Nutrition Influence on Blood Colloid and Biochemistry Parameters of the Lactating Cow

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The information about the metabolic changes in animal body is very important and usually obtained by biochemical analysis of cow blood. A surface tension measurement of the cow serum is a modern analytical approach for the preliminary assessment of biochemical blood composition. In turn, a feeding is one of the factors determining the physiological-biochemical status of the animal. The two animal groups: 1) on "summer" diet (with "green-grass" nutrients); 2) on "winter" diet (with "silage and the concentrate" nutrients) were formed in order to estimate the influence of the animal diet on the physiological-biochemical status. Both diets were balanced by nutrients and energy. The influence of "summer" or "winter" diet on such metabolic parameters as glucose, cholesterol, triglycerides, total protein and albumin fractions at the level of 10-20% was found by biochemical analysis of the cow blood. The difference between these groups at the level of mineral metabolism was minimal. The study assessed the reliability of the application of the biochemical method and measurements of surface tension of cow blood as the comprehensive assessment of the impact of diet on physiological-biochemical status of the lactating cows.

Keywords: Veterinary diagnostics, Biochemical analysis, Surface tension, Cow blood, Serum. biological active substances.

The information about the major properties of cow blood is an important in many aspects: from animal health estimation till the product quality assessment[1-3]. The comprehensive analysis of the colloid biochemical properties and dynamic surface tension (DST) parameters of cow blood is rapidly developing field of multidisciplinary research during the last years[4-6]. It is known[2, 4-7] that for healthy animals the content of biological active substances (BAC) in animal nutrition plays an important role. Feeding of the high-producing cows requires special attention and careful balancing rations for energy, nutrients, minerals and some essential BAC. It is of particular interest that the major types of animal digestion involve microflora[8, 9]. This is an important for digestive tract to establish a certain homeostasis of metabolites which can be absorbed and transported into the blood, forming the basis of its plasma[1, 4]. The intensity of the colonization of the digestive tract and the accumulation of microbial mass is dependent on the availability of affordable energy and nitrogen feed compounds[9, 10]. This can be achieved by means of different diets as well as the ratio between the body properties (genetic potential, milk yield, physiological condition, age, etc.) and feeding to be considered, regardless of the season[9]. This requires regular monitoring of the level of metabolic processes in the body of the

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animal. On the other hand, the monitoring allows to evaluate the state of animal health and the product quality assessment[11, 12].

The main aims of this study were the following: to obtain and compare the biochemical and surface tension parameters of cow blood serum; to evaluate the changes of these parameters depending on the animal feeding; to evaluate the reliability of these methods for the comprehensive assessment of the diet impact on biochemical and physiological status of lactating cows.

MATERIALS AND METHODS

The two cow groups of 10 animals each (as analogues from the farm total herd of black-motley breed cows – all of the 5 years old, 5 months of lactation, 3 month of pregnancy) were formed. During autumn time (September and October) the first group continued to receive so called "summer diet" (the diet based on the "green-grass" nutrients), whereas the second group started to receive the diet typical for the winter time (the diet based on the "silage and the concentrate"nutrients). Both diets were balanced by nutrients and energy. These experiments were fulfilled in order to estimate the influence of the animal diet on the animal physiological-biochemical status (PBS).

Blood sampling was fulfilled each morning by standard methods after the estimation of the basic parameters of animal PBS. The following parameters of the animal clinical examination were obtained (table 1):, respiratory rate (RR), heart rate (HR), frequency ruminatornyh movements (CHRD), thermometry (temperature), total animal weight, etc.

According to clinical examination (shown in Table 1) all animals were healthy at the time of the experiment and were kept in a state corresponding to the physiological norm (PBS) for their age group.

Biochemical analysis was performed on an automated biochemical analyzer URIT-8030 using the company's "Deacon" reagents. The following biochemical parameters of the animal blood were obtained: total proteins, albumins, globulins, glucose , cholesterol, triglycerides, some enzymes, minerals, etc.

