

Use of fat-soluble vitamins and feed additives in cow diets

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Abstract. The authors have created modern effective methods for controlling the vitamin content of highly productive lactating cows during the first period of lactation. The results were obtained on the content of vitamins in the diet, milk and blood when feeding with supplements Vitaminol and phytocomplex at 10, 15 and 20 g per animal unit daily separately and with mixed feed. The authors monitored the levels of vitamins A, carotene, D and E in cow's milk and serum. Scientific research was carried out for the agricultural enterprise "Novgorodsky Becon" of the Novgorod region. The cows ration was balanced by 50 nutrients and biologically active substances in accordance with the recommendations for animal feeding (Moscow, Russian Academy of Agricultural Sciences, 2003). Studies of the content of vitamins were carried out using the silage-concentration type of ration fed to lactating black-and-white cows in conditions without grazing. We conducted 2 scientific experiments and 2 physiological experiments with cows during the first 100 days of their lactation. The increase in the level of vitamin A in milk and blood was due to the use of feed additives in the diets. The use of feed additives increased the vitamin D levels in milk and serum. The balance of calcium and phosphorus metabolism in cows is positive. The use of "Vitaminol" together with compound feeds increased the level of calcium by 5.6–6.3 and phosphorus by 4.4–4.9 grams per 1 kg of milk with the natural fat content. The diets were admixed with the "Vitaminol" and phytocomplex ratio of Ca: P (1.3: 1) and Na: K (0.2: 1). With the same doses of feed additives, the ratio of acid and alkaline elements in the diets was the same: Vitaminol was 0.743 and phytocomplex was 0.709. Due to the use of "Vitaminol", the concentration of vitamin E in milk is 4.6-6 times higher than that in the control group, in blood and blood serum.

1 Introduction

An increase in the production of vitamin feeds, feed additives (preparations), an increase in their quality, stabilization of vitamins in plant-based feed are a means of increasing the usefulness of feeding highly productive lactating cows [1, 2, 3, 4].

It is known that the assimilation of vitamins depends on many factors: the ratio of vitamins to each other in diets, milk, the balance of diets in terms of minerals and amino acids [5, 6].

In the available literature there are very few modern experimental data on the problem of increasing the vitamin value of feed, rations, milk and blood of cows. The studies related to solving the problem of increasing the vitamin nutritional value of specific zonal typical rations and types of feeding of dairy cows in a year-round stable method of keeping are rare in the zootechnical literature, veterinary medicine and biology. When searching a solution to the problem of increasing the milk productivity of cows, many researchers have deviated from studying one of the main tasks of modern domestic and foreign science about animal feeding. In particular, they did not consider the influence of typical diets and types of feeding of dairy cattle on the degree of

vitamin sufficiency or deficiency, vitamins in their body and milk. The quality of life of people largely depends on the vitamin value of milk [7, 8].

2 Materials and methods

The composition and structure of diets affect the absorption of vitamins by the body of highly productive lactating cows during the milking period; therefore, it is advisable to show the interaction of vitamins with crude protein, sugars, crude fiber, crude fat, metabolic energy and a number of minerals and amino acids.

In this regard, it was necessary to study the influence of some factors on the dynamics of the content of vitamins in the milk of high-yielding lactating black-and-white cows during the milking period.

The studies were carried out in Novgorodsky Becon LLC, Novgorod Region, the milk production of cows for the previous lactation was 6000 kg. The rations for feeding cows are balanced by 50 indicators of nutrients and biologically active substances in accordance with the norms of feeding farm animals (M., RAAS, 2003).

Two scientific, economic and two physiological (balance) experiments were carried out. The diets of the cows of the first scientific and economic experiment included an additional feed additive (preparation)

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“Vitaminol”, and the second scientific and economic experiment – a feed additive in the form of a phytocomplex.

