# Water-soluble vitamins in the feed of high-yield lactating cows during the milking period

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**Abstract**. The aim of the work is to show how to increase the productivity of cows, to improve the feeding system, to introduce intensive, promising, effective, resource-saving milk production technologies, including the implementation of measures for the production and use of domestic vitamin feed products (preparations). The studies were carried out by the example of highly productive dairy cows with an annual productivity of over 6000 kg of milk per lactation. The type of feeding is the silage – hayage silage concentrate, the rations are balanced in terms of nutrients, biologically active substances and metabolic energy. It corresponded to the generally accepted norms of animal feeding in the country (M., RAAS, 2003). The diets of cows during the milking period included Vitaminol and a phytocomplex (of 13 medicinal forage herbs), 10 g, 15 g and 20 g per head per day. When milking cows (100 days), fed with Vitaminol, more milk was produced ranging from 2.7 to 9.9 %, the phytocomplex increased milk yield from 8.4 to 16.3 %. The consumption of metabolic energy of diets per 1 kg of milk is lower in cows of the experimental groups when using different doses of Vitaminol ranging from 2.8 to 9.9 %, and the phytocomplex allowed ranging it from 8.3 to 16.1 % compared to the control variant. To increase metabolic processes in the body, productivity and supply of water-soluble vitamins and mineral macronutrients in cows under the conditions of a year-round stable method of keeping, the rations included the optimal dose of Vitaminol and the phytocomplex (separately) amounting to 20 g per head a day. Vitaminol serves to replenish the body of highly productive lactating cows during the period of milk production with missing biologically active substances, vitamin nutritional value of milk, increase the digestibility of organic substances in rations, and improve metabolic processes.

## 1 Introduction

Over the past 15–20 years, more and more attention has been paid to the distribution of a number of vitamin preparations in dairy farming. It allows not only preventing vitamin deficiency diseases, but also increasing the productivity and vitamin value of cow milk [1, 2, 3], in particular with a year-round stall method of keeping [3, 4, 5].

At present, the possibility of using domestic, more effective, natural plant feed additives with the inclusion of wild crops in the diets of cows during the period of their milking has not been sufficiently substantiated [6, 7].

The main role in improving the vitamin nutrition of cows is played by natural sources of water-soluble vitamins (in particular, groups B, C): green fodder (feeding green mass) of pastures, silage, haylage, hay, grass flour [8, 9, 10]. However, in many regions of the country and abroad, dairy cattle are not grazed [11, 12]. Green fodder is delivered to the animals directly to the feeding trough [13, 14].

In this regard, it is necessary to make wider use of domestic feed additives Vitaminol and phytocomplex. Vitaminol contains a complex of water-soluble B vitamins, vitamin C, vitamin K and a number of dispersible forms of fat-soluble vitamins A, $D_3$ and E. Vitaminol is a white to cream powder made in accordance with GOST 35/095 - 97. The purpose of the phytocomplex is to significantly improve the taste and smell of freshly milked fresh milk due to the content in its composition of a range of beneficial essential oils and many healing (fodder) substances in the diet [15].

The phytocomplex included the dried medicinal fodder crops at the rate of 100 kg (flour). Milfoil was 2 kg (2.0 %), perennial timothy was 2 kg (2.0 %), orach was 3 kg (3.0 %), tansy was 4 kg (4.0 %), blueberries without berries were 4 kg (4.0 %), white sweet clover was 4 kg (4.0 %). White clover was 5 kg (5.0 %), pink clover was 5 kg (5.0 %), red clover, meadow were 5 kg (5.0%), goatweed was 6 kg (6.0%), big-sting nettle was 15 kg (15.0 %), fireweed was 15 kg (15.0 %) and alfalfa purple was 30 kg (30.0 % by mass). In total there was 100 %.

An increase in the production of vitamin complexes, medicinal herbs and supplements, an increase in their assortment, quality and safety in different seasons of the calendar year are a means of increasing the usefulness of feeding highly productive cows.

The aim of the study is to determine the effect of feeding Vitaminol and the phytocomplex to cows during the period of milk production on the productivity and

content of water-soluble vitamins in milk. The task was to study the use of various doses of the domestic vitamin complex Vitaminol and phytocomplex (of 13 medicinal herbs) on the productivity and vitamin value of milk.

