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Optimization of A-vitamin nutrition of calves

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Abstract

The effect of different doses of vitamin A on the digestibility and the use of diet nutrients, morphological and biochemical indices of blood, and milk production of calves was studied. According to the principle of pairs-analogues, four groups were formed, each of which received a certain dose of vitamin A with a daily diet.

In the last two months of pregnancy, mother cows were fed according to the detailed standards (1985). The diet included rump hay, corn silage, feeding beet, concentrates, common salt.

Keywords: feeding of calves, balance and use of nitrogen, digestibility of nutrients, and assimilation of carotene from diets.

INTRODUCTION

At the current stage of breeding development in Russia, one of the most important tasks is to increase the production and quality of beef, and to reduce production costs. In the system of measures aimed at solving this problem, the main place is given to the organization of the biologically complete feeding of calves. One of the most important criteria of the usefulness of calves feeding is the level of their provision with fat-soluble vitamins, and particularly vitamin A. This especially applies to the early period of calves' life. According to [1], little or no carotene is absorbed, and vitamin A is not transformed in calves up to being a month old. Therefore, colostrum and milk are the only sources of vitamin A for newborn calves (Table 1).

The colostrum of the first milk yield after calving contains 1,520 µg/l of carotene and 2,400 µg/l of vitamin A.

Table 1. The content of carotene and vitamin A in milk and colostrum, µg/l

Term of the study	Carotene	Vitamin A
Colostrum		
1st milk yield 3rd day after calving	1,520 ± 46.4 560 ± 12.7	2,400 ± 18.7 780 ± 20.1
Milk		
10th day after calving	176 ± 5.7	141 ± 9.1

At a later stage, the A-vitamin value of the colostrum decreased rapidly, and on the third day after calving it contained 560 µg/l of carotene and 780 µg/l of vitamin A. On the 10th day after calving, whole milk contained 176 µg/l of carotene and 141 µg/l of vitamin A, which was 3 and 5 times lower, respectively, as compared with the yield on the third day. It should be noted that the content of carotene in the colostrum corresponded to the physiological norm; at the same time the concentration of vitamin A was below the norm. It is recommended to judge on the state of vitamin nutrition in animals by the content of carotene and vitamin A not in feed, but in serum [1, 2, 3, 4, 5]. This is confirmed by our numerous studies.

However, the issue about the dosages of vitamin A in relation to the different conditions of animal feeding remains open. In this regard, studies aimed at determining the optimal level of A-vitamin nutrition of livestock, taking into account the type of feeding, are relevant. The purpose of these studies was the palatability of calves and milk productivity with different levels of vitamin A in diets [2, 4].

METHODS

The studies were conducted at LLC Niva of the Oktyabrsky District of the Republic of Mordovia.

For this scientific and economic experiment, 40-day old crossbred heifers of the first generation, obtained from crossing cows of black-and-white breed with Holstein bulls, were selected, which were divided into 4 groups of 10 animal units each according to the principle of analogues (breed, age, live weight, health condition).

The cows were calved in the maternity barn. After a daily stay of the calf with the cow, it was transferred to a prophylactorium house in an individual cage, and after 20 days - into a calf house, where the animals were kept in yard housing of 5 animal units in one stall. Calves were grown according to a unified scheme of milk feeding with consumption of 250 kg of whole and 600 kg of skim milk [3, 5].

From the age of 15 days, calves had been fed with oatmilk together with milk, and had been accustomed to hay. Since the 5th decade of life, they were fed with silage. Conditions for maintenance and care during the period of the experiment for all groups of calves were the same (Table 2).

Differences in the feeding of calves among the groups consisted in different levels of A-vitamin nutrition (Table 3) [1].

The first group was the control one and received vitamin A at the dose of 75% of the norm calculated by carotene. The second group received a full norm, the third group - 25% above the norm, and the fourth group - 50% above the norm (Table 3).

The level of vitamin A was regulated with an oil solution of retinol acetate (activity was 25 thousand IU in 1 ml). To fill the vitamin D deficiency, the calves of all groups were fed the same amount of Trivita AD_3E.

Vitamin preparations were prescribed with milk fodders from group drinking pans with a total dose of once per 10 days. In the post-milk period, vitamins were fed together with concentrates, previously emulsified in warm water [6, 7].