For each scientific and economic experiment, 4 groups of cows, 10 animal units in each, were formed. The animals of the first experimental group, in addition to the main diet (RR), were given 10 g of “Vitaminol”, the second experimental had 15 g, the third experimental group had 20 g per animal unit per day. For the cows of the control group, the drug was not included in the diets.

Similar doses of feeding the phytocomplex were made for cows of the experimental groups in the second scientific and economic experiment. For carrying out physiological experiments, 3 animal units with cows were selected according to the principle of paired analogs, taking into account the origin, breed, productivity and live weight.

The research methodology is based on scientific principles set forth in the works of domestic and foreign researchers on vitamin nutrition of animals. Zootechnical, physiological, biochemical and biometric research methods were used.

The purpose of the research is to study the effect of feeding cows during the milking period with feed additives “Vitaminol” and phytocomplex on the vitamin nutritional value of milk (A, D, E).

3 Results and discussion

The reasoning is as follows. During the milking period of cows, silage – 21.7%, haylage – 28.9% and compound feed – 36.2% were in the structure of rations in terms of nutritional value with a daily milk yield of 26-29 kg when using "Vitaminol" (Table 1). And when adding different doses of the phytocomplex to the diet, its structure consisted of silage – 20.0%, haylage – 32.8% and compound feed – 31.3%. The provision of the body of cows and milk with basic nutrients and biologically active substances, in particular, vitamins, was achieved through the inclusion of hay, silage, haylage, compound feed and feed additives in the diets [9].

Table 1. The composition of the diets of dairy cows in winter, % by nutritional value.

Kind of feed	Daily milk yield with natural content of fat during first part of lactation, during experimental period, kg	
	26 -29	26-29
	Main ration (MR) plus “Vitaminol”	Main ration (MR) plus phytocomplex
Hay from perennial grasses	9.6	11.1
Silage from mixed grasses	21.7	20.0
Wilted silage from mixed grasses	28.9	32.8
Concentrates (mixed feeds)	36.2	31.3
Sugar beet molasses	3.6	4.8
Total	100	100

The diets of cows using different doses of “Vitaminol” and the phyto-complex (separately) contained the following nutrients (Table 2).

Table 2. Some data on the composition of diets.

Data	Name of feed additive	
	“Vitaminol”	phytocomplex
Crude protein, % of DM	15.6	15.5
Fat, % of DM	3.3	3.3
Crude fibre, % of DM	27.4	28.7
Sugar, % of DM	8.3	9.0
Sugar-protein relation	0.82:1	0.90:1
Relation of acids elements to alkaline elements	0.743	0.709
Digestible protein in 1 feeding unit	111.2	115.9
Feeding unit in 1 kg of DM	0.86	0.84
Content of ME in 1 kg of DM	9.02	8.67
Carotene, mg	1838	1613
Vitamin E, mg	6470	6011

The existing structure of rations corresponds to the type of feeding and fodder production, depending on the prevailing conditions of the farm, its applicability and reliability.

According to experimental studies [10, 11], it was found that when including in the rations of feeds rich in protein, fiber, sugar, carotene and minerals, there was an unequal content of vitamins in cow's milk. The content

of fat-soluble vitamins in cow's milk largely depends on: breed, lactation phase, diet structure, type of feeding, physiological state, season of the year, keeping conditions, quality and chemical composition of voluminous plant feed, shelf life, harvesting technology and their processing [12].

The content of fat-soluble vitamins in the milk of cows was revealed with the silage-haylage-concentrate type of feeding under the conditions of a year-round stall-keeping method.

3.1. Methods for monitoring vitamin A supply

When adding different doses of the Vitaminol feed additive to the diets of cows, the vitamin A content ranged from 0.09 ± 0.002 to 0.24 ± 0.07 mg per 100 g of milk versus 0.06 ± 0.01 mg in cows of the control group (table 3). When feeding it to cows in the ratio of 10 g per animal units per day compared with the control, it was possible to note an increase in the content of this vitamin in milk by 50%. $P < 0.001$, and 15 g/animal units/day was 3 times, while when using the maximum doses of the drug there was 20 g/animal units/day, this indicator increased 4 times.

