agrarian complex of the country. Milk is a valuable food product. It plays an important role, especially during the first days of life of humans and animals. It includes all substances necessary for body functioning: proteins, fats, carbohydrates, mineral elements, and vitamins [1]. All these milk components are well balanced, which helps to be easily and fully absorbed by the body and contribute to increasing the overall resistance of human organism to diseases. To maintain a stable high milk production, cows need strong constitution and good health. The body of a lactating cow needs to replenish the physiological demands used for milk production. So their diet should have enough protein, carbohydrates, fats, macro- and microelements [2]. In case of their shortage the body spends nutrients in the body on milk production, as a result there are various diseases, such as osteodystrophy. In terms of environmental deficiency of separate micro - and macro elements the metabolism slows down considerably which leads to various pathological changes in the body, including decline in productivity and quality of the received products [3].

Biometals can help to influence the carbohydrate, fat, protein and mineral metabolism in the body. The application of various mineral agents can have a direct influence on feed efficiency, animal productivity and product quality. The mixed feed of domestic and foreign production includes additives without regard to local peculiarities of fodder resources. Lack of microelements in the diets of animals is usually compensated by means of sulphates which are difficult to absorb and not always effective [4,5]. The low efficiency of inorganic salts of microelements is associated with inadequate bioavailability of the contained cations. It does not usually exceed 20-30%. And in those cases, when the mixed feed included chelate compounds of microelements, their content in tissue depots increased by 30-50% [6,7]. Therefore, the introduction of biogenic metals in easily digestible form into the diets of animals is of great practical importance. And more efficient solution to this problem is the creation of their natural forms (proteins, chelates) or new agents containing organic forms of microelements. In this regard, the development of a new vitamin and mineral premixes on the basis of citric acid and microelements is relevant [8,9,10]. Microelements contained in these agents are in a stable chelated form which prevents metal binding with other compounds hindering its absorption in the digestive tract; they do not show inhibitory effect both to each other and to vitamins and other biologically active components. This allows using the combination of different citrates and vitamins in one agent.

MATERIALS AND METHODS

The aim of the research was to study the effect of feeding with mineral and vitamin premix on ruminal digestion, milk production and milk quality of cows. The object of the research was dairy black-and-white Holstein cows of the second lactation, when they were kept in the farm of the Belgorod district during the winter stall-feeding period. The experiment lasted 115 days, including 15 days of the preliminary period and 100 days of the accounting period. For the experiment, according to the principle of analogues, there were two groups formed of 8 dairy cows. The cows were fed in accordance with the farm regulations. The lack of minerals and vitamins in the main diet for the cows of the control group was replenished with the standard premix (consisting of inorganic compounds) at the rate of 1% to the diet, in the experimental group - with mineral and vitamin premix consisting of citrates of microelements in the amount of 60 g per cow per day. Milk production of cows was recorded by conducting test milking every ten days with the determination of the qualitative composition of milk. To assess the provision of cows' bodies with nutrient, mineral and biologically active substances it was necessary to determine biochemical values of blood serum which are most wide-spread in the veterinary practice: total protein, glucose, urea, alkaline reserve, calcium, phosphorus, carotene. The study was carried out at the veterinary station.

RESULTS AND DISCUSSION

The productivity of cows is largely dependent on their provision with exchange protein, which is known to be formed by microbial protein delivered from the stomach into the intestine, feed protein not decomposed in the rumen, and endogenous protein. A special role in the exchange of nitrogen-containing compounds among ruminants is given to the rumen, which is the place to perform the processes of amino acid

