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The study of new feed additives in the ration in newly-calved high producing cows

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Abstract. The paper highlights the results of a study on the combined use of the CattlePro Effect amido-vitamin-and-mineral complex and PassPro Ballans feed product in the diets of newly-calved high producing cows. The studies were carried out in the conditions of the Bolshevik collective farm of the Kalacheevsky district of the Voronezh region (Russia) according to the method of A.I. Ovsyannikov (1976) for three months after a 21-day equalizing period. During the course of the experiment, it was determined that the introduction of new feed additives into the diet leads to an increase in the consumption of dry matter by lactating animals by 1.0–6.2%. The basic fat content and protein content of milk was increased by 11.6–19.1%, and when adjusting the milk yield for 4% milk – by 9.3–17.4%. The digested feed particles in the feces were closer to normal in the cows of the experimental groups, which indicates the beneficial effect of the feed additive on the digestive processes of animals. When applying the studied feed additive, there was a certain decrease in enterobacteria and staphylococci in the samples of the rumen fluid and at the same time there was an increase in lactic acid microorganisms 1.6–2.0 times.

Key words: amido-vitamin-and-mineral complex, milk yield, newly calved high producing cows, protected protein.

INTRODUCTION

Animal productivity is increasing due to the transition of farms of all forms of ownership to intensive livestock production technologies. Therefore, it is especially important to develop the right feeding strategies so that the animal breeding system matches the available resources (Zenkin, et al., 2017).

The implementation of the program for the further development of animal husbandry is possible, first of all, on the basis of its intensification and the maintenance of high production performance of animals. Therefore, meeting the growing needs of the population for quality food remains the main concern of livestock production (Niu et al., 2016; McDonnell & Staines, 2017).

To date, the average productivity of cows has been increased to 7,000 tons of milk per year (Zhou et al., 2017; Weatherly et al., 2018).

Throughout life, the cow’s body goes through a series of cyclical conditions. Especially vulnerable of them are the period before calving and the first three months of lactation. In the first month after calving, the highest requirements are made for feeding cows, since errors in the diet during this period will greatly affect the productivity and health of the animal. Practice has shown that even with careful organization of feeding, only about 60% of cows after calving are completely healthy. Right after calving, a number of diseases associated with metabolism may appear, since during the transition from pregnancy to the post-calving period, metabolism changes. In order to smooth out the negative impact of this period, special attention should be paid to feeding three weeks before calving and three weeks after (Kolesnik et al., 2018).

During this period, there are such phenomena as negative energy and protein balance – when the cow needs more energy and protein than it has with the feed. The physiological status in the postpartum period is extremely important for health and fertility, because if you do not fill the deficiency of energy and protein during milking, this can lead to a number of diseases, and, as a consequence, a decrease in productivity and reproductive performance. Therefore, knowing the risk of such a condition, it is necessary to make every effort to prevent it with the help of rational feeding. The postpartum feeding requirements of cows are highest, since the consequences of using unbalanced diets in the first three months of lactation can be very severe. Even with a high level of feeding, only 60% of the cows in the first period of lactation have a normal metabolism (Gaworski et al., 2018; Klebaniuk et al., 2019).

Feeding should be based on knowledge of the animal’s need for basic nutrients, metabolism in the body through the inclusion of various feed products and ways to optimize nutrition by selecting and synergizing feed additives that show better efficacy (Aristov et al., 2018).

The cow has a very complex stomach, which is a biological fermenter in which a huge number of microorganisms and protozoa live. In turn, rumen bacteria use not only carbohydrates, but also nitrogen of amino acids, soluble fractions of feed protein. Therefore, the availability of amino acids for the body of cows should be ensured by the intake of at least 60% of the non-degradable protein in the rumen of cows. As far back as 20 years ago, it was believed that assimilation of microbial protein was sufficient for a cow, in addition to protein available from feed (Leso et al., 2019; Migulev et al., 2019).

For normal life, maintaining productivity and health in the body of a cow, especially in the first time of lactation, it is necessary to ensure the supply of a sufficient amount of protein. A protected protein is a protein that practically does not undergo cleavage in the rumen. It is very important when balancing the diet, because with insufficient intake of amino acids in the cow's body, metabolism is impaired, the protective functions of the body are reduced and the quality of milk is deteriorated (Velikanov et al., 2016; Zenkin et al., 2016).

