Nutrients digestibility and productivity of lactating cows consuming energy supplements

L V Sycheva¹, O Yu Yunusova¹, S V Pastukhov¹ and A N Popov²

¹ Department of Animal Production, Perm GATU, 23, Petropavlovsk str., Perm, 614990, Russia
² Department of Zootechnics, Perm Institute of the Federal Penitentiary Service of Russia, 125 Karpinsky str., Perm, Perm Krai, 614012, Russia

E-mail: lvsycheva@mail.ru

Abstract. The article provides the data of the scientific and economic experience in studying the influence of energy supplements included in the diet of lactating cows of black-motley breed during milking time on digestibility of basic nutrients and milk production. During the research period all experimental animals were kept in the same conditions corresponding to zoohygienic parameters. The differences were the following: in addition to the main silage consisting of alfalfa haylage, grass silage, grain turf and salt the animals of the experimental group I received “Cow Energy” supplement in a dose of 200 g/animal unit/per day; the animals of the experimental group II – “Ketostop-El” energy supplement at a dose of 200 g/animal unit/per day. Both supplements are of Russian production. Animals of the control group had only the main diet. Only clinically healthy animals participated in the experiment. It was found that the inclusion of energy supplements into the diet of lactating cows of the experimental groups compared with the ones of the control group during the milking period led to an improvement of the dry matter digestibility by 1.15–2.02 %, organic matter – by 0.92–2.19 %, raw protein – by 1.79–2.31 %, crude fat – by 1.88–2.35 %, crude fiber – by 0.80–1.88 % and nitrogen-free extractives – by 2.15–2.94 %. Also, it contributed to an increase in milk productivity and an increase in the qualitative composition of milk.

1. Introduction

In the conditions of the modern world livestock breeding the problem of reducing the productivity of cows, their economic longevity and the output of calves is still one of the main difficulties in dairy cattle breeding in the reason of the violation of the feeding balance of lactating cows particularly during the milking period in energy, biologically active and mineral substances [1]. The hormonal background of newborn cows changes, the level of metabolism aimed at the synthesis of milk constituents increases. No more than 30 % of the feed protein is used for lacto protein synthesis [2, 3]. However, in the first days after calving cows are not able to consume a large amount of feed needed to satisfy the requirements for basic nutrients and energy [4]. Therefore, in order to provide animals with nutrients during this period specialists use the diets with a concentrated feed share of more than 50 % [5]. The use of highly concentrated diets leads to a violation of ruminal digestion; it reduces the activity of microflora playing a major role in the feed digestion of ruminant animals. Thus, it turns to a productivity decrease, a low performance of the genetic potential, the appearance of diseases related to metabolic disorders and reducing the terms of economic use [6–8].
The problem of the diets balancing of lactating cows during the milking period turned out practically solved when introducing nutrients and energy feed supplements of various production [9]. At present the domestic feed industry produces a large number of different energetic supplements recommended for lactating cows during the DIM. Therefore, the search for more effective feed additives and the study of their effect on the nutrients’ digestibility in diets and on productivity, animal health and the products’ quality is a relevant task that represents a scientific and practical interest.

**The purpose of the research** is to study the effect of feeding energy supplements included in the diets for lactating cows during milking period on the digestibility of nutrients and productivity.

2. **Materials and methods**

To achieve the goal our scientific and economic experiment was carried out within the agricultural production cooperative “Kolkhoz im. Chapaeva” located in Kungur District of the Perm Region and involved dry and lactating cows of the black-motley breed at the age of 2nd–3rd lactation with a live weight of 550 kg. All groups of cows under study were kept in conditions of tie-up housing during the experiment. The animals of the control group were given the main feed diet launched within the farm and corresponding to the feeding standards of dairy cows [10]. This diet consisted of the following feeds: mixed grass silage, alfalfa haylage and grain sod with wheat, barley and oats mixed as well as table salt. Animals of the experimental group I in addition to the main diet received energy feed additive “Cow Energy” (NovaKorm, Russia) in the amount of 200 g/animal unit/per day and the animals of the experimental group II received the energy feed supplement “Ketostop EL” (ELEST, Russia) in a dose of 200 g/animal unit/per day. In accordance with recommendations of the manufacturers, these supplements were fed for 14 days before calving and 30 days after calving.

