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Optimization of Vitamin A Nutrition of Calves Fattened on Silage

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Abstract.
The authors performed a research to determine the optimum level of vitamin A in the diets of calves fattened on silage. The effect of various dosages of vitamin A on the vitamin A status, digestibility of nutrients, meat productivity and economic efficiency were studied. Using the principle of analogues, 45 calves were selected at the age of 12-13 months with the live weight of 275 - 285 kg, which were divided into three groups 15 calves in each. The animals were kept in the same quarters on the leash. The experiment lasted for 165 days [1].
Keywords: feeding calves, digestibility of nutrients, nitrogen balance, nitrogen use.

INTRODUCTION

At the present stage of animal husbandry development in Russia, one of the most important tasks is increasing beef production, improving the quality and reducing the costs. In the system of measures aimed at resolving this problem, the organization of biologically complete feeding of calves through the use of in-house produced fodder and wastes of the food industry is very important. This means that calves should receive from the fodder all nutrients and biologically active substances in accordance with their needs at a certain physiological state and level of productivity. Among biologically active substances, an important role is played by vitamins, vitamin A in particular. In the organism of calves, it performs many vital functions. Shortage of vitamin A results in retardation of growth and development, metabolic disorders, reduced productivity, reduced feed-conversion efficiency, occurrence of diseases and death of the calves, which brings substantial economic losses to livestock [2].

In dairy and meat cattle breeding, in the structure of rations, a significant share is taken by coarse and succulent vegetable fodders that do not contain vitamin A, but contain its precursor, carotene, which produces vitamin A in the organisms of the animals. However, the use of excessive dosages of mineral fertilizers, especially nitrogen ones, pesticides, herbicides, contamination of fodder with salts of heavy metals, as well as violations in the technology of silage procurement and storage result in the destruction of carotene in the fodder, and deterioration of its absorption and conversion into vitamin A. This particularly applies to maize silage. In its turn, carotene is completely absent in the wastes of the food industry. Despite these circumstances, there are still no official standards for vitamin A for cattle. Its rationing is based on the quantitative content of carotene in the diet. At the same time, scientists have proven that carotene content in the diet does not reflect the true need of the livestock in vitamin A and its provision, and recommend introducing into the diets vitamin A supplements both separately and in the composition of AVMA, and premixes. [3-7]. This is confirmed by numerous studies of the authors [8].

However, the issue of vitamin A dosages in relation to various conditions of animals' feeding remains unresolved. In this respect, studies aimed at determining the optimal level of vitamin A nutrition of livestock with regard to the type of the diet are relevant. This research was aimed at studying digestibility of nutrients, meat yield, and economic efficiency [9].

MATERIALS AND METHODS

The research was performed at LLC Niva in the Oktyabrsky district of the Republic of Mordovia. Out of all variants of behavior, diets of calves are the most important for the zootechnical practice.

The diets consisted of maize silage, straw of spring wheat, barley groats, feed additives and salts of trace elements [10].

The diets of the animals of all groups were identical, except for the level of vitamin A in the diets (Table 1).

Table 1. The scheme of the scientific and economic experiment

Group	Number of animals	Feeding scheme
I	15	Main diet (MD). The source of vitamin A: carotene in maize silage
II	15	MD + vitamin A at the dosage of 10,000 IU/100 kg of live weight
III	15	MD + vitamin A at the dosage of 15,000 IU/100 kg of live weight

In the diet of calves in the first group, the content of carotene complied with the norms of RAAS (1985), which, in terms of vitamin A, made 20,000 IU/100 kg of live weight (for cattle, 1 mg of carotene was equivalent to 400 IU of vitamin A). The second group of animals received extra 10,000 IU of vitamin A per 100 kg of live weight, or 50% more than the recommended norm calculated in terms of carotene. The calves in the third group received extra 15,000 IU of vitamin A per 100 kg of live weight, which was higher by 75% than the recommended norm. The level of vitamin A was regulated at the expense of retinyl acetate in oil [11].

Vitamin preparations in the form of an aqueous emulsion were mixed with concentrates and fed to the calves once in a decade in the morning before the main feeding, which ensured complete palatability of the vitamin by the animals.

The vitamin A status was determined by changes in the concentration of vitamin A in the liver and blood serum under the influence of various dosages of vitamin A. It has been found that before fattening, the liver of young cattle contained 25.72 to 26.37 µg of vitamin A per 1 g of raw tissue (Table 2) [12].

Table 2. Vitamin A content in the liver of calves

Indicator	Group		
	I	II	III
Liver weight, kg	3.58 ± 0.51	3.61 ± 0.05	3.56 ± 0.03
Vitamin A concentration in 1 g of raw liver tissue, µg	26.12 ± 0.28	25.72 ± 0.28	26.37 ± 0.43
The total content of vitamin A in the liver, mg	93.52 ± 1.49	92.94 ± 1.84	93.94 ± 1.64
Liver weight, mg	5.77 ± 0.08	5.90 ± 0.10	5.94 ± 0.11
Vitamin A concentration in 1 g of raw liver tissue, µg	28.66 ± 0.72	47.29 ± 0.71	64.44 ± 1.40
The total content of vitamin A in the liver, mg	156.43 ± 4.48	279.08 ± 7.33	382.64 ± 5.36

Enriching silage diets with vitamin A in the amount of 10,000 IU per 100 kg of live weight significantly improved vitamin A nutrition; the concentration of vitamin A in the liver by the end of fattening in the second group increased, and amounted to 47.29 µg/g of raw tissue, which, in the opinion of many researchers, corresponded to the optimal level of the physiological norm. With increasing the dosages of vitamin A up to 15,000 IU/100 kg of live weight, its reserves in the liver increased even more. In the third group, concentration of vitamin A amounted to 64.44 µg/g of raw tissue.