With the transition to acidic conditions of the abomasum, the protected protein disintegrates and begins to unwind, allowing digestive enzymes to penetrate the molecule, breaking down the protein into its constituent abomasum material and is used for milk synthesis (Yadav & Chaudhary, 2010; Astashova et al., 2017).

With sufficient intake of protected protein, there is every chance to maintain health and extend the productive longevity of the cow by improving its biological status as a whole. Studies, evaluating the effect of protected methionine intake on milk production, have shown an increase in the percentage of protein in milk (Toledo et al., 2017).

Feeding Holstein cows a protein supplement with protected lysine and methionine in the postpartum period, slightly increases milk yield and its protein content (Carder & Weiss, 2017).

Previous studies on the use of PassPro Balance in the diet of Simmental cows in the fresh season showed an increase in the consumption of the feed mixture by 0.9% and dry matter by 5.4%, the average daily milk yield by 29.2% ($p < 0.01$) and the profitability level of milk production – by 7.8%, and also reduces the service life by 5.0% and the consumption of concentrates for the production of 1 kg of basic fat milk by 22.8% (Yurina et al., 2019).

Vitamins and microelements in nutrition of cows, especially in the newly calved period, are important for metabolism and production. Moreover, the fact is known that proteins interact with minerals, producing complexes with a high biological role (Zang et al., 2019).

Copper is essential in the nutrition of newly calved cows and in its interaction with protein. Copper metabolism occurs mainly in the liver and hepatocytes are its main structures. The copper entering them initially binds to protein. Copper is involved in biochemical processes as a component of electron transfer proteins that oxidize organic substrates with molecular oxygen (Taov et al., 2019).

However, although the role of each trace element is important for the metabolism of the body, it is necessary to take into account the uniform intake (according to the standards) of each trace element separately, since minerals come into contact with each other. For example, cobalt has a positive effect on hematopoietic function with sufficient intake of copper and iron with feed, and copper, in turn, exhibits its properties better when magnesium is optimally absorbed into the body. Trace elements are involved in the metabolism, in the production of hormones, regulating the activity of enzymes, vitamins, and protein. Endogenous enzymes cannot be sufficiently active without an optimal amount of trace elements. Minerals are also involved in various mechanisms providing morphofunctional homeostasis in different animals, especially in the postpartum period, when the body needs to recover and gain strength for the next reproductive cycle. Cattle feeding is necessarily ensured by a complete, balanced diet for basic nutrients, and then for vitamins and minerals (Omur et al., 2016).

According to Taov et al. (2019), the intake of a sufficient amount of minerals increases milk yield by 0.95–1.45 kg. Calves from cows that received vitamin A and trivitamine develop better during the embryonic period, and their live weight at birth was 2.8–3.0 kg more compared to the control group.

The purpose and objectives of the researches. It was the purpose of the research to study the combined use of the CattlePro Effect amido-vitamin-and-mineral complex and PassPro Ballans feedstuff, which consists of protected soy and sunflower protein in the diets of newly-calved high producing cows.

To achieve the stated goal, the following tasks were set:

1) To develop the composition of compound feed and rations for newly-calved high producing cows, taking into account the determination of the dosage of the introduction of the studied feed.

2) To determine the effect of both separate and combined use of the CattlePro Effect amido-vitamin and-mineral complex and PassPro Ballans feedstuff, which consists of protected soy and sunflower protein in the diets of newly-calved high producing cows on milk productivity, milk quality.

3) To assess the digestion rate of the feed and analyze the microflora of the rumen fluid of the cows with separate and combined use of the CattlePro Effect amide-vitamin-mineral complex and PassPro Ballans feed product.

MATERIALS AND METHODS

The scientific and production experiment was carried out in the conditions of the enterprise of the Bolshevik collective farm in the Kalacheevsky district of the Voronezh region (Russia) according to the method of A.I. Ovsyannikova (1976). Four groups of newly-calved Simmental cows were formed, selected according to the principle of analogue pairs with 8 animals each: by age in calving, calving period, live weight, with high productivity for past lactation, fat and protein content in milk. The experiment has been continued after an equalizing period for 3 months. Cows were fed according to the scheme presented below (Table 1).