The following parameters of the dynamic surface tension (DST) of the animal blood were obtained from dependences of surface tension (ó) vs. time (t), so-called "tensiogram", at the particular points: t'!0 ($ó_0$), t=0.1 s ($ó_1$), t=1 s ($ó_2$) and t=10 s ($ó_3$); or as the initial and final tilts of the tensiogram ($ë_0$ and $ë_1$ values, respectively). The DST parameters were measured by the "maximum bubble pressure" method (Maximum Bubble Pressure Tensiometer) on tensiometer BPA-1P (Germany, Sinterface Technologies).

RESULTS AND DISCUSSION

To estimate the difference between the biochemical parameters of both animal groups (Table 2) is important for the evaluation of the metabolism rate and levels of the most valuable metabolites [1, 8].

For example, the levels of total proteins and albumins in the group 2 of "winter diet" were by about 10% and 20% higher (table 2) than those in the group 1 ("summer diet"). This indicated the increasing rate of protein metabolism in the group 2 as compared to those in the group 1 that was connected with increasing animal body weight. In contrast, the level of major globulins was a little bit lower (by 3.6% only) than those in the group 1 ("summer diet") (table 2). This was an additional indication that the increasing rate of protein metabolism in the group 2 was due to the total protein mass, but not connected with the special proteins (such as immunoglobulins, transporting proteins, etc.). For example, almost the same level of immunoglobulins (functioning as antibodies [8]) in both groups was an evidence that no diseases (inflammation, cancer, etc.) observed by the increase obtained for total proteins content in the animal blood.

The levels of cholesterol and triglycerides in the group 2 of "winter diet" were by 13% and 32% higher (table 2) than those in the group 1 ("summer diet"). This indicated the increasing rate of lipid metabolism in the group 2 as compared to those in the group 1. These can be due to the increase in the lipoprotein fractions, because both these metabolites (cholesterol and triglycerides) are an important components of various lipoproteins[8].

The level of glucose in the group 2 of "winter diet" was lower by 14.6% (table 2) as

compared to the group 1 ("summer diet"). This indicated the decreasing rate of carbohydrate metabolism in the group 1 as compared to those in the group 2. This can be due to the increasing rate of energy usage in the group 2 by more intensive animal growth[8].

In order to prove the abovementioned conclusions, the following biochemical parameters of the major enzymes were measured (table 3).

It is important to highlight that the activity of all studied enzymes were in the normal physiological-biochemical ranges for these animals. The activity of the following enzymes (table 3): alanine aminotransferase (ALT), aspartate aminotransferase (AST), lactate dehydrogenase (LDG) were about 5% or lower (5.0%, 3.3% and 2.3%, respectively) that had no meaning for serious discussion. It is only important to highlight that the reactions of the amino-groups transfer between amino-acids and keto-acids (essential for protein

Table 1. The data of the animal clinical examination (n=10; X±Sx)

Indicators	The first group	The second group
RR, per minute	23±4.3	23±3.7
HR, per minute	69±6.6	72±4.9
CHRD, per 5 minutes	3,7±0.7	3.9±0.7
Temperature, °C	38.7±0.3	38.4±0.3
Service period, days	60.6±1.4	60.9±1.5
Total animal weight, kg	537±17	534±17

Significant differences between the groups * p ≤ 0.05; ** P <0.01; *** P <0.001

Table 2. Indicators of protein, lipid and carbohydrate metabolism in blood serum (n=10; X±Sx)

Indicators	The first group	The second group
Total proteins, g/l	71.6±3.6	78.8±1.7
Albumins, g/l	36.8±1.4	44.2±0.8
Some globulins, g/l	30.4±2.6	29.3±1.5
Glucose, mmol/l	2.81±0.17	2.40±0.22
Cholesterol, mmol/l	5.50±0.50	6.21±0.42*
Triglycerides, mmol/l	0.31±0.08	0.41±0.06*

Significant differences between the groups * p ≤ 0,05; ** P <0,01; *** P <0,001.

