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Probiotic Premix and Its Experimental Evaluation in Beef and Dairy Cattle

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ABSTRACT

A new strain of propionic acid bacteria, Propionibacterium 1/18, was selected for inclusion in a probiotic feed additive. The Propionibacterium freudenreichii 1/18 strain was deposited in the Republican Collection of Microorganisms Limited Liability Partnership under the number B-RKM 1290. A study was conducted to determine the amino acids and B vitamins synthesized by this strain of propionic acid bacteria. Based on a combination of lactic acid bacteria (Lactobacillus plantarum 2B), cellulolytic bacteria (Cellulomonas flavigena 22), and a new strain of propionic acid bacteria (Propionibacterium 1/18), an optimal microbial association was formed and included in the feed additive, which was later tested on cattle. The feed additive in the form of granules consists of the following components: feed bentonite 600 g, feed bran 200 g, feed tricalcium phosphate 200 g, vitamin D 1 g, and a lyophilized association of probiotic bacteria Lactobacillus plantarum 2B, Cellulomonas flavigena 22, and a new Propionibacterium shermanii 1/18 strain. The actual chemical composition of the feed was studied, and detailed rations were developed. The research carried out to test the feed additive showed that it increased feed consumption, which ultimately had a positive effect on the dairy productivity of the animals in the experimental groups.

Keywords: *Premix, Cellulolytic bacteria, Propionic acid bacteria, Lactic acid bacteria, Animal productivity*

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INTRODUCTION

Animal husbandry is one of the main branches of global agriculture, providing the population with the necessary and valuable food products of animal origin. Dairy and meat products are important sources of protein, energy, and biologically active substances for a healthy human life. Currently, there is a significant increase in demand for livestock products, driven by population growth and a shift in dietary patterns towards greater consumption of these products. According to forecasts of international organizations, the demand for meat and dairy products will continue to grow, which requires a further increase in production volumes and an increase in the efficiency of livestock systems (Food and Agriculture Organization of the United Nations [FAO], 2025).

At the same time, livestock production faces several challenges related to the need to rationalize the use of feed resources and to increase farm animal productivity. The most important factor determining animal productivity and product quality is complete and balanced feeding, which requires providing all necessary nutrients. Proper nutrition, which meets the needs of farm animals' bodies, contributes to the normal functioning of metabolic processes and the maintenance of physiological condition.

Increasing feed efficiency and optimizing diets are considered important areas for the intensification of animal husbandry, since the quality of feeding determines growth rates, meat and dairy productivity, as well as the economic productivity of livestock production (Greenwood, 2021; Faverdin *et al*., 2022). Hence, there is a need for functional support of the digestive system through a combination of feed additives that improve feed assimilation efficiency.

Various types of feed additives are being developed for this purpose. The EU Association of Specialty Feed Ingredients and their Mixtures (FEFANA) identifies five main groups of feed additives (Kabanov *et al*., 1986): technical additives that act directly on feed, for example, organic acids; sensory additives that affect feed consumption, for example, flavors; nutritional additives that provide the necessary level of amino acids, vitamins and trace elements in the diet; zootechnical additives that improve the use of feed nutrients; and coccidiostats and histomonostatics. The group of zootechnical additives includes feed enzymes, feed antibiotics, probiotics, and prebiotics. Each group of additives has its own advantages and disadvantages that limit their use (Guillen & Pereira, 2024; Morgan *et al*., 2025).

The main purposes of using feed additives are to improve feed quality and digestibility, animal productivity, and animal health. For many years, antibiotic-based feed additives have shown promising results; however, their use in animal feed has several disadvantages. They can accumulate in animal products, and their widespread use further exacerbates antibiotic resistance (Bimenova *et al*., 2018; Ban & Guan, 2021). Probiotic microorganisms are widely considered an alternative to antibiotics, as they are included in ruminants' diets to improve feed digestion and alter the rumen microflora profile, leading to better ruminal fermentation, increased feed digestibility, and improved animal productivity. Compared with antibiotic-based feed additives, probiotics can inhibit the growth of harmful microorganisms in the gastrointestinal tract and alter the density of the host microbial population. This leads to the formation of a more favorable microbial community by shifting the balance between beneficial and harmful microorganisms (Elghandour *et al*., 2015; Anee *et al*., 2021; Abd El-Hack *et al*., 2022). In addition, probiotic microorganisms in feed additives help young calves adapt quickly to solid feed and prevent the proliferation of intestinal pathogens in the gastrointestinal tract (Mishra *et al*., 2025; Nagesh *et al*., 2025; Novak & Dvorak, 2025).