Table 1. Experimental design (n = 8)

Group	Experimental design
1 – control	Basal diet (BD) + compound feed (CF) with substitution
2 – experimental	BD + CF with substitution 1 kg CattlePro Effect
3 – experimental	BD + CF with substitution 2 kg PassPro Ballans
4 – experimental	BD + CF with substitution 1kg CattlePro Effect and 2 kg PassPro Ballans

The preparatory period was carried out 10 days before the date of the proposed calving and after within 10 days. Animals of the control and experimental groups during this period received the same diet. The experimental period was carried out from the 11th day after calving.

Feeding, milking and keeping animals were according to the adopted on the farm regime. Every ten days, control milking of each cow was carried out to determine the average daily milk yield and gross milk yield, as well as the fat and protein content in milk.

To determine the amount of feed consumed, control feeding was carried out (within 3 adjacent days) by taking into account the given feed mixtures and weighing their residues. Expected nutrient costs per unit of production were counted.

According to zootechnic records, the indicators characterizing the reproductive function of high producing cows were determined: the duration of the service period and the insemination index.

Mass fraction of protein and fat in milk was determined on a Lactan device.

The amount of milk fat and protein: gross milk yield per period was multiplied by the mass fraction of fat or protein.

To compare milk productivity of cows in the experiment, the corrected milk yield with 4% fat was calculated according to the formula:

$$\text{FCMY (fat corrected milk yield) } 4\% = M \times (0.4 + F \times 0.15), \qquad (1)$$

where M – the amount of milk received from cows in the experiment; F – the percentage of fat in cow's milk, actually obtained; 0.15 is a constant coefficient used for adjustment.

The calculation of the cow milk for delivery to the dairy was performed according to the following formula:

$$ABM = AF \times 0.4 + AP \times 0.6) / 3.16 \times M, \quad (2)$$

where ABM – the amount of milk of basic fat content and protein content, kg; AF – the percentage of fat in cow's milk, actually obtained; AP – the percentage of protein in cow's milk, actually obtained; 0.4 – fat value coefficient; 0.6 – protein value coefficient; 3.14 – the coefficient is calculated as follows: 3.4×0.4 (fat value coefficient) + 3.0×0.6 (protein value coefficient); 3.4 – the all-Russian basic standard of the mass fraction of fat in milk; 3.0 – the all-Russian basic standard of the mass fraction of protein in milk (Basonov & Muryanova, 2014).

The use of a feces separator makes it possible to relatively quickly get the first impression of providing animals with structural fiber. This is the first step in determining the effectiveness of the diet.

When evaluating feces, one can obtain information on how well the food is digested, whether the diet is correctly selected, whether the content of nutrients (proteins, fiber, carbohydrates) is balanced, whether the animal consumes enough water.

To analyze the assimilation of feed nutrients, a Nasco Pigestion Analyzer, a type feces separator (or Pennsylvania sieve) was used. It consists of 3 sieves with different hole diameters – wider in the upper sieve and narrow in the lower sieve. The feces was washed in a separator until clean water appeared, then it was removed from the sieves and weighed to calculate the percentage of the fractions being evaluated, the number of undigested grains was visually determined (Filinskaya & Kevorkyan, 2018).

Rumen fluid was taken with a rumen probe 3 hours after feeding. Microbiological values of the rumen fluid were evaluated in the Argus Testing Centre according to the guidelines 'Bacteriological diagnosis of dysbiosis' (Fedorov & Fedorova, 1989).

The research results were processed by the biometric method of variation statistics. Differences were considered statistically significant at * – $p < 0.05$; ** – $p < 0.01$; *** – $p < 0.001$ (Plokhinskiy, 1970). For analysis our data, we used the computer program Microsoft Excel.

Animal feeding diets were developed in according to NRC (2001) of modern detailed feeding standards for lactating cows, taking into account the actual productivity and physiological state (Table 2).

