Meeting the physiological requirements for energy and nutrients to manifest the genetic potential of dairy cattle

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Abstract. The paper presents the results of the scientific and economic experiment for the evaluation of the influence of the energy supplement included in the diet of lactating cows of the Brown Swiss breed. During the research period, all animals were kept in the same conditions, corresponding to zootechnical standards. They were divided into two groups differentiated only by the feed ration. The cows of the first (control) group were given rations typical for the farm corresponding to the feeding norms of dry and lactating cows. For the cows of the second group in the dry period (14 days before calving) the feeding ration was changed with a change in structure towards an increase in the proportion of concentrated feed, and immediately after calving, they received an energy feed supplement to maintain the physiological status of dairy cows after calving. Only clinically healthy animals participated in the experiment. It was revealed that the inclusion of the energy feed supplement in the diet of lactating cows in the experimental groups during lactation led to an increase in the productivity of livestock as compared with those in the control group.

1. Introduction

Dairy farming is the leading branch of animal husbandry in Russia and many countries of the world [1]. The issues of food security in Russia are based on the intensification of dairy farming, the main factor of which is the organization of full-fledged balanced feeding [2].

According to experts, the supply of high-grade feeds has the greatest impact on the productivity of cattle [3, 4]. The colossal loss of nutrients from the body of a lactating cow must be fully compensated by the influx of nutrients from the digestive tract through the processing of a sufficient and balanced diet [5].

One of the main reasons for the difficulties in the development of animal husbandry is the metabolic disorders of various types of substances (proteins, carbohydrates, lipids, vitamins, minerals - micro and macro elements) in the body of productive animals as a result of the imbalance in their feeding. Metabolic disorders are one of the most acute problems in modern animal husbandry in many countries. They cause structural changes in all organs and systems and impair the ability to perform physiological functions [6]. To drive active metabolic processes in cows, it is necessary to provide the optimal amount of normalized substances and elements in feed. The absence or excess of even one of them causes various metabolic disorders. It was practically confirmed that all normalized substances

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and elements are interconnected to activate metabolic processes that affect reproductive functions, the level of performance indicators, their vital activity, growth, and development. In terms of metabolic characteristics, monitoring and eliminating possible violations will increase the efficiency of dairy farming.

A number of authors believe that the diets of animals, including dairy cows, must contain a certain amount of nutrients and biologically active substances in accordance with the requirements [7]. In the conditions of modern livestock farming, the problem of reducing the productivity of cows, their economic longevity, and the production of calves are still some of the main difficulties in dairy farming due to the energy imbalance of cows feeding [8].

It is known that animals reveal their maximum genetic potential when getting a balanced feeding. The more accurately the animal nutrition (especially a highly productive one) needs are met, the higher is the nutritional value of milk and its processing properties. When balancing rations, these problems can be solved by choosing combinations of feed additives of the required composition [9].

The cow's body goes through a number of physiological conditions - the periods of dryness, calving, and lactation. In accordance with it, there are different approaches to feeding a cow at a certain stage of the physiological cycle, and, accordingly, various feed additives are used [10].

Lactation is an intense physiological process that requires high energy consumption of milk production. The demand for energy in animals is particularly high after calving when dietary nutrients cannot fully compensate for the energy lost for milk production. Therefore, as a rule, in the initial period of lactation, cows often have a significant energy deficit, which can lead to serious metabolic disorders.

The transition period is the most stressful for dairy cows in terms of metabolic rate and is characterized by dynamic changes in the hormonal profile, loss of appetite, negative energy balance, nutritional and vitamin deficiencies, decreased immunity and oxidative stress [11]. After calving, animals are faced with the problem of energy deficiency. Inappropriate feeding of fresh cows can cause a sharp decrease in live weight and productivity [12, 13].

At the beginning of lactation, high-yielding dairy cows experience a negative energy balance caused by a sudden increase in energy for milk production, while energy intake from feed during this period is limited [14].

The problem of balancing the diet of cows during lactation was practically solved with the introduction of various nutrients and energy additives [8]. However, there are quite a lot of energy supplements. So, it is necessary to test them in specific production conditions. Our research goal is to study the effectiveness of meeting the physiological needs for energy and nutrients to manifest the genetic potential of dairy cattle.

2. Materials and Methods
The studies were carried out on the basis of a peasant farm. The object of the study was Brown Swiss cows with an average live weight of 540 kg. To conduct a scientific and economic experiment, 12 heads of clinically healthy cows were selected, which, according to the principle of analogous pairs, were divided into two groups of 6 heads each.