Table 3. Enzymes blood serum of cattle (n=10; X±Sx)

Indicators	The first group	The second group
Alanine aminotransferase, U/L	40.4±2.9	42.4±7.5
Aspartate aminotransferase, U/L	83.7±9.2	86.5±8.7
Lactate dehydrogenase, U/L	299±22	306±15
Alkaline phosphatase, U/L	52.1±10.43	49.1±6.5
Creatine phosphokinase, U/L	82.7±11.9	87.8±7.5
Gamma-glutamyl transferase, U/L	15.5±3.47	19.3±1.1

Significant differences between the groups * p ≤ 0.05; ** P <0.01; *** P <0.001

Table 4. Trace element composition of blood serum (n=10; X±Sx)

Indicators	The first group	The second group
Calcium, mmol/l	2.49±0.14	2.56±0.11
Phosphorus, mmol/L	1.27±0.16	1.54±0.29
Potassium, mmol/L	4.46±0.41	4.35±0.48
Magnesium, mmol/L	0.96±0.06	0.99±0.05
Sodium, mmol/L	132.6±5.3	138.1±4.8
Chlorine mmol/l	102.0±1.5	103.3±3.6

Significant differences between the groups * p ≤ 0,05; ** P <0,01; *** P <0,001

Table 5. The dynamic surface tension of the blood serum (n=10; X±Sx)

Indicators	The first group	The second group
σ_0, mN / m	64.41±0.67	67.09±0.91
σ_1, mN / m	58.32±0.45	50.32±2.28
σ_2, mN / m	54.93±1.18	54.15±2.32
σ_3, mN / m	47.6±1.15	50.28±2.21
σ_0, mN•m^{-1}s$^{-1/2}$	5.57±0.92	5.26±1.32
σ_1, mN?m^{-1}s$^{1/2}$	30.47±9.75	14.32±0.86*

Significant differences between the groups * p ≤ 0,05; ** P <0,01; *** P <0,001

metabolism), as well as the interchanges of pyruvate and lactate (essential for carbohydrate metabolism) are going in the normal metabolic pass ways. The activity of the alkaline phosphatase (table 3) was by 5.8% lower in the group 2 as compared to those in the group 1. This indicated the decreasing rate of carbohydrate metabolism in the group 1 as compared to those in the group 2. The activity of the creatine phosphokinase (table 3) was by 6.1% higher in the group 2 as compared to those in the group 1. This can be due to the increasing rate of energy usage in the muscle tissue for animal of the 2nd group by more intensive animal growth[8]. The most active is the gamma-glutamyl transferase (an increase on 24.5% in the group 2 as compared to those in the group 1) which is critical for the amino acid transfer to the cell cytoplasm. This is an additional indication that the increasing rate of protein metabolism in the group 2.

The trace element metabolism was assessed by the level of calcium, phosphorus, sodium, potassium, magnesium and chlorine in the animal blood (Table 4). As seen from Table 4, no significant differences were found between the groups.

The data of biochemical studies suggest that in the second group (where there was a change in the type of feeding) in the past month there was a complete adaptation to the new seasonal diet. At the same time the digestibility of forages fully maintains the health of dairy cattle.

By analyzing tensiograms the DST parameter $ó_1$ the second group by 13.7% higher in comparison with the first group. This is, possibly, because of a higher content of total proteins and albumins in the animals of the second group, and leads to a more pronounced decrease in the DST parameters (such as $ë_1$).

The analysis of correlations between biochemical and DST parameters of cow blood revealed strong correlations between the content of total proteins and parameter $ó_3$ (r = 0,62; -0,74), the content of albumins parameters $ó_0$ (r = 0,57; 0,69) and $ó_3$ (r = -0.53; -0.75). This correlations are indicators for intensive protein metabolism and very important for the physiological-biochemical status of the animal.

Thus, nutrition has a great impact on physiological-biochemical status of the lactating cows.

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