The most accessible indicator that characterizes the vitamin A status of an animal is the concentration of carotene and vitamin A in the blood serum. However, it should be noted that the level of carotene in the blood largely depends on its content in the diet. In addition, carotene absorption from various types of fodder varies considerably [13, 14].

Results And Discussion

The most important indicator that determines the nutritive value and the productive action of fodder is palatability of the nutrients in the diets. Therefore, an important reserve of increasing productivity of agricultural animals is improving absorption of nutrients from the fodders used. It depends on the individual peculiarities of the animals, the technology of fodder provisioning and preparing it for feeding, the type and the structure of the diet, the level and the ratio of nutrients, and the presence of mineral and biologically active substances. From the large group of the latter, the most critical for young cattle are fat-soluble vitamins, especially vitamin A. In the complex process of metabolism, vitamins are closely related not only to one another, but also to the organic components in the animals' diet. The knowledge of the peculiarities of the relationship among the nutrients in the fodder allows directing metabolism in the organism towards efficient use of these relationships and obtaining the maximum yield. Lack or excess of nutrients in the diets, and their biological inferiority results in depressed growth and development of the animal, accompanied by complex and peculiar changes in the functional state of all organs and systems, including the digestive tract [15, 16].

In using wastes of food industry (pulp, distillery wastes, brewer's grains) for feeding cattle, animals receive little vegetable feed that contains carotene which is a precursor of vitamin A. Therefore, animals are additionally given vitamin A preparations in the diet [17].

The introduction of vitamin preparations into the diet of calves greatly improved vitamin A nutrition of the animals. In groups 2 and 3 that had additionally received 10,000 and 15,000 IU of vitamin A per 100 kg of live weight, respectively, its concentration by the middle of fattening increased twice, but only reached the lower limit of the physiological norm for cattle. Further, the reserves of vitamin A in the liver had continued increasing, and at the end of fattening, retinol concentration in blood serum of animals in groups 2 and 3 reached its optimal level. No difference in vitamin A content was noted between these groups, which confirmed the findings of scientists that vitamin A concentration in blood serum remained more or less stable while its reserves in the liver were being restored. In the first group of calves that did not receive vitamin additions, the content of carotene and vitamin A in blood serum did not change, and remained low throughout the entire fattening period.

In studying the effect of various levels of vitamin A content on the hematological indicators of experimental calves, no deviations from the physiological norms were noted [10, 18].

However, in the blood of the calves that received vitamin A in addition to the silage diet, increased contents of hemoglobin and erythrocytes were noted, which spoke of higher intensity of the redox processes in the organism. The total protein content increased veraciously; this increase occurred due to the albumin fraction, and the number of globulins remained virtually unchanged. As a result, the albumin-globulin index increased by 11.4%, which indicated the improved protein-generating function of the liver.

The research has shown that during cattle fattening on corn silage, enriching the diets with vitamin A at the dosage of 10,000 IU/100 kg live weight improves protein digestibility by 5.0% ($p<0.05$), and digestibility of fiber by 3.7% ($p<0.05$) (Table 3) [19, 20].

Table 3. Nutrients' digestibility coefficients, %

Indicator	Group		
	I	II	III
Dry matter	66.4 ± 1.07	67.4 ± 0.15	68.4 ± 0.80
Organic matter	68.9 ± 1.01	69.6 ± 0.52	70.7 ± 0.24
Protein	62.9 ± 1.14	67.9 ± 0.67	68.3 ± 0.65
Fat	55.2 ± 0.21	57.1 ± 0.90	56.9 ± 0.87
Fiber	51.5 ± 0.90	55.2 ± 0.58	55.7 ± 0.90
Nitrogen-free Extractive Substances	77.9 ± 1.23	76.2 ± 0.77	77.9 ± 0.12

The steady tendency to increasing palatability of dry, organic matter and fat was also noted.

The increased level of vitamin A to 15,000 IU/100 kg of live weight in group 3 did not result in further increase in nutrients' digestibility, the indicators remained almost the same as the indicators of group 2. However, compared to group 1 of calves that received the norm of carotene with maize silage, coefficients of feed digestibility in group 3 were also veraciously higher in terms of protein and fiber [21].

The performed physiological experiments have shown that carotene digestibility from silage diets (without vitamin additions) amounted to 37.51% (Table 4).

Table 4. Carotene digestibility from silage diets

Indicator	Group		
	I	II	III
Consumed with feed, mg	184.21	180.58	184.21
Excreted with faeces, mg	115.12	116.17	120.70
Digested: mg	69.07 ± 0.47	64.41 ± 1.74	63.51 ± 1.73
% of received	37.51 ± 0.80	35.67 ± 0.22	34.48 ± 0.35

Summarizing the results of the research, the following conclusion can be made: fattening of cattle requires that the content of vitamin A in the diet is 350,000-380,000 IU, which normalizes metabolism in the organism, improves the digestive activity, and increases meat productivity of calves [22].

Conclusions

1. Therefore, in order to optimize vitamin A nutrition of young cattle on silage fattening, the diets are to be enriched with vitamin A at the dosage of 10,000-15,000 IU/100 kg of live weight.

2. Additives of vitamin A improve mineral metabolism, as evidenced by an increased content of calcium (10.7-12.0%, $p<0.05$) and phosphorus (11.1-14.6%, $p<0.05$) in the blood serum of calves in groups 2 and 3.

3. Optimization of the vitamin A nutrition of young cattle had positive effect on the chemical composition of meat: the content of dry matter and protein veraciously increased. No difference was noted in terms of fat and ash content between the groups.

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