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Improving Vitamin A Nutrition in Cows

Andrey Vladimirovich Valoshin
Aleksander Fedorovich Krisanov
FGBOU VO "Mordovia Ogarev State University"
430005, Russia, Republic of Mordovia, Saransk, Bolshevistskaya Street, 68

Abstract

Studies have been carried out to determine the influence of different doses of vitamin A on digestibility and use of nutrients, blood morphology and biochemistry values, and milk production of cows. Based on the analogous pair principle, three groups were formed, each of which took a certain dose of vitamin A in their daily diet. The 1st test group took a 20% higher dose as compared to the existing norms (325 thousand IU), the 2nd test group – a 30% higher dose (350 thousand IU), and the 3rd test group – a 40% higher dose (380 thousand IU). Microvit A was used as a vitamin A source, and its activity was 500 thousand IU per 1 g. It was given to cows mixed with concentrates. Feed was given to each animal individually. This helps to improve digestibility of nutrients, use of nitrogen, calcium and phosphorus in the diet, normalize homeostasis, and increase meat production [1].

Keywords: cow feeding, eating behavior, feed consumption, milk production, reproductive capacity.

INTRODUCTION

Currently, one of the most important tasks for Russia's contemporary cattle breeding is to increase beef production, improve its quality, and reduce costs. Among the measures taken to solve this problem, the most important one is to provide biologically adequate cow feeding based on the use of locally produced feed, as well as food industry waste. This means that cows must get all necessary nutrients and biologically active substances from feed in accordance with their needs in a certain physiological state and productivity level. Among biologically active substances, vitamins, vitamin A in particular, play an important role. It performs a lot of essential functions in the cow organism. Vitamin A deficiency leads to stunted growth and development, metabolic disorders, lower productivity, lower compensation of feed costs with produce, disease and death in cows, which implies huge economic losses for animal husbandry [2].

In milk and meat cattle breeding, diets comprise mainly coarse and succulent vegetable feed, most of which does not contain vitamin A, but its precursor – carotene, which produces vitamin A in the animal's body. However, the use of excessive doses of mineral fertilizers, especially nitrogen ones, as well as pesticides and herbicides, feed contamination with heavy metal salts, as well as violations of preparation and storage processes lead to the destruction of carotene in the feed and affect its absorption and conversion into vitamin A [3]. This is particularly true for maize silage. Food industry waste does not contain any carotene at all. Despite this, there are still no official regulations for vitamin A intake for cattle. Such regulation should be based on the quantitative content of carotene in the diet [2]. At the same time, scientists have proved that the content of carotene in the diet does not reflect the real needs and provision of livestock with the vitamin, and recommend adding vitamin A preparations into the diet, both separately and in combination with albuminous vitamin-mineral additives or premixes [4, 5, 6, 7, 8]. This is confirmed by our numerous studies [9, 10, 11].

However, the issue of using different vitamin A doses for different feeding conditions still remains unsolved. In this regard, studies of the appropriate level of vitamin A nutrition of livestock, taking into account the type of feeding, remain relevant. This research studies feed consumption by cows, milk production and cows' reproductive capacity with different vitamin A intake [12].

METHODS

The research was conducted at the Niva LLC in the Oktyabsky District in the Republic of Mordovia. Of all the types of behavior, the most important one for zootechnics is feeding behavior. Knowing the influence of various factors on the frequency and duration of the most important biological processes, one can improve animals' productivity and ensure appropriate feeding and resting routines. Having studied the feeding behavior of the experimental animals, we noted that cows treated with vitamin A spent more time eating feed and chewing it than the control ones (Table 1) [9, 10].

The total duration of these processes for the control cows was 16.5 hours, or 68.9% of the day, for the animals in the 2nd test group – 17.5 hours, i.e. one hour longer. For the cows in the 3rd test group, this difference amounted to 31.4 minutes. The animals in these groups consumed feed 2.6 to 3.3 times more often and had 5.0 to 7.3 times more chewing cycles [11].

As for the number of chewing movements per one minute, the difference between the groups was insignificant. It should be noted that the cows spent more time on the chewing cycle as compared to consumption and preferred to chew food in a lying position.

Longer duration of the eating process for the animals in the test groups was accompanied by a large number of approaches to water. In the 2nd test group, there were 5.1 times more of such approaches, and in the 1st and 3rd test groups there were 2.5 and 3.8 times more of them, respectively, as compared to the control group.

