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Correction Of Metabolic Disorders In Ketosis Using Energy Metabolism Substrates.

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ABSTRACT

The aim of the research was to evaluate the effect of an injection preparation, including succinic acid and organic phosphorus, on some biochemical blood parameters of patients with subclinical ketosis of cows. Three groups of cows with ketosis were formed, 10 heads each. The first group was administered intramuscularly three times with an interval of five days of the studied drug at the rate of 10 ml / animal, the second - 15 ml / animal, the third group served as a control. The analysis of the biochemical status of animals in the conditions of the dairy complex "New Sheshma" of the Republic of Tatarstan at the first stage of the experiment revealed deviations of carbohydrate, protein and lipid metabolism in cows, which characterize subclinical ketosis. It was established that intramuscular injection of the test agent to cows of the experimental groups over the period of the experiment led to a significant increase in blood glucose in cows of the experimental groups by 15-27% compared with the control and to a significant decrease in the total number of ketone bodies in cows of the experimental groups of 2-2, 5 times. Established positive changes in the quantitative expression of the milk productivity of the cows of the experimental groups. Thus, the average daily milk yield for fresh cows in the experimental groups was 6-10% higher than in the control.

Keywords: cow, subclinical ketosis, blood, succinic acid, phosphorus, total protein, albumin, glucose, ketone bodies, cholesterol

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INTRODUCTION

Ensuring the health of cows, and as a consequence, an increase in the period of their production exploitation is the most important problem of veterinary science and practice. Among the many causes of premature retirement of cows from the herd, profound disturbances in metabolic processes are of decisive importance [1]. One of the most common diseases of highly productive cows is ketosis [2, 3]. It is well known that the negative energy balance during ketosis is covered mainly due to gluconeogenesis, which occurs mainly in the liver [4,5]. The intensity of gluconeogenesis and glycolysis is regulated by the bioavailability of phosphorus, since it plays an important role in the metabolism of carbohydrates in the liver, within which all intermediate products of gluconeogenesis must be phosphorylated [6,7]. In addition, the prevention of disorders occurring during ketosis is associated with the possibility of relieving gluconeogenesis, and thus releasing oxaloacetate for energy. This workaround is associated with the use of the propionate pathway for obtaining glucose in the blood, and succinic acid can be used as an activator of such a pathway [8]. Thus, we assumed that the composition consisting of succinic acid and organic phosphorus, developed at the Department of Therapy and Clinical Diagnostics with X-ray, may be a biologically active means of directional action in order to prevent and normalize possible metabolic disorders of dairy cows, in t. h with ketosis.

MATERIALS AND METHODS

To confirm the diagnosis of “subclinical ketosis”, fresh cows belonging to the New Sheshma Company of the Republic of Tatarstan were selected, Holstein black-and-white breed, 3-4 lactations were examined by clinical examination, the determination of ketone bodies in the urine and milk with Ketotest test strips with further clinical research according to the standard scheme. For the rapid determination of ketone bodies in the blood, a Free Style Optium glucometer adapted for measuring β-hydroxybutyric acid as the most stable fraction of ketone bodies was used.

In order to study the effect of the test substance on some biochemical parameters, three groups of cows of patients with subclinical ketosis were formed, 10 animals each. The first group of cows was injected three times intramuscularly with an interval of five days of the study drug at a dose of 10 ml, the second - 15 ml, the third group served as a control.

Clinical, physiological and hematological parameters of blood served as criteria for evaluating the effectiveness of therapeutic and preventive measures, which were studied every 10 days during the experimental period. Clinical studies of animals and morphological studies of blood were carried out by standard methods. Ketone bodies were determined in blood serum by reaction with salicylic aldehyde, total protein by the refractometric method, albumin level, glucose, cholesterol, triglycerides, and serum urea using a biochemistry analyzer Biochem SA based on the laboratory of the veterinary clinical diagnostic center.

The data obtained as a result of the research were subjected to variation-statistical processing using the Student's criterion of reliability on a personal computer using Microsoft Excel.

RESULTS AND DISCUSSION

In order to monitor the level of metabolic processes in animals, an outpatient examination of fresh-water cows was carried out. 3-4 lactations of golshtinizirovannoy black-and-white breed according to the standard technique.

In the analysis of the diet of dairy and dry cows, it was established: a significant excess of raw and digestible protein, a sharp decrease in sugar and some minerals (phosphorus, sulfur, zinc, cobalt, iodine). Sugar-protein ratio was 0.4, which is significantly below the norm. In addition, in the feeding of dry cows of this economy until the moment of calving, a significant amount of silage is used, often with the content of butyric acid, which is confirmed by the data of laboratory analysis.