## 2 Materials and methods

The studies were carried out by the example of lactating black-and-white cows on the basis of an experimental dairy farm of OOO Novgorodsky Bacon. The groups of cows were formed by the method of analogue groups, taking into account the age, live weight, productivity for the previous lactation of 6.5 thousand kg of milk, origin, pedigree and timing of insemination. To solve the set tasks, two scientific, economic and physiological experiments were carried out in accordance with generally accepted methods. Scientific and economic experiments consisted of periods: preparatory – 10 days, accounting – 100 days.

The accounting of actually consumed feed and feed additives was carried out daily. The rations were formulated taking into account the chemical composition and nutritional value of the feed based on detailed norms recommended by the Russian Academy of Agricultural Sciences and the Russian Academy of Sciences (2003). The dairy productivity of cows was monitored on a daily basis. 10 days before the end of the scientific and economic experiment, a physiological experiment was carried out to determine the mass of excretory products (faeces, urine and milk) by weighing them on a scale, the digestibility of nutrients in rations, the use and assimilation of nitrogen, calcium and phosphorus by the body.

The number of cows in scientific and economic experiments was 10 heads in each of the groups, physiological experiments were 3 heads. The cows were fed on a leash in stalls three times a day in individual feeders. The faeces were stored in desiccators with lids, and the urine was stored in bottles containing 2 - 4 thymol crystals. Waste products were weighed once a day. A 10 % average sample was taken from the daily amount for preservation with a 10 % HCl solution. The content of nutrients in biological samples was determined in accordance with generally accepted methods, minerals - by the method of atomic absorption spectrophotometry (Perkin Elmer USA, Analyst 400) in the central chemical laboratory of PJSC Akron, Novgorod region.

The content of water-soluble vitamins in bioassays was determined using a Kapel device at the Epidemiological Center of the Russian Federal Service for Supervision of Consumer Rights Protection and Human Welfare in the Novgorod Region.

## 3 Results and discussion

### 3.1. Use of feed additives

When feeding lactating cows during the milking period, the rations included bulky plant foods: hay produced from cereal perennial grasses, silage from cereal and leguminous grasses, haylage from cereal and leguminous perennial grasses. The feed additive Vitaminol was added to the diets of cows (in the first scientific and economic experiment), and in the second scientific and economic experiment, the phytocomplex, respectively, 10 g, 15 g and 20 g per head per day (depending on each experimental group). Animals of the control and all experimental groups were given a mineral supplement in the form of sodium chloride and feed precipitate. It contained 23.980 kg of the dry substance, 15.6 % of crude protein, 3.3 % of crude fat and 27.4 % of crude fiber from dry substance, 111.2 g of digestible protein per 1 ECU, 8.3 % of sugar from dry substance, 21.63 ECU and 216.3 MJ of metabolizable energy.

The main diet of cows with the addition of a phytocomplex in doses of 10 g, 15 g and 20 g per head a day in a mixture with a concentrate feed also included hay, silage, molasses (molasses), table salt, and fodder precipitate. The diets of the cows of the first experimental group, the second experimental and the third experimental group contained 21.368 kg of dry matter, 15.5 % of crude protein, 28.7 % of crude fiber, 3.3 % of fat, 9.0% of sugar from dry matter, 115.9 g of digestible protein per 1 ECU, 18.53 ECU and 185.3 MJ of metabolic energy. The cows of the control group were not fed the fodder supplement in the form of a phytocomplex.

Medicinal fodder crops were collected in the tracts of the Novgorod district of the Novgorod region.

When added to the diet, for example, 10 g/head/day of Vitaminol, the average daily milk yield of natural fat cows was 27.24 ± 1.85 kg, which is 2.7 % higher than that of the control group. And in the case of an increase in the dose to 15 g/head/day, the average daily milk yield of cows in the second experimental group increased to 28.27 ± 1.85 kg, which is 6.6 % higher than that in the animals of the control group. The inclusion in the diet of cows of the third experimental group of 20 g of this feed additive per head per day contributed to an increase in milk yield of natural fat content to 29.13 ± 1.15 kg, which is 9.9 % ($P>0.05$) higher than the control level.

The use of a number of nutrients and biologically active substances of medicinal fodder and other crops as part of the phytocomplex against the background of the main diet contributed to an increase in the average daily milk yield of natural fat content in cows of the first experimental group. Thus, it was 28.11 ± 1.16 kg (8.4 %), the second experimental group had 28.67 ± 1.24 kg (10.6 %) and the third experimental group had 30.15 ± 1.82 kg (16.2 % of the control). This indicator in cows of the control group was 25.93 ± 1.80 kg.