When using different doses of the phytocomplex in the diets (out of 13 medicinal feed crops), the vitamin A content in cow's milk ranged from 0.08 ± 0.003 to 0.18 ± 0.03 mg ($P < 0.001$) versus 0.07 ± 0.001 mg in peers of the control group (Table 3).

3.2. Methods for monitoring vitamin D supply

Vitamin D is involved in the regulation of calcium-phosphorus metabolism. Direct control methods include: accounting for the content of calcium, phosphorus in the diets, their ratio, the ratio of acid gram-equivalents to basic gram-equivalents, the structure of the diet, type of diet, type of feeding, conditions of detention, control of the content of basic nutrients and biologically active substances in the diet.

The inclusion of different doses of "Vitaminol" in mixed foods with feeds increased the content of vitamin D in milk from 0.29 ± 0.09 to 0.41 ± 0.03 mg versus 0.18 ± 0.01 mg in the control (see table 3). Its maximum content in milk was found in cows of the experimental group when this preparation was included in the diet of 20 g/animal units/day, which is 2.3 times higher than that of peers in the control.

The existing structure of rations for feeding highly productive cows with the use of domestic feed additives corresponded to an improvement in the absorption of vitamin D in the body and its accumulation in milk, which is confirmed by the results of experimental studies.

When a phytocomplex of 10 g/ animal units/day was included in the diet, milk contained 0.28 ± 0.06 mg of vitamin D, which is 1.5 times higher than the control level, and 15 g/animal units/day – 0.31 ± 0.09 mg (1.6 times higher) and, finally, 20 g/animal units/day – 0.40 ± 0.09 mg (2.1 times higher).

It should be kept in mind that in the diets of cows with the addition of "vitaminol" and a phytocomplex, the Ca: P ratio was 1.3: 1 and the Na: K ratio was 0.2: 1. With the same doses of additives, but not the same in the structure, chemical composition and properties, close relationships between these mineral macronutrients in diets are obtained. And the ratio of acid gram equivalent to the main gram equivalents in the diets of cows during milking when using different doses of Vitaminol was 0.743, and the phytocomplex was 0.709.

As a result, in the first case (Vitaminol) with milk, 35.14 ± 0.35 ($P < 0.001$) to 39.03 ± 0.18 g of calcium ($P < 0.001$) were excreted versus 33.67 ± 0.20 g in the peers of the control group. Due to the increase in the milk production level of cows, the degree of calcium deposition in the body decreased from 37.02 to 29.5 g against 37.9 g in animals in the control.

In the second case (phytocomplex), a similar trend was observed in the use of calcium by cows.

As for the phosphorus metabolism in the body of cows, when using Vitaminol with milk, from 21.52 ± 0.32 ($P < 0.001$) to 26.51 ± 0.39 g ($P < 0.001$) were excreted, while peers of the control group were 19.35 ± 0.24 g. The phosphorus retention in the body is positive; however, it decreased from 36.40 to 23.7 g, depending on the increase in milk production of cows.

When various doses of the phytocomplex are included in the diet, phosphorus is excreted per day from 24.66 ± 0.20 ($P < 0.001$) to 25.63 ± 0.12 g ($P < 0.001$), while in animals of the control group this indicator is 22.56 ± 0.18 g. In cows of the control and experimental groups, the phosphorus balance is positive.

When feeding cows with Vitaminol (with mixed feed) per 1 kg of milk, the fat content accounted for 5.6 - 6.3 g of calcium and 4.4 - 4.9 g of phosphorus, and the phytocomplex amounted to 4.9 - 5 for calcium, 6 g for phosphorus and others to 3.8 - 4.4 g.