The imperfect structure of diets, low sugar-protein ratio, the presence of butyric acid in the silo caused a change in the digestive processes in the foregut and a violation of carbohydrate-protein metabolism in cows, which was confirmed by the results of a clinical study of cows and laboratory analysis of blood, urine and milk.

Clinical studies of 100 cows revealed: pathology of the cardiovascular system - in 15% of animals, impaired digestive tract activity in the form of reduced food excitability, lethargic, rare gum, rumen hypotension - in 20% of animals, an increase in liver boundaries, its soreness - in 40 % of animals, symptoms of mineral metabolism disorders - in 30% of cows.

Due to the fact that such symptoms are not strictly pathognomonic, blood was collected from the examined population to determine the extent of metabolic disorders, followed by hematological examination.

An analysis of biochemical blood tests showed that all of the cows studied had a blood glucose level lower than the standard values by 15% and averaged 1.96 mmol / l. The alkaline reserve in the blood serum of all the studied cows was significantly reduced and amounted to 394-408 mg%, which is lower than the average standard values by 13-14% (the norm is 460-540 mg%).

The level of ketone bodies under farm conditions was determined by the express method using a glucometer adapted for measuring β-hydroxybutyric acid, by the method described above. Of the 50 cows examined in this way, the permissible level of β-hydroxybutyric acid was exceeded in 20 animals (40%) and ranged from 1.1 to 2.8 mmol / l. This was also confirmed by the qualitative reaction of the determination of ketone bodies in urine and milk. Ketouria and ketolacty were found in these cows in 75 and 15% of the samples studied, respectively. Hypoglycemia, acidotic state, acetonemic syndrome (ketonemia, ketouria and ketolactia) suggest the spread of subclinical ketosis in the household among the hotels.

In the background study, in all groups of cows, the number of erythrocytes was at the lower boundary of the physiological level, which may be due to the inhibitory effect of ketone bodies on hematopoiesis, and also, possibly, due to iron deficiency in the postpartum period.

It is known that the subclinical form of metabolic disorders, in particular ketosis, is often accompanied by a lack of a clear clinical picture of the disease and changes in blood morphological parameters that are within physiological norms, while blood biochemical parameters, reflecting the level of metabolism, may differ significantly from normal quantities/

The total protein content in the blood of cows of the experimental and control groups at the beginning of the experimental period was above the physiological limits (Table 1), which was due to the high-protein feeding level. At the same time, the dynamics of changes in the indicator under consideration in the blood of cows of the studied groups further had differences. Thus, in all experimental groups there was a decrease in the concentration of total protein in the blood to normative reference values. By the end of the experiment, the level of protein in the groups to which the test drug was used became higher than the control group by 10-11%.

The dynamics of changes in the level of albumin in the blood of both groups differed from that in total protein. Thus, the concentration of the albumin fraction increased throughout the entire experiment in the experimental groups and was not significantly reduced in the control group, which can be explained by an improvement in the protein-synthesizing function of the liver under the influence of the preparation. At the same time, despite the growth, this indicator during the whole experimental period was within the physiological limits, both in the experimental and in the control groups.

Table 1: Some indicators of protein, carbohydrate metabolism in experimental cows (M±m, n=10)

Группы	Terms of research, days			
	background data	10	20	30
	Total protein, g/l			
1 group	88,4±3,97	78,0±6,74	78,0±2,12	74,6±2,96*
2 group	90,4±4,50	84,0±5,65	80,0±3,67	76,6±2,07*
Control	86,2+2,58	80,6±3,5	71,8±2,94	67,8±7,9
	Albumen, g/l			
1 group	33,32±4,57	37,26+2,89	35,98+0,97	36,66±2,33

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2 group	34,62±2,36	35,64+2,64	37,32+1,38	38,20±1,3
Control	34,56±2,11	33,22+2,38	30,2+2,43	30,08±2,96
	Urea, mmol/l			
1 group	7,0+0,11	7,38±0,10	7,12±0,11	7,42+0,21
2 group	6,9+0,25	7,08±0,29	6,92±0,09	6,58±0,19
Control	7,06±0,23	6,82±0,17	6,72±0,07	6,32±0,13
	Glucose, mmol/l			
1 group	1,96±0,09	2,54±0,09	2,68±0,03	2,42±0,09
2 group	1,97±0,06	2,64±0,08	2,82±0,05	2,66±0,07
Control	1,96±0, 03	2,24±0,06	2,28±0,04	2,12±0,04

The content of glucose in the blood of highly productive cows is one of the most important parameters of carbohydrate metabolism. It is well known that one of the main causes of ketosis is the insecurity of the body during the period of digestion of easily digestible carbohydrates, which is expressed by hypoglycemia. Our research confirms this fact. The level of glucose in the serum of all animals was 15% lower than the standard values. In the future, it increased in all experimental groups, which may be due to the physiological compensation of the organism mobilizing additional sources of energy. At the same time, in the control group this indicator increased slightly - by 8%, in the first experimental group by 23.5%, and in the second by 35%, reaching maximum values on the 20th day of the study.