Dosed use of Vitaminol as a source of water-soluble and a number of fat-soluble vitamins (A, D and E) in the composition of diets positively influenced not only the level of productivity, but also corrected the ratio of Ca: P in the diet, milk and during their retention (accumulation) in the body due to the improvement of this indicator among the main chemical minerals in the optimal nutrition of cows, the quality, composition and

taste of milk in the conditions of a year-round stall method of keeping (Table 1).

**Table 1.** Influence of feeding various feed additives to dairy cows during the milking period on the dynamics of the Ca:P ratio in the diet, milk and during retention (accumulation) in the body.

| Group of cows | When using Vitaminol, the ratio of CA:P | | | When using the phytocomplex, the CA:P ratio | | |
|---|---|---|---|---|---|---|
| | in the diet | in the milk | their retention in the body | in the diet | in the milk | their retention in the body |
| Control (OR) | 1.04:1 | 1.74:1 | 0.87:1 | 1.09:1 | 1.47:1 | 0.98:1 |
| Experimental I (OR + 10 g/head/day) | 1.04:1 | 1.63:1 | 1.01:1 | 1.09:1 | 1.46:1 | 1.23:1 |
| Experimental II (OR + 15 g/head/day) | 1.04:1 | 1.49:1 | 1.19:1 | 1.09:1 | 1.56:1 | 0.81:1 |
| Experimental III (OR + 20 g/head/day) | 1.04:1 | 1.47:1 | 1.25:1 | 1.09:1 | 1.73:1 | 0.93:1 |

The use of Vitaminol and phytocomplex with high antioxidant and sorption properties in the diets simultaneously allowed more fully realizing the level of productivity. It was manifested in an increase in the average daily milk yield of natural fat milk in the first case from 2.7 to 9.9 %, in the second – from 8.4 to 16.2 % in comparison with the control variant. There was also the absence of salt poisoning and gastrointestinal tract disorders, impairment of the functional and excretory systems of the kidneys. The use of nutrients and biologically active substances in the herbs of the phytocomplex in the composition of the rations for feeding cows is given in Table 2.

A relatively high concentration of iodine was noted in the composition of stinging nettle (0.16 mg/kg), fireweed (willow weed, 0.16 mg/kg), pink clover (flowers, 0.20 mg/kg), meadow clover (0.14 mg/kg) and orach (0.25 mg/kg). As for the content of ferrous iron, its concentration increased with the use of the following medicinal herbs: St. John's wort (248 mg/kg) > meadow timothy (333 mg/kg) > blue lucerne (367 mg/kg) > stinging nettle (375 mg/kg).

A high concentration of copper was found in the following herbs: orach (7.95 mg/kg), meadow clover (8.40 mg/kg), goat weed (8.51 mg/kg), pink clover (8.82 mg/kg), milfoil (9.14 mg/kg) and tansy (10.4 mg/kg).

Natural plant resources at the regional level are suitable for enriching the body of highly productive lactating cows with mineral microelements (J, Fe, Cu, Mn, Zn). The leaves and stems of blueberries contain 559 mg / kg of manganese, which is 3-15 times more than that in other studied green herbs. Also, the types of medicinal herbs in the phytocomplex of antioxidant and sorption action had a positive effect not only on the level of productivity, but also increased the body's resistance to stressful situations, defences for the functioning of the nervous system, resistance to overload, the condition of the skin, skeleton, blood vessels, ligaments and joints.

### 3.2. The influence of the use of Vitaminol and the phytocomplex in the diets of cows during the milking period on the content of water-soluble vitamins in milk.

To increase the productivity and vitamin value of milk in lactating cows during the milking period, especially in the conditions of a year-round stable method of keeping, it is necessary to take into account all possible sources on which the supply of the body with vitamins depends.

Improvement of metabolic processes in the body of cows throughout the year-round stable method of keeping is closely related to the balance of daily rations for nutrients and biologically active substances and metabolic and energy, and with the use of domestic highly effective feed additives in animal feeding. In view of the fact that these domestic feed additives are currently insufficiently studied, especially in feeding highly productive lactating cows to the discord phase, with a year-round stall (tethered) method of keeping, solving the problem of increasing milk production is of extremely important economic importance.