Methodology of the experiment was in the formation of three groups of dry cows by the method of pair analogues of 10 animals each. For the formation of groups the following physiological indicators were taken into account: age, breed, live weight and lactation [11].

Within the scientific and economic experiment a physiological test with three animals taken from each experimental group was conducted thus making possible to determine the digestibility of the diets nutrients. The conditions of feeding and keeping the experimental cows during the run of physiological experiment were identical to the scientific and economic experience. Physiological experience consisted of two periods: preliminary and reference ones. The last included a daily inventory of livestock, the amount of given feed, uneaten residues, daily milk production and the amount of excreted feces.

Biological objects were clinically tested and analysed in accordance with commonly recommended methods in the Zoo- and Agrotechnology Development Laboratory of the Federal State Budget Educational Establishment of Higher Education Perm State Agro-Technological University.

Milk productivity was taken into account by the control milking method, i.e. the mass fraction of fat and protein was determined in the average milk samples with the help of the “Lactan-1-4” milk-quality analyzer.

The obtained results were processed in accordance with commonly recommended methods of variation statistics [12] using the Microsoft Office software package using the Excel program (Microsoft, USA). The difference at $P \leq 0.05$ was considered reliable.

3. **The discussion of the results**

The effectiveness of the feed nutrients use is evident due not only to their quality but also because the direct reliance to the processes that occur in the digestive tract of ruminants. An important role in digestion and assimilation of nutrients processes in the pancreas is given also to the accurately calculated ratio in the diets of dry matter, carbohydrates, mineral elements, fiber, biologically active substances, vitamins and energy. Achieving favourable feeding conditions entails additional difficulties because the increase of the cows’ productivity requires also increasing animals’ needs to deliver the nutrients and minerals as well as vitamins to their diets. A repeated shortage or overage of one or more nutritional components leads to metabolic diseases of the cow and, as a result, to a decrease in productivity, reproductive qualities, diseases and to a reduction of economic use period.
A particular significance is given to the energy consumed by cows, especially, in the first weeks after calving as highly productive cows’ metabolism is at full capacities of the animals’ physiological capabilities in order to increase milk production. The energy rate increase of the new-born cows’ diets by 15–25 % by contrast with the existing norms results in a more efficient digestion of nutrients in the fore stomachs, in an increase of microbial protein biosynthesis and in an improvement in the use of feed nitrogen.

Currently the most of agricultural producers solve the problem of energy supply of lactating cows during the milking period not by improving the quality of bulk feed of the main diet but by feeding large amounts of concentrated feed. It leads from the one part to a rise of rations costs and from another part to a violation of animals’ metabolic processes serving a help to reduce the nutrients use and to decrease the animals’ milk production. However in the agricultural production cooperative where the scientific and economic experience was carried out the problem of providing new-born cows with an easy access to energy is solved by introducing energy supplements into the diets that provides animals with a sufficient level of glucose to prevent ketone bodies formation.

It is known that a deficiency in the feed of digestible carbohydrates, the use of a large number of concentrates and the predominance of acidic feed leads to a sharp decrease in propionic acid concentration necessary to maintain glucose level in the blood of animals [1].

During the balance experiment run aimed on studying the effect of feeding energy supplements on the diets nutrients digestibility we counted the nutrients fed to the cows as well as the amount of nutrients being digested and the ones excreted with feces. On the base of the data we calculated digestibility coefficients characterizing the nutrients digestion. Analysing the indices of nutrients digestibility we should note that the use of energy supplements in the animals’ diets increased in fact the digestibility of nutrients (Table 1).

| Indices                  | Control Group | Experimental Group I | Experimental Group II |
|-------------------------|---------------|----------------------|-----------------------|
| Dry matter              | 71.57±1.12    | 72.72±0.97           | 73.59±0.86            |
| Organic matter          | 72.20±0.68    | 73.12±1.18           | 74.39±0.52*           |
| Crude protein           | 66.2 ±1.21    | 68.06±0.74           | 68.58±0.89            |
| Crude fat               | 65.50±1.42    | 67.38±1.23           | 67.85±0.79            |
| Crude fiber             | 52.24±0.75    | 53.04±0.64           | 54.12±1.18            |
| Nitrogen-free extractives| 75.26±0.57   | 77.41±0.84           | 78.20±0.71*           |