proteolysis and deamination, as well as biosynthesis of microbial protein. Proteosynthesis of non-protein nitrogenous compounds largely depends on the presence of easily fermentable carbohydrates, which are a source of keto acids necessary for the synthesis of amino acids. The degree of the use of nitrogenous substances in the feed and amino acid composition of protein available for absorption in the intestine depends on the state of ruminal digestion, the number and activity of microflora living in the rumen. Our experiments show that the feeding mineral premix containing the citrates of microelements contributed to the increased intensity of metabolic processes in the rumen of lactating cows of the experimental group. The activity of the ruminal fermentation is demonstrated by the level of volatile fatty acids (VFA) in its liquid, because the rumen microorganisms convert up to 50% of the feed carbohydrates into the acetic, propionic, oil and other acids which are absorbed by the forestomach walls, enter the bloodstream and are used in metabolism providing 70% of animal energy. The concentration of volatile fatty acids (VFA) in ruminal fluid of cows of the experimental group increased to 10.5 mmol/100 ml in 3 hours after feeding compared with 9.6 mmol/100 ml in the control group. Acetic acid was predominant among the VFA amounted to 65.8%, whereas propionic acid made 20.6% and oil acid - 14.6%. Each of these acids has a certain physiological function. Acetic acid is a precursor of the milk fat, propionic and oil acids are involved in the energy supply of the body, the first being a glucogenic factor and the second being a one of the sources of ketone bodies. Therefore, the increase of these acids in ruminal contents of cows of the experimental groups can be considered as a positive phenomenon. For example, a reliable increase in the concentration of acetic acid in the ruminal contents of cows of the experimental group by 6.1% compared to the control group contributed to the consistent increase in milk fat. The intensity of proteolysis in the rumen can be measured by the change in the content of nitrogen-containing compounds of different chemical nature in the ruminal fluid. The content of total nitrogen in the rumen fluid of cows in 3 hours after feeding increased to 90.9 mg/100 ml compared with 86.2 mg/100 ml in the control group.The content of nonprotein nitrogen in the ruminal fluid of cows also increased to 22.1 and ammonia to 7.8 mg/100 ml in comparison with 21.2 and 7.2 mg/100 ml in the control group respectively. This means that when animals of the experimental groups consumed the premix containing citrates of metals, the rumen was evidently more inhabited by microflora and digestive processes were held more intensively, which had a positive effect on the overall metabolism of the body and helped to increase the gross yield of milk by 16.9%. The biological full value of milk is determined by its chemical composition, i.e. content of proteins, lipids, carbohydrates, mineral substances and other components in milk. Milk and dairy products, due to their high nutritional value and good digestibility, are valuable and indispensable food for a person of any age, and full value of milk and dairy products is conditioned not only by the contained organic substances but also by many minerals (Macro & Microelements).

As the results of our research have shown, the introduction of the organic salts of biometals in the diet of cows improves the quality of milk; at the same time fat content increases by 0.14%, protein – by 0.15%, lactose - by 0.24%, dry matter – by 0,48%, values of mineral and vitamin composition of milk improve as well. Thus, the content of total calcium in the milk of cows of the experimental group was higher than in the control group by 5.0%, phosphorus – by 5.1%, iron – by 14.3%, copper – by 12.5%, zinc – by 13.4%, cobalt – by 13.1%, manganese – 9.7%, iodine - by 16.7%, carotene – by 5.9%, vitamin A - by 4.8%, vitamin D - by 3.5%, vitamin E - by 4.0%. Cows of the experimental groups having received mineral and vitamin premix expressed their genetic potential more fully and used nutrients in the diet for milk production more efficiently. Data of milk production of cows, fat and protein content in milk during the accounting period of the experiment are shown in Table 1.