The conditions of keeping animals in the groups were the same and corresponded to zootechnical standards. The differences in feeding between the experimental groups were as follows. The cows of the first (control) group were on the rations adopted on the farm corresponding to the feeding norms of dry and lactating cows. For the cows of the second group in the dry period (14 days before calving) the feeding ration was changed with a change in structure towards an increase in the proportion of concentrated feed, and immediately after calving, they received an energy feed supplement Reviva to maintain the physiological status of dairy cows after calving.

The energy feed supplement is a multicomponent mixture that is dissolved in water, and the solution is fed to the cow immediately after calving. This supplement contains bioavailable calcium, an electrolyte complex, prebiotics and probiotics, vitamins and microelements in chelated form, whey, organic acids, dextrose, wheat flour, flavor. The components of the supplement provide the cow with
readily available energy, and, along with the flavoring agent, stimulate the consumption of not only this drink but also stimulate the appetite, as a result of which the cow consumes the main feed faster and more, which helps to prevent abomasum displacement and stimulates milk production. The manufacturer of this additive is Trau Nutrition Voronezh LLC, Liski, Russia.

During the study, the composition of feed, hematological picture, feed consumption, clinical and productivity indicators of animals were assessed. The composition of feed was studied in the laboratory using Foss equipment for automated chemical analysis. Hematological assessment was carried out in the laboratory using Abacus Junior Vet hematological analyzer and biochemical analyzer Clima MC - 15. Feed consumption was determined by the difference between the amount of feed dispensed and the amount of feed left before the next dispensing. Milk productivity was taken into account by the method of control milking: the daily amount of milk from each animal was individually counted, followed by quality analysis. The experimentally obtained material was processed using Microsoft Excel.

3. Results and Discussion
Taking into account the animal's requirements for nutrients and energy during the production cycle, the diet should be balanced depending on the physiological state. A deviation from the norm in a particular nutrient or energy indicates an unbalanced feeding, which further affects the state of the animal's body. The feeding ration of Brown Swiss cows at the farm is presented in table 1.

Table 1. The feeding ration of Brown Swiss cows of the experimental groups

| Feed                  | Dry period (14 days before calving) | Milk production (14 days after calving) | Lactation 1 phase |
|-----------------------|-------------------------------------|----------------------------------------|------------------|
|                       | Amount, kg  | Structure, %  | Amount, kg  | Structure, %  | Amount, kg  | Structure, %  |
| Mixed grass hay       | 12          | 28           | 12          | 14           | 15          | 16            |
| Vetch-oat hay         | 8           | 53           | 15          | 62           | 25          | 57            |
| Concentrate mixture   | 1           | 19           | 2           | 24           | 3           | 27            |
| Characteristics       | Contained in the diet | Deviation from the norm | Contained in the diet | Deviation from the norm | Contained in the diet | Deviation from the norm |
| E.C.U.                | 14          | -            | 17          | -            | 19.5        | -             |
| DM, kg                | 14.1        | -            | 17.5        | -            | 21.5        | -             |
| DC, g                 | 1930        | -            | 2500        | -            | 2600        | -             |
| Sugar, g              | 1080        | -6           | 1500        | -11          | 1550        | -11           |
| Starch, g             | 1260        | -2           | 2600        | -7           | 2660        | -4            |
| DF                    | 2950        | +6           | 3400        | +5           | 3450        | +6            |
| Ca, g                 | 115         | -            | 117         | -            | 210         | -             |
| P, g                  | 65          | -            | 85          | -            | 88          | -             |

The diet included the following feeds: mixed grass hay, vetch-oat hay, concentrate mixture, which included grain feed and meal in a certain proportion depending on the stage of lactation. We note a quantitative increase in the group of concentrated feed at the stage of milk production and the beginning of lactation up to 27% of dry matter. This contributed to an increase in the total energy content of the diet. As shown by the analysis of the diet (Table 1), in general, it was balanced in essential nutrients. However, during the period of milk production and the first stage of lactation, there is a deviation in sugar and starch. This deficiency during the milk production period will significantly affect the energy content. Therefore, the introduction of a multicomponent energy supplement into the diet in the experimental group will help to normalize the energy nutritional imbalance.
The effect of introducing the energy feed supplement Reviva into the diet on the physiological state of animals was studied using the results of clinical and hematological indicators of the state of the cows' organism (Table 2-3).