So, the digestibility of dry matter was at the level of 72.72 and 73.59 % (the animals of the experimental groups I and II) that is more by 1.15 and 2.02 % respectively compared to ones of the control group animals. However the difference is not reliable statistically. A significant increase in the organic matter and nitrogen-free extractives digestibility is statistically significant. The digestibility indices of organic matter in the experimental group II the animals of which received “Ketostop EL” energy supplement was significantly higher by 2.19 % (P≤0.05) and was equal to 74.39 %; the digestibility ratio of nitrogen-free extractives – by 2.94 % (P≤0.05) and was at the level of 78.20 % compared with the anallogical ones of the control group where the lactating cows received the ration. The experimental animals of this group exceeded the digestibility indices of organic matter and nitrogen-free extractives and anallogical ones of the experimental group I where the cows received “Kau Energy” supplement by 1.27 and 0.79 % respectively. We noted a line of an increase in the digestibility of crude protein, crude fat and crude fiber by animals of the experimental groups I and II compared to their control group analogues by 1.79 and 2.31 %, 1.88 and 2.35 %, 0.80 and 1.88 % respectively.
Thus, the data on the digestibility of nutrients allow us to conclude that animals that consumed “Ketostop EL” and “Kau Energy” energy supplements digested the feed nutrients slightly better and thus provided an additional source of energy for milk synthesis in the bodies of newborn cows.

One of the criteria allows us to assess the usefulness of the diet and its balance during the research as well as to study the positive effect of feed additives is the level of milk productivity and its qualitative composition (Table 2).

| Indices                  | Control Group       | Experience Groups | Experience Group I | Experience Group II |
|--------------------------|---------------------|-------------------|--------------------|--------------------|
| Milk yield, kg           | 2562.50±43.42       | 2620.30±56.48     | 2718.80±151.64     |
| Milk fat, %              | 3.71±0.08           | 3.78±0.09         | 3.89±0.10          |
| Protein level, %         | 3.17±0.02           | 3.19±0.01         | 3.23±0.02*         |
| Dry matter, %            | 12.61±0.25          | 12.78±0.07        | 12.86±0.08         |
| Nonfat milk solids, %    | 8.04±0.20           | 8.10±0.16         | 8.26±0.11          |
| Ash, %                   | 0.75±0.07           | 0.81±0.04         | 0.85±0.04          |

The analysis of the milk production indices of the experimental animals proved that during the experiment period the cows received “Ketostop EL” energy supplement used the nutrients of the diet most effectively to maintain the health and synthesis of milk. It was found that the milk yield per 100 days of lactation in this group amounted to 2718.8 kg, which is 6.09 % and 3.76 % higher than the animals of the experimental group compared with the analogical ones of the control group. Feeding energy supplements had a positive effect on the chemical composition of milk. So the content of milk fat was the highest in the milk of the cows the experimental group II and amounted to 3.89 %, i.e. an excess compared to the control group by 0.18 % and from the experimental group by 0.11 %.

A similar tendency was noticed by us in relation to the protein indices: it was also significantly higher in the cows’ milk of experimental group II compared with the control group – by 0.06 % (P ≤ 0.05) and from the experimental group I – by 0.04 %.

The study has revealed that there is no significant difference in the dry matter content in the milk of experimental animals of all groups; this indicator was at the level of 12.61 % in the control group, 12.78 % in the experimental group I and 12.86 % in the experimental group II. The proportion of nonfat milk solids was also the highest in the II experimental group and amounted to 8.26 % that is higher in comparison with the analogical ones of the control group by 0.22 % and in comparison with the analogues of the I experimental group by 0.16 %. The highest indices for minerals or ash were observed in the milk of cows of the experimental group II – 0.85 % that is in 0.10 % higher compared to the same indicator for animals of the control group and in 0.04 % compared with ones of the experimental group I.

Consequently, we made a conclusion that the introduction of energy supplements in the diet for dairy cows in the first phase of lactation had a positive effect on their milk production and the chemical composition of milk.

4. Conclusion

Studies conducted by one of the leading agricultural enterprises of the Perm Region and aimed at studying the effect of feeding energy additives in the diets of lactating cows during the milking period allow us to make a conclusion. The inclusion of “Ketostop El” in the amount of 200 g/animal unit/per day for 14 days before calving and 30 days after calving helped to improve the digestibility of the main nutrients of the diet as well as to increase milk production and its quality.

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