Probiotics affect pathogens through several basic mechanisms, including the release of bacteriocins, organic acids, and hydrogen peroxide, which inhibit their growth and competitively displace pathogens by competing for nutrients and attachment sites on the intestinal mucosa, thereby preventing colonization (Ayalew *et al*., 2022; Novak & Dvorak, 2025).

Lactobacilli are gram-positive bacteria belonging to the group of lactic acid bacteria (LAB). These include more than 100 species, most of which are part of the normal mammalian microbiota (Arsène *et al*., 2021). Species of this group are commonly used as probiotics in both dairy and non-dairy products intended for human consumption (Götz *et al*., 2006; Manga *et al*., 2019; Novak & Jelic, 2025). Lactobacillus strains produce various food enzymes, including protease, amylase, lipase, and phytase, which aid in the digestion and assimilation of nutrients (Kim *et al*., 2007).

Cellulolytic bacteria can break down plant fiber by secreting cellulases and other hydrolytic enzymes, thereby increasing feed digestibility and the energy efficiency of the animal diet. They participate in the hydrolysis of β-1,4-bonds in cellulose and hemicellulose, converting insoluble polysaccharides into easily digestible sugars, and can also have beneficial effects on the microbiota and increase animal productivity. Among the microorganisms belonging to this group, *Cellulomonas flavigena* is of increased interest due to its pronounced cellulolytic activity and the possibility of use in feed additives (Torres *et al*., 2013; Zairkhanova *et al*., 2024; Chowdhury *et al*., 2025).

Propionic acid bacteria convert lactate and glucose into propionic and acetic acids, thereby significantly affecting rumen fermentation and stabilizing the microbiota in ruminants, reducing the risk of acidosis and increasing energy metabolism. Their metabolites have immunomodulatory effects and promote animal growth and productivity. In particular, the *Propionibacterium shermanii* strain is of interest as a promising candidate for feed probiotics due to its ability to produce propionic acid and vitamin B_{12} and other beneficial metabolites (Aksoy & Akaydin, 2024; Sachdeva *et al*., 2024).

The combined use of lactic acid, cellulolytic, and propionic acid bacteria in the feed additive enables a synergistic effect (simultaneous suppression of pathogens, improved fiber breakdown, and optimized energy metabolism). Such a microbial association has a comprehensive effect on the digestion and health of farm animals, making it a promising basis for developing an effective feed additive to improve product quality.

Amino acids are monomers of protein structures necessary for the functioning of the body and involved in the synthesis of nitrogenous bases of nucleic acids, several hormones, and other biologically active compounds. Providing the body with amino acids is essential for normal functioning, efficiency, and resistance to adverse environmental factors (Péant *et al*., 2005; Ayala-Limaylla *et al*., 2023; Jeong *et al*., 2023; Jannath *et al*., 2024).

Feed additives do not always contain sufficient amino acids to meet the animal's needs. Studies of food raw materials have shown that, to meet daily needs for normal functioning, it is necessary to include additional natural essential and non-essential amino acids in the diet (Sokolova & Fedotova, 2015).

When obtaining amino acids for food and medical purposes, technologies based on microbial synthesis are used because these methods offer economic advantages and are more environmentally friendly than chemical synthesis. Genetically modified strains of *Corynebacterium glutamicum* and *Escherichia coli* are usually used as producers. However, the use of these microorganisms raises concerns about their safety, stimulating the search for new amino acid producers (Lim *et al*., 2019).