Table 2. Composition of diets for cows in the first phase of lactation

Component	1 group		2 group		3 group		4 group	
	DM	Fraction, kg	DM	Fraction, kg	DM	Fraction, kg	DM	Fraction, kg
Meadow hay	0.919	1.0	0.919	1.0	0.919	1.0	0.919	1.0
Corn silage	7.350	21.0	7.350	21.0	7.350	21.0	7.350	21.0
Grass-legume silage	3.840	8.0	3.840	8.0	3.840	8.0	3.840	8.0
Fresh beet pulp	1.200	6.0	1.200	6.0	1.200	6.0	1.200	6.0
Compound feed	7.139	8.0	6.247	7.0	5.355	6.0	4.462	5.0
CP Effect PMVC	–		0.929	1.0	–		0.929	2.0
PassPro Balance	–		–		1.863	2.0	1.863	1.0
Total	20.45	44.0	20.49	44.0	20.53	44.0	20.56	44.0

Nutritional value presented below (Table 3).

Table 3. Nutritional value

Nutrient index	1 group	2 group	3 group	4 group
Dry matter, g	20448	20485	20527	20563
Crude protein, g	2575.64	2922.08	3100.15	3446.59
Digestible protein. g	2834.32	2879.86	3181.32	3226.86
Crude fat, g	541.56	541.74	604.44	604.61
Starch, g	6463.4	5990.03	5517.71	5044.33
Sugar, g	702.69	758.6	816.86	872.77
Rumen UDP, %	22.94	23.04	31.57	30.79
Calcium, g	142.375	161.692	141.54	160.857
Phosphorus, g	82.21	80.823	82.526	81.14
Sodium, g	61.795	56.89	50.717	45.812
Magnesium, g	41.305	41.342	42.547	42.584
Crude fiber, g	4064.51	4136.12	4184.26	4255.87
Vitamin A, IU	94000	94000	94000	94000
Vitamin D, IU	9400	9400	9400	9400
Vitamin E, IU	320	320	320	320
Zinc, mg	752	752	752	752
Iron, mg	106.86	106.86	106.86	106.86
Manganese, mg	564	564	564	564
Copper, mg	188	188	188	188
Cobalt, mg	2.82	2.82	2.82	2.82
Iodine, mg	7.52	7.52	7.52	7.52
Selenium, mg	5.64	5.64	5.64	5.64

CattlePro Effect is an amido-vitamin-and-mineral complex in the form of grains. It contains feed urea, which is a source of readily available nitrogen. (Table 4). CattlePro effect contains 11.2 MJ of metabolic energy, 52.0% crude protein, 6.2% crude fat, and 6.5% crude ash. Also contains a probiotic complex.

The PassPro Balance feed stuff production technology (manufactured by Protectfeed LLC) is based on the extrusion of oilseeds, expansion, and then additional processing of the product under pressure and temperature to the required protection characteristics against the decay in the rumen of animals with a multi-chamber stomach. Processing modes are selected so that digestibility in the small intestine remains at a high level. PassPro Balance contains (on absolutely dry matter basis): 42.0% crude protein, 8.5% crude fat, 13.2% crude fiber and 12.3 MJ of metabolic energy, 'protected' soy and sunflower proteins have a stable rate of protein protection (protein non-degradable in the rumen 65–70%) with digestibility up to 95–96%.

Table 4. The nutritional value of the studied feed additives

Nutrient index	CP Effect	PassPro Balance
Metabolic energy, MJ	11.2	12.3
Humidity, %	9.5	9.0
Crude protein, %	52.0	42.0
Crude fat, %	6.2	8.5
Crude ash, %	6.5	6.0
Crude fiber, %	12.0	13.2
Sugar, %	7.5	4.9
Starch, %	2.5	1.7
Calcium, %	2.7	0.7
Phosphorus, %	1.0	0.6

From the data of Table 2 it follows that the diet was completely balanced according to the requirements of the cows of the first phase of lactation.

RESULTS AND DISCUSSION

After the control feeding, it was found that feeding the studied feed additive in the second experimental group made it possible to increase the dry matter intake by 1.0% relative to the control. In the third experimental group, the consumption was higher by 3.6%, and in the fourth experimental group by 6.2% dry matter ($p < 0.01$).