**Table 2. Clinical indicators of the state of the body of cows, M±m**

| Characteristics | Meas. unit | Control group 1 Start of the experiment | End of the experiment | Experimental group 2 Start of the experiment | End of the experiment |
|-----------------|------------|----------------------------------------|-----------------------|---------------------------------------------|-----------------------|
| Temperature     | °C         | 38.1±0.33                              | 38.2±0.37             | 38.0±0.41                                  | 38.1±0.48             |
| Pulse rate      | beats/min  | 68.9±1.02                              | 70.1±1.24             | 68.6±1.09                                  | 70.9±1.33             |
| Respiratory rate| breaths/min| 24.3±1.34                              | 24.7±2.01             | 24.5±1.28                                  | 24.6±1.66             |

The data in Table 2 show that the pulse rate of cows in the experimental group increased by 0.8 beats/min in relation to the control group, and the temperature and respiratory rate decreased by 0.1 °C and 0.1 beats/min, respectively. However, the data were not reliable (P> 0.05), which may indicate that the introduction of the energy drink did not affect the state of the animals organisms.

**Table 3. Hematological parameters of experimental groups of cows, M±m**

| Characteristics | Meas. unit | Control group 1 Start of the experiment | End of the experiment | Experimental group 2 Start of the experiment | End of the experiment |
|-----------------|------------|----------------------------------------|-----------------------|---------------------------------------------|-----------------------|
| Erythrocytes    | 10¹²/l     | 6.9±0.67                              | 6.7±0.58              | 6.8±0.49                                    | 6.8±0.61              |
| Hemoglobin      | g/l        | 117.0±3.41                            | 117.7±3.54            | 117.3±2.95                                  | 121.9±2.89            |
| Leukocytes      | 10⁹/l      | 7.6±0.23                              | 7.6±0.31              | 7.7±0.29                                    | 7.4±0.37              |
| Total protein   | g/l        | 82.4±1.25                             | 82.6±2.01             | 82.6±1.42                                   | 83.3±2.15             |
| Calcium         | mmol/l     | 2.7±0.19                              | 2.8±0.37              | 2.8±0.28                                    | 2.9±0.46              |
| Phosphorus      | mmol/l     | 1.6±0.38                              | 1.5±0.29              | 1.6±0.34                                    | 1.7±0.55              |

The data from Table 3 show that the concentration of hemoglobin in the experimental group increased by 3.6% in relation to the control group, and the content of erythrocytes increased by 1.5%. This testifies to the observance of physiological norms in the blood of lactating cows and some normalization of metabolic processes in the body. So, observed is the positive effect of introducing an energy supplement into the ration of feeding cows after calving, when they experience a significant lack of energy, which physiologically cannot be replenished at the expense of basic feed.

One of the criteria for assessing the nutritional value of the diet and its balance, as well as for studying the positive effect of the feed additive is the level of milk productivity (Table 4).

**Table 4. Milk productivity of cows of experimental groups, M±m**

| Characteristics | Group of animals | 1 | 2 |
|-----------------|------------------|---|---|
| Average daily milk yield from a cow for the first month of lactation, kg | 19.4±1.05 | 20.1±0.93 |
| Average daily milk yield from a cow for the second months of lactation, kg | 21.7±0.55 | 23.3±0.51* |
| Average fat content in milk for the first three months of lactation,% | 3.7 ± 0.09 | 3.8 ± 0.06 |

* - reliably with P < 0.05;
month of lactation in the experimental group exceeded that of the control group by 3.6%, for 2 months of lactation it exceeded by 7.4%, respectively (P < 0.05). This indicates that the components of the energy supplement not only increased the energy and nutritional value of the diet of animals after calving, but also had a biological effect on the animal's body. The average fat content in milk for the first three months of lactation in the experimental group exceeded that of the control group by 0.1%. But the data are not reliable (P > 0.05). This may be due to the fact that the Reviva energy drink, introduced into the diet as an energy source, is mainly used for milk production and not for the synthesis of milk fat. In this regard, we state the fact that the introduction of an energy supplement into the diet of dairy cows at the first stage of lactation had a positive effect on milk production.

4. Conclusion
The addition of the studied energy supplement Reviva as a drink to the feeding ration of Brown Swiss cows after calving for energy balancing normalizes physiological processes and increases the degree of manifestation of the genetically inherent productivity potential of dairy cattle.

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