Eating activity adequately reflected in bowel and bladder functions. In the 2nd and 3rd test groups, the number of bowel and bladder functions was correspondingly 2.7 to 3.5 and 1.5 to 2.3 times higher [13, 14].

DISCUSSION AND RESULTS

The most important indicator determining the nutritive value and productive effect of feed is the digestibility of nutrients contained in diets. Therefore, an important growth area for the efficiency of livestock lies in the improvement of the absorption of nutrients contained in feed. It depends on animals' individual characteristics, feed storage and preparation, the type and structure of the diet, the content and ratio of nutrients, and the content of minerals and biologically active substances. Of numerous minerals and biologically active substances, fat-soluble vitamins, in particular vitamin A, are the most critical ones for the young cattle [15]. Sophisticated metabolic processes imply close interaction of vitamins with each other, as well as organic components contained in an animal's diet. Knowing the peculiarities of relations between nutrients contained in feed, one can manage metabolism, making it use them efficiently and ensuring maximum production. The deficiency or excess of nutrients in a diet and its biological inferiority cause growth and development depression in an animal, accompanied by complex and peculiar changes in the functional state of all organs and systems, including the gastrointestinal tract [16].

Table 1. Cows' eating behavior

Indicator	Group			
	control group	1st test group	2nd test group	3rd test group
1	2	3	4	5
Frequency of feed consumption, times	16.7 ± 0.95	18.0 ± 1.13	20.0 ± 1.65	19.3 ± 1.52
Duration of feed consumption, min	455.8 ± 2.63	466.0 ± 2.95	481.2 ± 3.24	471.0 ± 2.56
Duration of chewing, min	536.2 ± 2.52	543.0 ± 2.36	571.4 ± 1.56	552.4 ± 1.23
including:				
in a lying position	301.3 ± 1.95	316.3 ± 2.03	328.6 ± 2.41	321.2 ± 1.53
in a standing position F	234.9 ± 1.21	226.7 ± 1.30	242.8 ± 2.13	231.2 ± 1.45
requency of chewing cycles, times	17.5 ± 0.84	21.3 ± 0.94	24.8 ± 1.12	22.5 ± 0.65
including:				
in a lying position	8.3 ± 0.65	10.3 ± 0.39	12.1 ± 0.41	11.2 ± 0.84
in a standing position	9.2 ± 0.69	11.0 ± 0.85	12.7 ± 0.95	11.3 ± 1.02
Number of chewing movements per one minute, times	58.3 ± 1.23	60.7 ± 1.84	62.4 ± 1.58	61.1 ± 1.76
Total duration of rest, min	342.4 ± 2.56	318.3 ± 3.24	303.4 ± 2.63	311.2 ± 1.95
including:				
in a standing position	124.3 ± 3.62	103.0 ± 2.52	89.6 ± 3.24	96.3 ± 4.05
in a lying position	218.1 ± 3.69	215.3 ± 3.75	213.8 ± 4.32	214.9 ± 2.85
Frequency of rest, times	10.6 ± 0.62	11.7 ± 0.84	12.5 ± 1.12	12.1 ± 1.10
including:				
in a standing position	4.5 ± 0.74	3.7 ± 0.69	2.8 ± 0.45	3.2 ± 0.71
in a lying position	6.1 ± 0.23	8.0 ± 0.47	9.7 ± 0.92	8.9 ± 0.82
Frequency of sleeping cycles, times	6.8 ± 0.35	6.3 ± 0.41	5.5 ± 0.29	5.8 ± 0.53
Sleep duration, min	110.3 ± 1.68	96.7 ± 1.42	93.1 ± 2.14	94.2 ± 1.86
Frequency of approaches to water, times	13.2 ± 1.06	15.7 ± 1.24	18.3 ± 1.19	17.0 ± 1.14

When food industry waste is used for cattle feeding (pulp, distillers' grains, spent grain), it means that little vegetable feed, containing carotene, which is a precursor of vitamin A, is used. That is why animals are given vitamin A supplements.

The results of our research show that the animals taking vitamin A in their diet consumed more of both coarse and succulent feeds. The greatest feed consumption was noted in the animals of the 2nd test group. They consumed 98.7% of hay, which was 6.8% more than in the control group; for haylage, these figures were 95% and 6.7%, respectively; for silage – 90.5% and 8.4%, green feed – 95.3% and 6.9% [17].