In the period when the high plastic and energy needs of the body for milk formation cannot be fully covered by the nutrients supplied with food, there is a shortage of energy, which is the trigger mechanism of excess ketogenesis [9]. The initial stage of the disease is characterized by significant changes: ketonemia, canonuria and ketolacty, which we observed in animals at 8-10 days after calving.

The results of the study of the concentration of total ketone bodies and their fractions in the blood serum are presented in Table 2. In our studies, cows treated with the drug in various doses, the main indicators of ketogenesis (OCT, AcAc, HH) significantly decreased, and the HH / AcAc ratio increased. While, in the control group of cows, the value of these indicators decreased slightly, remaining at a higher level relative to the analogues of the experimental groups.

Table 2: The content of ketone bodies in experimental animals (M±m, n=10)

Группы	Terms of research, days			
	background data	10	20	30
1 group Total amount of ketone bodies (OCT), mg% β – hydroxybutyric acid (HH) Acetone + acetoacetic acid (AcAc)	10,2±0,2 5,9±0,02 4,3±0,02	9,86±1,12 5,2±0,56 4,66±0,34	8,9±2,34 5,3±0,12 3,6±0,25	6,94±0,35 4,44±0,42 2,5±0,09
2 group Total amount of ketone bodies (OCT), mg% β – hydroxybutyric acid (HH) Acetone + acetoacetic acid (AcAc)	11,2±0,22 6,2±0,05 4,3±0,02	10,06±2,22 5,97±0,67 4,09±0,26	8,4±3,56 4,5±0,08 3,9±0,56	6,58±1,25 3,8±0,11 2,78±0,17
Control Total amount of ketone bodies (OCT), mg%	10,7±1,26	12,7±3,45	13,9±2,56	14,3±2,23

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β – hydroxybutyric acid (HH)	6,8±0,29	7,6±2,42	7,9±0,52	8,7±0,45
Acetone + acetoacetic acid (AcAc)	3,9±0,14	5,1±0,12	6,0±0,31	5,6±0,28

Thus, by the third study, the arithmetic mean values of the concentration of total ketone bodies in the blood of animals of the experimental groups were significantly lower than those of the control group by 2-2.5 times, which indicates the normalization of metabolic processes, while in the control group the level of ketogenesis remained without correction at high level

The increase in the second fraction of ketone bodies (acetone + acetoacetic acid) in the blood of patients with ketosis of control animals relative to the initial data against the background of a slight increase in OCT seems to be due to a violation of the synthetic processes in the body, in particular in the liver, and with an increasing degree of toxicosis caused an increase in the number of oxidized metabolites.

Cholesterol is a precursor of the hormones glucocorticoids and mineralocorticoids, which are involved in the processes of splitting fatty acids, the formation of ketone bodies, the development of the secretory cells of the mammary gland. In the initial period of lactation, these processes increase, and therefore, an increase in cholesterol indirectly reflects the intensification of metabolic processes. Excessive ketogenesis can also lead to an increase in cholesterol levels, since cholesterol is synthesized from acetyl coenzyme A molecules [10].

In the course of our studies, it was found that cholesterol levels in cows with subclinical ketosis were determined within physiological norms throughout the entire experiment period, but by the end of the research period in the control group, the studied parameter was 37–44% higher than in experimental groups (table 3).

The level of triglycerides in all groups had the same tendency in dynamics and was below the normative values throughout the entire study period by an average of 44%.

Table 3: Some indicators of fat metabolism (M±m, n=10)

Группы	Terms of research, days		
	background data	10	30
	Cholesterol, mmol / l		
1 group	2,54±0,41	2,16±0,11	2,04±0,21
2 group	3,04±0,31	2,18±0,24	1,94±0,41
Control	2,86±0,20	2,8±0,16	2,8±0,12
	Triglycerides, mmol / l		
1 group	0,12±0,02	0,16±0,03	0,11±0,01
2 group	0,14±0,02	0,14±0,01	0,13±0,02
Control	0,16±0,02	0,14±0,02	0,12±0,02

Analysis of the milk productivity of cows in the experiment showed a positive effect of the agent on milk yield, both during the period of use of the drug and in the subsequent period of lactation. The average daily milk yield for fresh cows in the experimental groups was higher by 9.6% and 5.7%, respectively, than in the control.

CONCLUSION

Thus, the composition of succinic acid and organic phosphorus, developed at the Department of Therapy and Clinical Diagnostics with X-ray, corrects metabolic processes in the body of animals, which is characterized by the normalization of carbohydrate-fat and protein metabolism and can be a biologically active means of preventive action and correction of metabolic disorders in dairy cows, incl. with ketosis.

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