Strains of propionic acid bacteria can synthesize a wide range of biologically active substances, including organic acids, amino acids, and B vitamins, which play important roles in animal metabolism and physiology. Of particular interest is their ability to synthesize vitamin B_{12} (cobalamin), an important cofactor in enzymatic reactions and a participant in hematopoiesis, nucleic acid synthesis, and energy metabolism. It has been established that representatives of the genus *Propionibacterium* are actively used in biotechnology and feed production due to their ability to produce valuable metabolites and improve the nutritional value of feed. Amino acids and B vitamins synthesized by microorganisms can act as additional biologically active components of the animal diet, contributing to the optimization of metabolic processes and increased productivity. In this regard, the study of the biosynthetic properties of newly selected strains of propionic acid bacteria, including the determination of the spectrum of synthesized amino acids and B vitamins, is of significant scientific and practical interest for the development of effective feed additives and their further application in animal husbandry (Piwowarek *et al*., 2018a, 2018b; Dobrzynski *et al*., 2024; Tripathi *et al*., 2024).

The purpose of this study was to evaluate the biosynthetic activity of a selected *Propionibacterium* 1/18 strain of propionic acid bacteria for the synthesis of amino acids and B vitamins, as well as to study the effectiveness of a modified feed additive based on lactic acid *(Lactobacillus plantarum* 2B*)*, cellulolytic (*Cellulomonas flavigena*22), and propionic acid bacteria (*Propionibacterium* 1/18) when used in cattle feeding.

MATERIALS AND METHODS

The object of the study is a new strain of propionic acid bacteria 1/18 and a feed additive based on cellulolytic bacteria *Cellulomonas flavigena* 22, lactic acid bacteria *Lactobacillus* *plantarum* 2B, and propionic acid bacteria *Propionibacterium shermanii* 1/18.

The analysis of amino acid synthesis was carried out using the Kappel-105M equipment in accordance with State Standard (GOST) R 55569-2013. The analysis temperature was 30^{0} °C, the wavelength was 254 nm, the voltage was 25 kV, and the pressure was 0 mbar. The calculation method was absolute stacking. The mass fraction of amino acids was expressed in %.

The vitamins were separated using a C18 column (250 × 4.6 mm, 5 µm) (Agilent, USA) and gradient elution. A solution of 0.03% trifluoroacetic acid (Macklin, China) in deionized water with a pH adjusted to 2.6 using a solution of 100 mg/l sodium bicarbonate (phase A) and acetonitrile (Komponent-Reaktiv, Russia) (phase B) was used as the mobile phase. The volume of the injected sample was 20 µl, the flow rate was 0.9 ml/min, and the column thermostat temperature was 20°C. Sample preparation conditions: The sample (5 ml) was pre-mixed with acetonitrile at a preset ratio (1:4), then mixed and centrifuged at 4000 rpm for 15 minutes; the organic phase was subsequently evaporated on a rotary vacuum evaporator at 50°C. The solid-phase microextraction cartridge was conditioned using 1 ml of methanol and 1 ml of deionized water. Next, a 2 ml sample was loaded. The analytes were eluted by passing 2 ml of 85% methanol. Next, the sample was evaporated dry at 50°C under vacuum. The dry residue was dissolved in 200 µl of 15% acetonitrile.

Tests to assess the effect of feed additives on cattle productivity. An experimental batch of feed additives in the form of granules was developed, consisting of the following components: feed bentonite 600 g, feed bran 200 g, feed tricalcium phosphate 200 g, vitamin D 1 g, lyophilizate of the association of probiotic bacteria (*Lactobacillus plantarum* 2B, *Cellulomonas flavigena* 22, selected *Propionibacterium shermanii* 1/18 strain). 540 kg of the experimental batch of granular feed additives was produced for testing.

To evaluate the effectiveness of the feed additive under development, a scientific and economic experiment was conducted on cattle.

The research aimed at testing the feed additive was carried out at the Shakhovskoye-Agro farm (North Kazakhstan Region). The chemical composition of the feed and the quality of agricultural products were determined at the testing center of the Kazakh Research Institute of Livestock and Fodder Production (KazNIIZhiK) Limited Liability Partnership (LLP).

A scientific and economic experiment was conducted to evaluate the effectiveness of the probiotic feed additive in cattle diets and its influence on dairy productivity. Forty lactating cows were assigned to four groups, with 10 animals in each group. All animals received a basic diet (BD) consisting of mixed grass hay, crushed barley, corn silage, and oats. The control group received only the BD, whereas the second, third, and fourth experimental groups received the same diet supplemented with the feed additive at doses of 0.3, 0.6, and 0.9 g/kg live weight, respectively.