Our research has shown that the 3rd test group also had high feed consumption. As for the 1st test group, which was given a smaller dose of vitamin A, the feed consumption was also higher, but not so much. Concentrated feeds, syrup, oil cakes and mineral supplements were consumed completely according to the diet.

As expected, the amount of feed consumed directly correlated with the animals' eating activity. The greatest amount of feed was consumed by the cows in the 2nd test group. As compared to their peers in the control group, this advantage amounted to 3,513 MJ of metabolizable energy, i.e. 8.0%. The consumption in the 3rd test group was 2.5% greater. The structure of a diet taking into account energy density was almost the same in all the groups [18].

Minerals play an important role in ensuring the normal functioning of the body. They are structural material for bone tissue, part of some compounds vital for the body, and they also create the conditions necessary for the normal functioning of hormones, vitamins, enzymes, take part in digestion, synthesis, decomposition, and discharge of substances from the body. A number of scientists note that the metabolic exchange between vitamin A and various minerals implies close interaction [5] However, there is very little data about the influence of retinol on calcium phosphorus nutrition of young cattle, and the existing data are contradictory and do not take into account the type of feeding [19].

Our studies show that adding vitamin A in dairy cows' diets and increasing its content, taking into account the share of carotene, to 350 - 380 thousand IU activate animals' eating behavior, increase their appetite, which leads to greater feed intake and, consequently, has a positive effect on milk production.

The optimization of vitamin A nutrition of young cattle ensuring the normal course of metabolic processes in the body had positive impact on the growth rate and animals' meat productivity [20].

In farms located close to breweries, spent grain is widely used for cattle feeding as an additional source of protein, which can significantly reduce the consumption of expensive concentrated feeds. However, to achieve high productivity with such feeding, it is necessary to enrich the diet with vitamin A, which is not contained in spent grain. Scientists have proved that vitamin A and its carotene precursor play an important role in the body functioning: they normalize metabolism, take part in redox processes, the formation and functioning of bones and mucous membranes, regulate the growth of new cells, increase reproductive capacity, resistance to diseases and productivity of animals [21].

However, it still remains unclear how much vitamin A cattle need. Reference books do not provide such information, and vitamin A intake regulation must be based on the content of carotene in feed, which then transforms into vitamin A in the body. But this process is influenced by many different factors.

Scientists have conducted numerous studies and have found that regulation of vitamin A nutrition of cattle based on weight units of carotene does not reflect the real needs and provision of livestock with vitamin A. That is why vitamin preparations should be added to the diet. This increases animals' productivity and improves the quality of products [4, 7, 9, 10, 11, 13, 16].

However, scientists' views on vitamin A doses vary a lot. That is why further research into the appropriate content of vitamin A in the cattle diet is important and relevant [22].

The influence of vitamin A on nitrogen metabolism was also reported [13].

To boost the growth of young cattle, it is important to provide them with sufficient minerals, calcium and phosphorus in particular. Scientific works provide reports on the interrelation between vitamin A and calcium and phosphorus metabolism. Scientists say that vitamin A supplements increase the absorption

of these elements contained in feed, their content in blood, and intensity of calcium and phosphorus metabolism in animals.

The optimization of vitamin A nutrition of young cattle ensuring the normal course of metabolic processes in the body had positive impact on the growth rate and animals' meat productivity [23].

Summarizing our results, we can conclude as follows: cattle feeding must provide 350 to 380 thousand IU of vitamin A to regulate metabolism in the body, improve digestion, and increase cows' milk production [24].

CONCLUSION

1. Thus, adding vitamin A into dairy cows' diet and increasing its content, taking into account the carotene content, to 350 - 380 thousand ME activate animals' eating behavior and improve their appetite, which results in greater feed intake and, consequently, has positive impact on milk production.
2. The use of vitamin A helped to increase not only milk production, but also fat and protein content in milk.
3. The appropriate dose of vitamin A normalizes metabolism in the body, which is proved by greater amounts of hemoglobin and red blood cells, total protein and albumin, alkaline reserve, total calcium and inorganic phosphorus.
4. In cows, whose diet contained 350 to 380 thousand IU of vitamin A, the impregnation rate reached 100%, which was 13% higher than that of the control group ($p<0.01$). In these groups, the majority of cows were fertilized in the first insemination (54 to 55%).
5. The multiplicity of insemination in cows treated with vitamin A decreased significantly. While in the control group it was 2.1 times, for the 1st test group it was 1.7 times, and in the 2nd and 3rd groups – 1.6 times.

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