When recalculating the milk yield taking into account the basic fat content and protein content of milk, a significant excess of the control value was found in the second and fourth experimental groups by 11.6 ($p < 0.05$) and 19.1% ($p < 0.01$). The third group showed an increase tendency by 12.3%. According to the correction of fat corrected milk (4% milk), in the second experimental group, the dynamics of increase by 9.3% is visible, and in the third and fourth experimental groups this indicator significantly exceeded the control by 12.8 ($p < 0.05$) and 17.4% ($p < 0.01$).

The data obtained are consistent with the results of studies by several authors (Niu, 2016; Carder & Weiss, 2017; Toledo et al., 2017).

The results of feces flushing on a Pennsylvanian sieve are shown in Table 5.

Table 5. Results of feces flushing on the Pennsylvanian Sieve, n = 3

Group	Sieve type		
	upper	lower	middle
1 (control)	55.1 ± 1.9	150.0 ± 3.7	360.0 ± 13.3
in %	9.8	26.5	63.7
2 (experiment)	45.6 ± 0.6**	109.8 ± 5.4***	402.2 ± 10.2
in %	8.2	19.7	72.1
3 (experiment)	51.1 ± 2.0	99.5 ± 4.2***	384.3 ± 14.2
in %	9.6	18.6	71.8
4 (experiment)	44.3 ± 1.5***	92.5 ± 5.6***	392.1 ± 9.2
in %	8.4	17.5	74.1
Norm, %	< 10	< 20	> 50

* – $p < 0.05$; ** – $p < 0.01$; *** – $p < 0.001$.

It was found that closer to the norm, according to the size of the digested feed particles in the feces, were cows of the experimental groups, especially of the fourth group, which consumed the CattlePro Effect amido-vitamin-and-mineral complex and PassPro Ballans feedstuff in combination with the basal diet, which indicates better digestion of animals compared to the control.

When analyzing the rumen fluid of the cows, it was revealed that the number of enterobacteria - representatives of the normal microflora of the rumen – did not differ significantly in groups and amounted to 1.4×10^2; 2.0×10^2 and 1.1×10^2 CFU g^{-1} according to the experimental groups versus the control – 1.0×10^2 CFU g^{-1} (Table 6).

Clostridia, which break down simple fiber and other carbohydrates, are present in small quantities, namely in the form of one colony, in the fourth experimental group.

The content of lactic acid microorganisms practically does not differ in the experimental groups in comparison with the control, which suggests that the studied feed does not negatively affect the content of 'useful' microorganisms in the rumen of experimental cows.

Table 6. The composition of the microflora of rumen fluid in cows

Items	1 group (control)	2 group	3 group	4 group
Enterobacteria, CFU g^{-1}	1.0×10^{2}	1.4×10^{2}	2.0×10^{2}	1.1×10^{2}
Clostridia, in 1 ml	Not detected	Not detected	Not detected	1.0
Lactic acid microorganisms, CFU g^{-1}	2.0×10^{5}	8.0×10^{4}	1.0×10^{5}	5.0×10^{4}
Yeast, CFU g^{-1}	3.0×10^{6}	5.0×10^{4}	3.0×10^{6}	3.0×10^{6}
Mold, CFU g^{-1}	8.0×10^{1}	2.5×10^{2}	9.0×10^{1}	Not detected

The yeast in the rumen stimulates the growth of bacteria utilizing strong organic acids, which helps to maintain normal pH in the rumen. Thus, optimal digestion conditions are created, and acidosis is prevented. The number of yeast in the rumen of the cows of the first, third and fourth groups was 3.0×10^{6} CFU g^{-1}. In the second group, this indicator amounted to 5.0×10^{4} CFU g^{-1}.

It should be noted that when cows fed the CattlePro Effect amido-vitamin-and-mineral complex and PassPro Ballans feed stuff, molds are not found in the analysis of the rumen fluid, which indicates the effectiveness of the combined use of these feed products.

CONCLUSIONS

The best use should be considered the combined use of the CattlePro Effect amido-vitamin-and-mineral complex and PassPro Ballans feed stuff in combination with the basal diet of newly-calved high producing Simmental cows from the 11^{th} day after calving for three months (the rate of introduction of the fourth experimental group).

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