Organization and improvement of biochemical control of full-fledged feeding of cows

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Abstract. The current development of dairy cattle breeding raises an urgent problem of feeding improvement; it concerns the preparation of high-quality feed and diets depending on the physiological state of the animal. While solving this problem, it is necessary to pay special attention to the organization and improvement of biochemical control of full-fledged feeding of cows. This research pays considerable attention to the theoretical component of the topic, namely, it justifies the significance of zootechnic and physiological-biochemical methods used on dairy farms in order to control the completeness of cows feeding. The analytical study is based on the monitoring of biochemical control methods used in the studied farm for the purpose of prompt response to the organization of full-fledged feeding of cows; the recommendations are given on testing biological fluids in real time. The research also touches upon the aspect associated with metabolic disorders, which appear with an imbalance of vital substances in the diet and does not display any symptoms. The long-term influence of unbalanced feeding leads to diseases of animals and, accordingly, to economic damage due to a sharp decrease in milk production, reproductive capacity and other indicators. As a result, the genetic potential of animals is not fully realized. In this regard, it is evidently confirmed that in order to increase the productivity of black-and-white cows, it is necessary to constantly improve and optimize their feeding diets, to monitor the physiological state of animals using biochemical indicators.

1. Introduction
Feeding is the most important factor in the development of milk production. World practice in the development of livestock industries and many researchers, for example, M.T. Moroz et al. [1], A. Francesio et al. [2], RZ Zhong, et al. [3], M. Munnich et al. [4], L. Grille et al. [5] confirmed that in order to increase the productivity and maintain active metabolic processes in the body, the cows should receive all the normalized substances and elements in the optimal amount with the diet. With an increase in productivity, the intensity of metabolic processes also increases.

By now, practical experience shows that all normalized substances and elements play an important role in activating metabolic processes that affect reproductive functions, the level of productivity of animals, their vital activity, growth and development. Along with this, the due attention to metabolism peculiarities, monitoring and eliminating possible violations will help to increase the efficiency of dairy farming.

However, according to a number of authors [1, 5, 6, 7, 8], it is necessary in any case to maintain the content of nutrients and biologically active substances in the diets of dairy cows in accordance with their physiological needs.
The fact is that the completeness of feeding cows on dairy farms is controlled by zootechnic and physiological-biochemical methods. The first control makes it possible to assess diets in terms of nutritional value, feed intake, as well as the amount and chemical composition of milk, reproductive capacity of cows and other indicators. Biochemical control includes both laboratory and express methods for analyzing blood, milk, and urine. At the same time, professionals working in this field need effective and convenient methods and tools to conduct biochemical control of full-fledged feeding in an operational mode, based on the cows’ physiological state.

At the same time, some researchers [9, 10, 11] believe that there is a need for a new generation of professionals who will facilitate the transition to a new technological system, the introduction of innovations in agricultural production, the active use of information and analytical systems, including the organization and improvement of biochemical control of full-fledged feeding of cows.

2. Objects and methods of research
The research was carried out in the collective farm “Rossiya” SPK of the Novgorod Region [12, 13, 14]. The number of dairy cows of the black-and-white breed has remained at a stable level over the past 5 years and at present amounts to 900 head. Milk yield per average annual cow in 2020 amounted to 6001 kg of milk. This is 695 kg of milk or 13% higher than in 2019 and 860 kg or 17% higher than in 2016. Mass fraction of fat in milk is stable and remains at the level of 3.76%. Over the past two years, the mass fraction of protein in milk has increased and amounted to 3.02%. The profitability of dairy cattle breeding in the study period on the farm increased from 14.9 to 24.7%.

The farm has monitored the use of biochemical control over the completeness of feeding and the physiological state of animals. The analysis of cattle blood serum was carried out in accordance with the requirements of the normative documentation for test methods at the Novgorod Regional Laboratory of Veterinary Medicine.

The given research uses general scientific approaches. One of the research methods is the theoretical analysis of publications of foreign authors [2, 3, 4, 5, 6], which would improve the biochemical control of full-fledged feeding of cows.

3. Results and discussion
The organization of control over the completeness of feeding cows and the ability to respond quickly and to adjust the diet for nutrients can be done using biochemical and hematological indicators, which are manifested in deviations from the norm of a number of substances in biological fluids and tissues. As a rule, this is either an increase or decrease in concentration, or sometimes the appearance of an unwanted substance. At the initial stage of the subclinical course of the process, these changes may be imperceptible. Therefore, the increased requirements are imposed on the frequency of analysis, its accuracy and the specificity of analytical tests. In this regard, it is necessary to organize monitoring of biochemical parameters and to accumulate information using digital technologies. Health problems are associated with diseases that cause a decrease in productivity and the terms of the economic use of animals, their forced culling. Diseases are the result of profound metabolic disorders.

Usually biochemical studies reveal a variety of metabolic disorders in regards to proteins, carbohydrates, fats, macro- and microelements, vitamins.