Table 1: Milk production by cows

Value	Group	
	control	experimental
Average daily milk yield per cow during the accounting period, l	12.74	13.95
Milk yield per group in terms of 4% fat in the accounting period, l	1084,82±106,8	1145,15±62,32
Average content of fat in milk per cow, %	3.70	3.56

ISSN: 0975-8585

Amount of fat per group in the accounting period, kg	43,39±4,27	45.8±2.48
Average protein content in milk per cow, %	3.24	3.28
Protein content per group in the accounting period, kg	38.10±3.22	42.14±2.11

Table 2: Biochemical parameters of cow blood serum

Value	Group				
	control		experimental		Norm
	beginning	end	beginning	end	
Total protein, g/%	78.4	75.9	81.8	77.2	72–86
Glucose, mmol/l	3.0	5.86	3.0	4.88	2.2–3.3
Alkaline reserve, the amount of CO^2	54.1	66.5	52.2	65.4	46–66
Urea, mmol/l	2.3	0.75	2.2	1.41	3.3–6.7
Calcium, mmol/l	2.95	2.78	2.92	2.89	2.5–3.12
Phosphorus, mmol/l	2.42	3.09	2.42	3.07	1.45–1.94
Carotene, mg/%	0.73	0.33	0.75	0.28	0.4–1.0
Calcium to phosphorusratio	1.22	0.92	1.20	0.94	1.64

The analysis of the data in Table 2 noted the tendency to an increase in total protein in the blood serum of the experimental cows, indicating an increasing synthesizing liver function and enhancing protein metabolism in the animal body. One of the values of carbohydrate metabolism is glucose, the level of which in blood depends on a number of factors, in particular on the total quantity of easily soluble carbohydrates in the diet and forestomach functions among ruminants. Having analyzed the level of glucose in the blood of the control and experimental groups, we can state the decrease of glucose level to 4.88 and 5.25 mmol/l among animals of the 1st and 2nd experimental groups, which is apparently associated with increased glycolysis or increased glycogen synthesis in the liver of cows. Values of alkaline reserve in blood remained within the physiological norms in the control and experimental groups throughout the entire experiment. Changes in urea content in blood were noted both in the experimental and control groups by the end of the experiment, allowing to speak about the strengthening of the processes of ammonia conversion into urea in the liver. According to the results of calcium and phosphorus metabolism, one can judge about normally occurring metabolic processes and maintaining acid-base homeostasis in animal bodies. The ratio of calcium to phosphorus in the blood serum at the end of the experiment was 0.92 in the control group, 0.94 in the 1st experimental group and 0.97 in the 2nd experimental group. The decrease in the carotene level in the blood serum is explained by the reduction of its quantity in the diets of animals and the transition from grazing system to stalling.

CONCLUSION

Thus, the results of the research may allow to conclude that the replacement of standard microelement premixes based on the sulfate salts with the agent under study contributed to the increased activity of the microflora in cow forestomach, the increased secretion of digestive juices and their increased

enzymatic activity; it favored the proteinosis activation and maintenance of the significant proteolysis, as well as biosynthesis of amino acids of ruminal digestion and led to the increase in milk production.

REFERENCES

[1] Bagrov A.M., Bondarenko L.G., Gamygin E.A. Technology of pond pisciculture2014: 358.
[2] Burlachenko I.V., Yakhontova I.V. Proceedings of VNIRO2015; 153: 137-153.
[3] Alami-Durante H., Fauconneau B., Rouel M., Escaffre, A.M. J. Fish. Biol. 1997; 11: 1285-1302.
[4] Ennion S., Gauvry L., Butterworth P., Goldspink, G.J. Exp. Biol. 1995; 198: 1603-1611.
[5] Fauconneau B., Alami-Durante H., Lacoche M., Marcel J., Vallot D. Aquaculture 1995; 129: 265-297.
[6] Johnston I.A. San Diego: Academic Press2000: 318.
[7] Semenov E.I., Semenov E.I., Tremasov M.Y., Matrosova L.E., Tarasova E.Y., Kryuchkova M.A., Smolentsev S.Y., Korosteleva V.P. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2016; 7(1): 1860-1868.
[8] Rowlerson A., Vegetti A. Muscle development and growth. Academic Press 2001: 103-140.
[9] Vieira V.L., Norris A.A., Johnston I.A. J. Aquaculture2007; 272: 100-109.
[10] Weatherley A.H., Gill H.S., Lobo A.F J. Fish Biol. 1998; 33: 851-859