### 3.3. The influence of the use of Vitaminol and the photo complex in the diets of cows during the milking period on the content of water-soluble vitamins in milk.

To increase the productivity and vitamin value of milk in lactating cows during the milking period, especially in the conditions of a year-round stable method of keeping, it is necessary to take into account all possible sources on which the supply of the body with vitamins depends.

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**Table 2.** The content of nutrients and biologically active substances in the herbs of the phytocomplex.

| The name of the green mass of different herbs of the phytocomplex | Organic substance, % | | | | Mineral macroelements, g/kg | | | | | | Mineral microelements, g/kg | | | | | Heavy metals, mg/kg | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | dry substance | protein | fibre | nitrogen-free extractive substances (NFES) | Mg | S | Na | P | K | Ca | $Fe^{2+}$ | J | Mn | Cu | Zn | Pb | Cd | Ni |
| Goatweed | 90.4 | 11.87 | 26.4 | 52.1 | 0.15 | 0.09 | 1.79 | 17.3 | 10.46 | 7.07 | 248 | 0.07 | 159 | 8.51 | 41.28 | 0.230 | 0.186 | 1.15 |
| Orach | 90.9 | 22.06 | 14.2 | 54.6 | 0.31 | 0.48 | 2.48 | 4.19 | 47.75 | 9.13 | 158 | 0.25 | 138 | 7.95 | 52.04 | 0.304 | 0.047 | 0.41 |
| Big-sting nettle | 89.7 | 23.42 | 15.1 | 51.2 | 0.39 | 0.82 | 2.82 | 5.93 | 25.03 | 18.80 | 375 | 0.16 | 122 | 7.65 | 38.75 | 0.499 | 0.054 | 0.40 |
| Fireweed | 90.0 | 13.31 | 25.6 | 51.1 | 0.17 | 0.20 | 2.58 | 3.98 | 15.11 | 8.78 | 132 | 0.16 | 65.7 | 5.54 | 33.26 | 0.279 | 0.031 | 0.76 |
| Blueberry (leaves and stems) | 91.3 | 8.98 | 32.4 | 49.9 | 0.11 | 0.10 | 2.01 | 1.40 | 5.40 | 9.81 | 106 | 0.10 | 559 | 5.73 | 17.07 | 0.125 | 0.041 | 0.42 |
| Tansy | 90.1 | 12.30 | 23.5 | 54.3 | 0.15 | 0.28 | 2.34 | 5.67 | 25.87 | 9.81 | 167 | 0.10 | 60.2 | 10.4 | 37.11 | 0.162 | 0.121 | 0.91 |
| Milfoil | 89.5 | 9.95 | 31.5 | 48.1 | 0.13 | 0.84 | 3.80 | 3.08 | 13.94 | 7.60 | 141 | 0.08 | 95.2 | 9.14 | 50.11 | 0.309 | 0.362 | 1.54 |
| Perennial timothy | 91.4 | 9.97 | 32.8 | 48.6 | 0.14 | 0.17 | 1.91 | 2.88 | 12.10 | 4.55 | 333 | 0.08 | 68.2 | 4.96 | 37.92 | 0.197 | 0.011 | 0.69 |
| White sweet clover | 90.1 | 16.50 | 36.7 | 36.9 | 0.16 | 0.20 | 2.08 | 2.45 | 10.29 | 8.21 | 128 | 0.08 | 29.0 | 6.57 | 19.33 | 0.239 | 0.047 | 2.16 |
| White clover | 88.7 | 15.91 | 26.9 | 45.9 | 0.11 | 0.10 | 2.54 | 2.59 | 16.05 | 8.73 | 88 | 0.02 | 57.7 | 6.04 | 26.97 | 0.256 | 0.018 | 2.26 |
| Alsike clover | 90.0 | 18.78 | 21.9 | 49.3 | 0.24 | 0.20 | 2.42 | 2.70 | 23.93 | 13.30 | 176 | 0.20 | 73.7 | 8.82 | 35.75 | 0.252 | 0.026 | 1.22 |
| Red clover (meadow) | 90.4 | 16.56 | 23.2 | 50.6 | 0.21 | 0.10 | 2.71 | 2.79 | 17.55 | 11.50 | 167 | 0.14 | 37.7 | 8.40 | 26.26 | 0.247 | 0.018 | 1.25 |
| Alfalfa purple | 90.7 | 15.86 | 28.0 | 46.8 | 0.14 | 0.19 | 1.94 | 2.41 | 17.72 | 9.45 | 367 | 0.10 | 92.2 | 6.60 | 26.44 | 0.164 | 0.027 | 0.77 |
| Herbal mixture of phytocomplex | 83.8 | 16.07 | 24.8 | 42.9 | 0.28 | 0.18 | 2.88 | 2.90 | 17.69 | 6.30 | 193 | 0.16 | 102 | 5.00 | 27.66 | 0.200 | 0.041 | 1.09 |