An increase in the level of vitamin A to 420 IU did not cause any further increase in the digestibility of nutrients, their indices practically remained the same as the indices of group III (350 IU) (Table 4). In comparison with group I (210 IU), digestion coefficients were also significantly higher by all indices [8, 9].

DISCUSSION AND RESULTS

The digestibility of the diet nutrients is the most important indicator determining the nutritional value and productive effect of feed. Therefore, an important reserve of increase in the productivity of agricultural animals is improving their digestibility of nutrients contained in used feeds. It depends on the individual characteristics of animals, the technology of fodder conservation and its preparation for feeding, the type and the structure of diets, the level and ratio of the nutrition elements in them, and the presence of mineral and biologically active substances. Of the large group of the latter, fat-soluble vitamins, especially vitamin A, are the most critical for young cattle [10]. In a complex metabolism process, vitamins are in close contact not only with each other but also with organic components of the

animal's diet. Knowledge of the peculiarities of the interrelation among the feed nutrients makes it possible to direct the metabolism in the organism towards their effective use and to obtain the maximum production. Deficiency or excess nutrients in diets and their biological deficiency cause depression of 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 [11, 12].

When studying the effect of different levels of vitamin A in diets on the hematological indicators of calves, no deviations from physiological norms have been observed. However, the blood of animals that had received elevated levels of vitamin A, contained more hemoglobin and erythrocytes, which indicated more intensive flow of redox processes in their body.

Table 2. Scheme of feeding of heifers up to the age of 6 months

Age		Live weight at the end of the decade	Daily dose, kg						Minfal feeding, g	
Month	Decade		Milk		Clover hay	Corn silage (wax ripeness)	Grass (clover) meal	Grinding (barley-corn)	Common salt	Precipitated calcium phosphate
			whole	skim						
1	1 2 3		6 6 6		accu st.			 0.1 0.2	 5 5	 5 5
For the 1st month		60	180					3	100	100
2	4 5 6	-	4 2 1	4 8 7	0.2 0.3 0.5	accust. 0.5	 0.1	0.3 0.4 0.6	10 10 10	15 15 15
For the 2nd month		81	70	190	10	5	1	13	300	450
3	7 8 9			8 7 6	0.7 1.0 1.2	1.0 1.5 3.0	0.1 0.2 0.2	1.0 1.0 1.0	10 10 10	20 20 20
For the 3rd month		103		210	29	55	5	30	300	600
4	10 11 12			6 6 6	1.5 1.5 1.5	4 4 4	0.3 0.3 0.3	1.4 1.4 1.4	15 15 15	20 20 20
For the 4th month		126		170	45	120	9	42	450	600
5	13 14 15			3	2 2.5 2.5	5 6 7	0.4 0.4 0.4	1.5 1.5 1.5	20 20 20	20 20 20
For the 5th day		148		30	70	180	12	45	600	600
6	16 17 18				2.5 2.5 2.5	8 8 8	0.5 0.5 0.5	1.5 1.5 1.5	20 20 20	20 20 20
For the 6th month		170			75	240	15	45	600	600
Total for 6 months			250	600	229	600	42	178	2350	2950

Table 3. Scheme of the scientific and economic experiment

Group	Number of calves, animal units	The level of vitamin A,% to the norm, calculated by carotene	The level of vitamin A in diets, IU per 1 kg of live weight		
			0-1 months	2-3 months	4-6 months
I – control	10	75	220	21	200
II – experiment	10	100	290	280	270
III – experiment	10	125	360	350	340
IV – experiment	10	150	435	420	405

Table 4. Coefficients of digestibility of nutrients

Group	Dry matter	Organic matter	Protein	Fat	Cellulose	Free-nitrogen extracts
3 months						
I	66.2 ± 0.21	67.7 ± 0.21	66.8 ± 0.37	62.0 ± 0.61	42.2 ± 0.49	75.6 ± 0.77
II	67.42 ± 0.51	69.0 ± 0.44	68.0 ± 0.98	63.6 ± 0.84	45.5 ± 0.84	76.0 ± 1.93
III	69.0 2 ± 0.64	70.5 ± 0.66	71.5 ± 0.26	64.0 ± 0.53	47.7 ± 0.79	79.0 ± 0.34
IV	70.42 ± 0.60	71.2 ± 0.53	72.6 ± 0.56	64.1 ± 0.56	47.5 ± 0.55	80.0 ± 0.89
6 months						
I	67.6 ± 0.39	68.2 ± 0.30	63.4 ± 0.63	64.5 ± 0.63	51.0 ± 0.61	77.3 ± 0.21
II	68.4 ± 0.46	70.3 ± 0.90	65.6 ± 0.56	66.2 ± 0.61	53.7 ± 0.49	79.8 ± 1.57
III	71.0 ± 0.46	72.5 ± 0.30	68.4 ± 0.49	70.4 ± 0.60	56.6 ± 0.46	81.7 ± 0.20
IV	72.3 ± 0.57	73.4 ± 0.60	68.8 ± 0.69	70.7 ± 0.60	57.0 ± 0.46	83.0 ± 0.67