The composition of the blood is usually maintained at a constant level (homeostasis), although shifts in the intensity and direction of metabolic reactions can be observed. With significant metabolic disorders, the composition of the blood changes significantly. At the same time, blood is one of the most important systems of the body, playing an important role in its life. It is an indicator showing a complete picture of metabolic processes in the body.

On the farm, blood samples are taken on an ongoing basis to determine the presence of such basic elements as calcium, phosphorus, total protein, reserve alkalinity, carotene. For completeness of the analysis, it is advisable to take into account the physiological state and daily productivity of the animal at the time of sampling.
Analyzing the results of the study of blood serum over the past three years, it is possible to note a tendency for the improvement of all the studied parameters. The calcium level should be in the range of 2.6–3.5 mmol/l, the content of this indicator in the group of animals under study was 2.2–2.6 mmol/l.

The phosphorus level should be in the range of 1.29–2.25 mmol/l, its content was 1.23–2.23 mmol/l, which corresponds to the norm.

According to the results, the content of total protein in the blood serum was in the range from 77.4 to 87.2 g/l with a norm of 70–89 g/l.

The content of reserve alkalinity in blood plasma should be 46–56 Vol. % CO₂, the actual content was from 47 to 51 Vol. % CO₂, which corresponds to the norm.

Carotene in animals’ blood serum fluctuated from 0.87 to 1.25 mg%. The last blood sampling was carried out on September 25, 2020, which corresponds to the grazing period, the norm for which is from 0.4–1.0 mg%.

One of the significant indicators characterizing the completeness of feeding cows is milk, which allows determining protein metabolism. An excess of protein in the diet increases the urea content in milk, with the upper limit 30 mg/100 ml of milk. If the milk protein content is within the normal range and the urea content exceeds 30 mg/100 ml, then the amount of protein in the diet should be reduced to avoid the load on the cow’s liver. If the urea content is below 15 mg, it means that the intake of protein is negligible and needs to be increased. The urea in milk depends on the digestibility of carbohydrates in the diet. This relationship is negative and indicates that the more dietary carbohydrates are available, the more likely it is that the decomposed nitrogen is used in the rumen and the less it passes into milk as urea. Feeds rich in starch and sugar will dramatically increase the protein in milk.

The reason for determining ketones in milk is to detect ketosis even before an outbreak occurs. If, as a result of feeding, a cow receives a small amount of energy, her body begins to produce ketone substances. It becomes especially evident during the milking period. Ketones, which are acetic acid and acetone, are released into milk, where they can be measured. If data on latent ketosis are obtained in a timely manner, then the disease can be treated before it causes losses to production.

Biochemical indicators of urine are often used to monitor the completeness of feeding cows. The rate of urine reaction in cattle with normal metabolism is alkaline pH 7.0–7.8.

There is practically no protein in the urine of healthy animals; usually, it is so little that it is not captured by ordinary samples. In turn, if there are a lot of proteins in the diet and the ash part is acidic, then the reaction can be acidic. A prolonged change in the reaction of urine towards an increase in acidic elements is a sign of the acidosis. It is considered normal when in the urine the total amount of nitrogen, urea nitrogen is 80%, of amino acids nitrogen – 4.8–5 and ammonia nitrogen 2.5–4.5%. In healthy cows, the content of ketone bodies in urine is 9–10 mg%. An increase in ketone bodies in the urine indicates ketosis (0.2–0.3 g/l).

The presence of protein in the urine is noted during ketosis and renal dystrophy, the presence of glucose is a sign of diabetes mellitus. A large amount of concentrated or acidic food contributes to a shift in the reaction of urine towards acidic and appears with acidosis. An alkaline environment is observed with rumen alkalosis, the intake of a large amount of sodium and calcium into the body. In some cases, urine tests can detect nutritional diseases faster than blood tests. Urine samples should be collected from at least 8 cows 4–8 hours after feeding. The manifestation of ketone bodies in urine is observed with a lack of carbohydrates, as well as with abundant breakdown of fats and proteins. The proportion of ketone bodies rapidly increases during the cattle ketonemia and diabetes mellitus.

4. Conclusion
As a research result, it was found out that the present development of dairy cattle breeding requires special attention to the biochemical control of full-fledged feeding, which allows detecting a variety of metabolic disorders in regards to proteins, carbohydrates, fats, macro- and microelements, vitamins. Diseases appear as a consequence of profound metabolic disorders and lead to economic damage. This fact confirms the importance of organizing and improving biochemical research. In this case, it is
advisable for the completeness of the analysis to take into account the physiological state and daily productivity of the animal at the time of sampling.

In the future, special attention should be paid to the introduction of adapted feeding norms for black-and-white cows, ensuring their need for nutrients.

Besides, for early detection and prompt response to physiological changes in animals on the farm, it is necessary to carry out biochemical control in terms of blood, milk and urine using the “Ketometer” device, “Ketogluk” test strips, “EasyTouch GC” biochemical analyzer, and other express-tests.

In this regard, the organization and further improvement of biochemical control of full-fledged feeding of cows by professionals will ensure the good health of animals, correct physiological processes combined with high productivity and optimal duration of their economic use.

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