In view of the fact that these domestic feed additives are currently insufficiently studied, especially in feeding highly productive lactating cows to the discord phase, with a year-round stall (tethered) method of keeping, solving the problem of increasing milk production is of extremely important economic importance.

Some regional features of the properties of medicinal fodder crops and their phytocide activity were used to improve the vitamin value of fodder, rations, body resistance, health status and quality of milk of cows.

The effect of the dosed use of the studied feed additives in the diets of cows on the content of water-soluble vitamins in milk is given in Table 3.

The biological activity of B vitamins is closely related to protein metabolism, the provision of cows with protein, carbohydrates, and the lack – to a decrease in glycogen in the liver, a delay in the oxidation of lactic and pyruvic acids. And they are needed for protein optimization [16].

The need for highly productive cows for water-soluble vitamins is not well understood. They take part in the exchange of mineral trace elements. Both the antioxidant and sorption effects of feed additives, as well as the biologically active substances introduced into the composition, determine when feeding them to cows, along with an increase in the activity of enzyme systems, an increase in the anti-toxic function of the liver and the body as a whole. At the same time, the degree of localization of heavy metals (Pb, Cd, Ni) in the phytocomplex itself significantly decreased during the formation of certain medicinal herbs for their inclusion in the diet, and the functional activation of the digestive system of the cow's body increased. Therefore, in the phytocomplex itself, the total content of lead (0.200 mg/kg) and cadmium (0.041 mg/kg) is significantly lower than that in the rest of the studied laconic herbs.

With increasing doses of Vitaminol and phytocomplex from 10 to 20 g per head per day, there was a tendency to increase the content of all water-soluble vitamins in cow's milk during milk production, which is explained by an increase in the activity of the functional activity of enzyme systems, blood circulation and mammary gland. And the value of a particular water-soluble vitamin in the body of lactating cows is increased in combination with many minerals, amino acids, protein, fat and carbohydrates in the diet.

*Vitamin $B_{12}$ (cyanocobalamin)* participates in the metabolism of protein and carbohydrates. Iron protects

vitamin $B_{12}$ from interaction with vitamin $B_5$, and copper accelerates the loss of activity of this vitamin. For the synthesis of vitamin $B_{12}$ by microorganisms, the presence of carbon, nitrogen and cobalt is necessary. This vitamin is associated with the biological activity of B vitamins, accumulation (retention) and assimilation of nitrogen and a number of amino acids in the body. It promotes the purification of blood corpuscles and is rich in animal feed.

The composition of the diet influences the intestinal synthesis of vitamin $B_{12}$. The presence of a feed additive in the form of a phytocomplex in the diets of the silage-hay-concentrate type of feeding improves $B_{12}$, the vitamin supply of the organism of highly productive lactating cows during the milking period and increases its content in milk.

## 4 Conclusion

To normalize metabolic processes, increase milk productivity and vitamin nutritional value of cows' milk during the milking period, it is advisable to use domestic, environmentally friendly feed additives in a mixture with compound feed.

According to the results of the experimental studies, the parameters of the content of water-soluble vitamins in the milk of black-and-white cows during the milking period (in 100 g) are given in Table 4.