Table 5. Balance and use of nitrogen

Group	Administered	Isolated		Deposited in the body	Used, % of administered
		in the feces	in the urine		
3 months					
I	75.52 ± 1.33	25.00 ± 0.72	25.85 ± 0.34	24.60 ± 0.30	32.57 ± 0.23
II	79.84 ± 0.33	25.55 ± 0.69	26.94 ± 0.67	27.35 ± 0.37	34.26 ± 0.39
III	83.84 ± 0.72	23.89 ± 0.45	29.51 ± 0.39	30.44 ± 0.61	26.31 ± 0.64
IV	84.32 ± 0.72	23.10 ± 0.50	30.20 ± 0.20	31.02 ± 0.77	36.79 ± 1.65
6 months					
I	103.36 ± 1.04	37.86 ± 0.93	38.39 ± 0.91	27.11 ± 0.41	26.23 ± 0.38
II	104.19 ± 4.73	36.05 ± 1.98	39.66 ± 3.08	28.48 ± 0.41	27.33 ± 0.89
III	114.19 ± 1.48	36.09 ± 0.95	45.71 ± 0.69	32.39 ± 0.29	28.36 ± 0.25
I V	111.97 ± 2.87	34.92 ± 0.92	44.22 ± 2.88	32.83 ± 0.53	29.45 ± 1.24

The introduction of vitamin A into the diet of calves did not significantly change the leukocyte count in blood [13, 14].

With the age increase of the calves, the number of erythrocytes and leukocytes remained practically unchanged, while by the 6-month age the hemoglobin concentration had increased by 4.8-7.7%.

As the dose of vitamin A increased, the reserve alkalinity of blood increased in calves' diets.

Some changes also occurred in the protein spectrum. The serum of blood of calves of groups III and IV contained significantly more albumins in all age periods, and the content of globulins was approximately the same in all groups. An increase in the albumin content in the blood indicates an increase in the protein-synthesizing function of the liver.

The elevated levels of vitamin A have improved the mineral metabolism in the body as evidenced by an increase in the serum of calves of the III and IV groups of calcium at the 1-month age by 15.1-17.1%, at the 3-month age - by 19.5-20.0%, and at the 6-month age - by 21.4-21.8% ($p < 0.01$), and of the phosphorus - by 11.8 - 14.7; 5.6 - 6.8 and 14.4-15.4%, respectively ($p < 0.01$).

As a result of our studies, we have found that the inclusion of vitamin A in the diets of calves at a dose of 350 IU/kg of live weight contributes to a significant increase in the digestibility of dry matter by 2.8 - 3.4%, organic matter - by 2.8 - 4.3%, protein - by 4.7-5.0%, fat - by 2.0-5.9%, fiber - by 5.5-5.6%, and free-nitrogen extracts - by 3.4-4.4% (Table 4) [15, 16].

An increase in the level of vitamin A to 420 IU did not cause any further increase in the digestibility of nutrients, their indices practically remained the same as the indices of group III (350 IU). In comparison with group I (210 IU), digestion coefficients were also significantly higher by all indices [17].

As might be expected, with the increase in the dose of vitamin A in calves' diets, the use of feed nitrogen also increased (Table 5). While in the first group of calves who received vitamin A 25% less than the norm calculated by carotene, 24.60 g of nitrogen were deposited in the body at the age of 3 months, and 27.11 g of nitrogen at the age of 6 months, in the second group receiving the vitamin A norm, these indices were 27.35 and 28.48 g, or 11.2 and 5.1% higher, respectively. With an increase in vitamin A level by 25% compared to the norm calculated by carotene, nitrogen deposition in the body of calves increased by 11.3% at the age of 3 months, by 13.7% ($p < 0.05$) - at the age of 6 months, and in comparison with the first group, by 23.7 and 19.5% ($p < 0.01$), respectively.