3.3. Methods for monitoring vitamin E supply

Most often, the lack of vitamin E in the body is manifested, especially in high-yielding cows, during the dry period of pregnancy, as well as during the period of milking in conditions of year-round stall keeping. Vitamin E (tocopherol) has antioxidant properties (reproduction vitamin). In animals provided with vitamin E, vitamin A is better absorbed and accumulates in milk and blood. It is believed that cows on diets low in vitamin E have an increased need for vitamin A and ascorbic acid [13]. In this regard, it is advisable to control the activity of these vitamins in finished food products.

When adding different doses of "Vitaminol" to the diets, an increase in the content of vitamin E in cow's milk was established during milking (see table 3). So, the use of this drug in a mixture with animal feed contributed to an increase in the activity of vitamin E in milk from 4.6 to 6.0 times in comparison with the control.

The ratio of vitamin E to vitamin A in milk can serve as a sensitive, effective test of high availability, vitamin

E sufficiency in the body of cows. When using the Vitaminol preparation at a dose of 10 g/animal units/day, the ratio of vitamin E: vitamin A in cow's milk was 3.5: 1, and at a dose of 15 g/animal units/day, it was 1.9: 1 and at a dose of 20 g/animal units/day was 1.7: 1 versus 1.2: 1 in the control. As for this indicator in blood serum, it had the following form: at a dose of 10 g/animal units/day there is 31.5: 1, a dose of 15 g/animal units/day gives 22.8: 1 and a dose of 20 g/animal units/day is 20.6: 1.

When different doses of the vitamin E phytocomplex were included in diets, milk contained it from 0.30 (P <0.001) to 0.39 ± 0.004 mg versus 0.08 ± 0.001 mg in the control. In the case of applying the minimum amount of additive in the milk of cows of the experimental group, vitamin E is noted 3.7 times more than that in milk of the peers of the control group, and the maximum amount is 4.9 times.

Table 3. Content of vitamins in cow's milk in the first part of lactation, in 100 ml.

Experiment	Cows group	Vitamin A	Vitamin D	Vitamin E
1	Control group - MR	0.06 ± 0.001	0.18 ± 0.01	0.07 ± 0.002
	1-st experimental group (MR + "Vitaminol", 10 g per animal unit daily)	***	0.29 ± 0.09	*
	2-nd experimental group (MR + "Vitaminol", 15 g per animal unit daily)	0.09 ± 0.002	0.34 ± 0.17	0.32 ± 0.11
	3-rd experimental group (MR + "Vitaminol", 20 g per animal unit daily)	* 0.18 ± 0.05	***	0.35 ± 0.12 0.42 ± 0.14
2	Control group - MR	0.24 ± 0.07	0.41 ± 0.03	0.08 ± 0.001
	1-st experimental group (MR + phytocomplex, 10 g per animal unit daily)	0.08 ± 0.003	0.28 ± 0.06	*** 0.30 ± 0.001
	2-nd experimental group (MR + phytocomplex, 15 g per animal unit daily)	*** 0.15 ± 0.02	0.31 ± 0.09	*** 0.32 ± 0.001
	3-rd experimental group (MR + phytocomplex, 20 g per animal unit daily)	*** 0.18 ± 0.03	0.40 ± 0.09	*** 0.39 ± 0.004

*P<0,05; *** P<0,001

4 Conclusion

On the basis of experimental data, modern, effective methods of monitoring the supply of fat-soluble vitamins in highly productive lactating cows during milk production with a silage-hay-concentrate type of feeding in a year-round stall method of keeping are presented.

The activity of the vitamins under study was noted not only in their content in diets, but also in milk. At the same doses (10, 15 and 20 g/animal unit/day), using different types of feed additives (Vitaminol and phytocomplex), but not identical in structure, chemical composition and properties, close ratios of Ca:P and Na:K were obtained in diets. The dosed inclusion of feed additives in the composition of rations contributed to an increase not only in the average daily milk yield, but also in the content of fat-soluble vitamins (A, D, and E) in milk.

To improve the vitamin value of milk, metabolic processes in the body, it is necessary to use such feed additives as "Vitaminol" and phytocomplex in a mixture with compound feed at a dose of 20 g per animal unit per day.

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