**Table 3.** Vitamin content in milk of cows during the milking period (per 100g).

| Experiment | Group of cows | Water soluble | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $B_1$ (thiamine), mg | $B_2$ (riboflavin), mg | $B_3$ (pantothenic acid), mg | $B_5$ (PP, nicotinic acid), mg | $B_6$ (pyridoxine), mg | $B_7$ (biotin), µg | B9 (folic acid), µg | $B_{12}$ (cyanocobalamin), µg | C (ascorbic acid), mg |
| 1 | Control (OR) | 0.02±0.001 | 0.09±0.001 | 0.27±0.011 | 0.04±0.001 | 0.02±0.001 | 1.82±0.05 | 0.10±0.01 | 0.18±0.06 | 0.64±0.09 |
| | Experimental I (OR + 10g/head/day "Vitaminol") | 0.03±0.002 | 0.11±0.011 | *** 0.35±0.02 | *** 0.09±0.001 | *** 0.08±0.002 | *** 2.21±0.07 | *** 0.25±0.03 | 0.28±0.07 | *** 1.10±0.04 |
| | Experimental II (OR + 15g/head/day "Vitaminol") | *** 0.04±0.002 | ** 0.18±0.013 | 0.44±0.12 | *** 0.10±0.001 | *** 0.16±0.01 | *** 2.86±0.09 | *** 0.40±0.02 | * 0.31±0.09 | *** 1.89±0.07 |
| | Experimental III (OR + 20g/head/day "Vitaminol") | *** 0.06±0.003 | *** 0.23±0.011 | * 0.57±0.11 | *** 0.20±0.02 | *** 0.18±0.12 | *** 3.14±0.08 | *** 0.54±0.01 | *** 0.44±0.04 | *** 2.04±0.07 |
| 2 | Control group (OR) | 0.03±0.001 | 0.09±0.002 | 0.29±0.04 | 0.04±0.004 | 0.03±0.001 | 1.86±0.06 | 0.12±0.009 | 0.22±0.07 | 0.58±0.08 |
| | Experimental I (RR + 10g/head/day of phytocomplex) | 0.04±0.002 | *** 0.14±0.001 | ** 0.42±0.03 | *** 0.11±0.001 | *** 0.10±0.001 | *** 2.17±0.05 | 0.37±0.16 | 0.27±0.05 | *** 1.17±0.12 |
| | Experimental II (OR + 15g/head/day of the phytocomplex) | *** 0.05±0.003 | *** 0.15±0.002 | *** 0.49±0.03 | *** 0.16±0.001 | *** 0.12±0.001 | *** 2.74±0.06 | *** 0.49±0.02 | ** 0.49±0.02 | *** 1.79±0.06 |
| | Experimental III (OR + 20g/head/day of phytocomplex) | *** 0.05±0.001 | *** 0.22±0.003 | *** 0.57±0.04 | *** 0.26±0.02 | *** 0.17±0.002 | *** 2.96±0.02 | *** 0.63±0.07 | *** 0.52±0.01 | *** 2.09±0.09 |

*P < 0.05; **P < 0.01; ***P < 0.001

**Table 4.** Parameters of the content of water-soluble vitamins in the milk of black-and-white cows during the milking period (in 100 g).

| Name of the water-soluble vitamin | The name of the feed additive | |
|---|---|---|
| | Vitaminol | Phytocomplex |

| | | |
|---|---|---|
| $B_1$ (thiamine), mg | 0.03 – 0.06 (control 0.02) | 0.04 – 0.05 (control 0.03) |
| $B_2$ (riboflavin), mg | 0.11 – 0.23 (control 0.09) | 0.14 – 0.22 (control 0.09) |
| $B_3$ (pantothenic acid), mg | 0.35 – 0.57 (control 0.27) | 0.42 – 0.57 (control 0.29) |
| $B_5$ (PP, nicotinic acid), mg | 0.09 – 0.20 (control 0.04) | 0.11 – 0.26 (control 0.04) |
| $B_6$ (pyridoxine), μg | 0.08 – 0.18 (control 0.02) | 0.10 – 0.17 (control 0.03) |
| $B_7$ (biotin), μg | 2.21 – 3.14 (control 1.82) | 2.17 – 2.96 (control 1.86) |
| B9 (folic acid), μg | 0.25 – 0.54 (control 0.10) | 0.37 – 0.63 (control 0.12) |
| $B_{12}$ (cyanocobalamin), μg | 0.28 – 0.44 (control 0.18) | 0.27 – 0.52 (control 0.22) |
| C (ascorbic acid), mg | 1.10 - 2.04 (control 0.64) | 1.17 – 2.09 (control 0.58) |

To increase the efficiency of the use of water-soluble vitamins in the diets, it is necessary to include feed additives Vitaminol and phytocomplex (separately) in a dose of 20 g per head per day.

When improving the methods of providing water-soluble vitamins in cows with a silage-hay-concentrate type of feeding in conditions of year-round stall keeping, it is recommended to optimize the parameters of their content in milk per 100 g as compared with peers in the control group.

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