A further increase in the dose of vitamin A (by 50% to the calculated norm) was no longer accompanied by an adequate increase in the use of nitrogen, its deposition in the young stock bodies remained at the same level as in the third group of calves, but in comparison with the first and second groups it was higher by 26.1 and 13.4% at the 3-month age, and by 21.1 and 15.3% at the 6-month age, respectively [18].

Mineral substances play an important role in the normal functioning of the organism. They are a structural material for the formation of bone tissue, form the part of vital components of the body, create the necessary conditions for the normal function of hormones, vitamins, enzymes, and participate in the processes of digestion, synthesis, decay and isolation of substances from the body (Table 5). A number of scientists pay attention to the fact that there is a close relationship in the process of metabolism between vitamin A and various mineral elements [3]. However, there are very little data on the effect of retinol on the nature of phosphate-calcium nutrition in young cattle, and the available ones are contradictory and do not take into account the feeding type [19].

The scientists have proved that vitamin A, its precursors and carotene play an important role in the body's vital activity: they normalize metabolism, participate in redox processes, formation and functioning of bones and mucous membranes, regulate the growth of new cells, increase reproductive ability, and disease resistance and productivity of animals [20].

In this regard, it is recommended to additionally introduce vitamin preparations into diets. At the same time, there is an increase in the productivity of animals and the quality of the products [9, 14] .

Also report on the effect of vitamin A on the metabolism of nitrogen.

For the intensity of growing young cattle, it is very important to provide the body with a sufficient amount of minerals, in particular calcium and phosphorus. The reports of the relationship between vitamin A and phosphorus-calcium metabolism exist in the literature. Scientists note that the additions of vitamin A increase the digestibility of these elements from the feed, their content in the blood gives higher intensity of phosphorus-calcium metabolism in animals [14].

Optimization of A-vitamin nutrition of young stock, ensuring a normal course of metabolic processes in the body, positively influenced the intensity of growth and the formation of meat production of animals.

CONCLUSION

1. As a result, by the age of 6 months, their live weight was 12.4 kg higher. An increase in the dose of vitamin A to 350 IU/kg of live weight promoted more intensive growth of young stock, the daily increase in their live weight was 832 g, or 27.4% more, and by the end of the period, their living weight was 181.2 kg.

2. A higher dose of vitamin A in the fourth group (420 IU) had virtually no effect on the further increase in the growth energy of the young stock, although the average daily increments remained at a high level and exceeded that of their peers from the first group by 29.2% ($p < 0.01$).

3. Exterior and body type are important indicators of breeding and productive qualities of farm animals. Therefore, in the production environment, the assessment and selection of animals based on these traits, which are formed from an early age, are widely practiced.

4. We have found that the increase of the biological usefulness of the diet through the use of A-vitamin supplements contributed to the formation of more pronounced dairy body type of heifers. Although at the age of 6 months it is difficult to judge this from the measurements, nevertheless, in the experimental animals with the large live weight, such measurements as the oblique length of the trunk, width, depth and girth of the chest, the width in makloks and the half-girth of the quarters were high.

REFERENCES

[1] Dusheyko A.A, Vitamin A: Exchange and functions. [Vitamin A: Exchange and functions.] Kiev: Naukova Dumka, 1989, pp. 288

[2] Belikova A. S. Vliyaniye belkovo – vitaminnogo premiksa na kachestvo korov'yego moloka [Influence of the protein - vitamin premix on the quality of cow milk]. Animal Science, 2005; 2: 13 – 15.

[3] Berzin N.I. Vzaimosvyaz' vitamina A i tsinka v organizme zhivotnykh [The relationship between vitamin A and zinc in animals]. Scientific foundations of vitamin nutrition of farm animals. Riga: Zinatne, 1987, pp. 41 – 43.

[4] Dvinskaya L.M. Vitaminnoye pitaniye zhivotnykh v usloviyakh promyshlennoy tekhnologii [Vitamin nutrition of animals in industrial technology]. Nauchnyye osnovy polnotsennogo kormleniya sel'skokhozyaystvennykh zhivotnykh. [Scientific basis of high-grade feeding of agricultural animals.]. Moscow, 1986, pp. 224 – 234, 235 – 243.

[5] Draganov I. F. Povysheniye rezistentnosti organizma korov s pomoshch'yu b – karotin. [Increase of resistance of the organism of cows with β-carotene]. Zootechniya, 2003; 9: 11 – 13.

[6] Zuyev, L.S., Vliyaniye A – i E– vitaminnykh preparatov na ispol'zovaniye azota i obmen aminokislot u telyat [The effect of A- and E- vitamin preparations on the use of nitrogen and the exchange of amino acids in calves.]. Problemy kormleniya v sovremennom zhivotnovodstve. [Feeding problems in modern livestock breeding]. Moscow: MBA, 1984, pp. 34 – 39.

[7] Kalashnikov, A.P. Normy i ratsiony kormleniya sel'skokhozyaystvennykh zhivotnykh. [Norms and rations of feeding of farm animals.] Reference Guide. Moscow, 2003, pp. 486

[8] Emelina, N.T. Vliyaniye fosfatidov na ispol'zovaniye vitamina A laktiruyushchimi korovami [Influence of phosphatides on the use of vitamin A lactating cows]. Tr. MBA, 1960; 29: 320

[9] Krisanov, A.F., Lukacheva, V.A. and Valoshin, A.V. A – vitaminnyy status i produktivnost' bychkov pri otkorme na pivnoy drobine [A-Vitamin status and productivity of bull-calves when fattening on beer grains]. Bulletin of the Altai State Agrarian University, 2012; 8 (94): 95 – 98.

[10] Keller H. E. Methods for Vitamins and Caratinoids in Feed. Roch: Basle, 1982; 1982: 3-5.

[11] Krisanov A. F., Valoshin A. V., Gayirbeqov D. S., Mungin V. V. and Zenkin A. S. Influence of different doses of vitamin A in diets on a metabolism and meat efficiency of bull-calves at feeding with brewer`s grain. Eco. Evn. & Cons, 2017; 23 (2): 1119-1124

[12] Gayirbegov D. S., Mungin V.V., Gibalkina N. I., Loginova L. N. and Valoshin A. V. The impact of the new fodder additive “M-feed” on the microorganisms of the rumen contents of calves and their growth energy. Eco. Evn. & Cons. 2017; 23 (1): 425-431.

[13] Kallaur, M.G. Effektivnost' primeneniya razlichnykh doz vitamina A pri vyrashchivanii telyat na komplekse [The effectiveness of the application of various doses of vitamin A in the cultivation of calves at the complex]. Zootechnical science of Belarus, 1985; 26: 88 – 91.

[14] Lisunova, L.I. Kormleniye sel'skokhozyaystvennykh zhivotnykh [Feeding of farm animals]. Novosibirsk: Zolotoy Kolos, 2011, pp. 294

[15] Mingazov, T.A. Vliyaniye vitamina A na vosproizvoditel'nuyu funktsiyu korov [The effect of vitamin A on the reproductive function of cows]. Bulletin of agricultural science of Kazakhstan, 1983; 8: 69 – 72.

[16] Weber S. Analytical Methods for Vitamins and Caratinoids in Feed. Roche, 1982; 1982: 99

[17] Privalo, O.E. Optimizatsiya A– i E– vitaminnogo pitaniya molochnogo skota v sovremennykh sistemakh kormleniya: [Optimization of A- and E-vitamin nutrition of dairy cattle in modern feeding systems]. The author's abstract of the Doctor of Agricultural Sciences. Moscow, 1987, pp. 24

[18] Porfiryev, A.I. Metabolizm vitamina A i besplodiye u vysokoproduktivnykh korov pri nesbalansirovannosti ratsionov [Metabolism of vitamin A and infertility in highly productive cows with imbalance in diets].Agricultural Biology, 2007; 4: 83 – 95.

[19] Starikova, N.I. Obmen vitamina A u korov posle otela [Exchange of vitamin A in cows after calving]. Vereinariya, 1994; 12: 35 – 36.

[20] Puzach, L.V. Vyrashchivaniye remontnykh telok pri ispol'zovanii premiksov s raznym urovnem vvoda vitaminov A i D. [Growing repair heifers when using premixes with different levels of input of vitamins A and D] The author's abstract of the Cand. of Agricultural Sciences.Borovsk, 1991, pp. 26