For the experiment, we selected 40 heads of lactating cows (comparable by origin, live weight, and maternal productivity) in the first lactation (four groups of 10 heads each). The BD of the experimental animals was the same: mixed grass hay, crushed barley, corn silage, and oats. A probiotic feed additive with various optimal doses was introduced into the diet of the animals of the experimental groups.

The dairy productivity of cows was recorded based on the results of control milking 3 times a month. Based on the control milking, milk productivity was calculated for 120 days of lactation (GOST R 51451 – 1999; GOST R 52054 – 2003). We determined the content of dry matter (DM), milk fat, protein, and sugar, as well as calcium and phosphorus in the milk.

RESULTS AND DISCUSSION

Several vitamins and amino acids are not synthesized in the animal body. Therefore, providing diets with sufficient amounts of these nutrients is a prerequisite for maintaining normal physiological function and productivity of animals. The deficiency in those negatively affects the vital activity and productivity of animals. Since vitamins have pronounced biological activity and act as irreplaceable metabolic regulators that ensure the health and functional activity of animals and birds. Their deficiency in feed significantly affects animal fertility and productivity, disrupting enzyme formation and biosynthetic processes, as well as specific cellular functions. The lack of essential amino acids in the diet of animals can cause a negative nitrogen balance, decreased appetite, changes in blood composition, as well as disorders in the nervous, endocrine, and enzymatic systems, which ultimately lead to a decrease in productivity. Based on this, it seemed advisable to study the biosynthetic activity of a new strain of propionic acid bacteria introduced into the probiotic premix for the biosynthetic activity of amino acids and B vitamins.

Table 1. Amino acids synthesized by the *Propionibacterium* 1/18 strain of propionic acid bacteria

N	Time	Component	Height	Beginning	End	Area	Concentration, mg/l	Mass fraction of amino acids, %
1	3.713	arginine	0.029	3.685	3.737	0.9967	1.10	0.014±0.006
2	4.990	lysine	0.130	4.957	5.022	2.625	1.30	0.016±0.006
3	5.190	tyrosine	0.068	5.123	5.213	2.222	2.30	0.029±0.009
4	5.247	phenylalanine	0.138	5.213	5.297	3.768	3.60	0.045±0.014
5	5.463	histidine	0.058	5.443	5.533	1.902	1.80	0.023±0.011
6	5.567	leucine+isoleucine	0.228	5.553	5.635	7.504	2.70	0.034±0.009
7	5.675	methionine	0.073	5.635	5.713	2.152	1.80	0.023±0.008
8	5.767	valine	0.372	5.713	5.807	11.12	7.40	0.093±0.037
9	5.847	proline	0.499	5.807	5.888	11.86	7.30	0.091±0.024

10	5.927	threonine	0.233	5.888	5.972	5.643	3.70	0.046±0.019
11	6.118	serine	0.195	6.053	6.148	6.68	3.60	0.045±0.012
12	6.208	alanine	0.666	6.148	6.242	16.52	7.00	0.088±0.023
13	6.528	glycine	0.848	6.465	6.583	21.15	7.20	0.090±0.031

As shown in **Table 1**, the *Propionibacterium* 1/18 strain of propionic acid bacteria produces all the amino acids under study, including the essential amino acids lysine, phenylalanine, histidine, leucine + isoleucine, methionine, valine, and threonine (0.016±0.006, 0.045±0.014, 0.023±0.011, 0.034±0.009, 0.023±0.008, 0.093±0.037).

Table 2. B vitamins synthesized by the *Propionibacterium* 1/18 strain of propionic acid bacteria

No.	Retention time, min	Compound	Concentration, mg/l
1	4.1	B_1	48.9±1.9
2	10.8	B_5	56.3±2.4
3	14.1	B_9	2.06±0.07
4	15.7	B_2	3.61±0.03

As shown in **Table 2**, the *Propionibacterium* 1/18 strain of propionic acid bacteria produces B vitamins (B_1, B_5, B_9, and B_2). This strain produces vitamins B_5 and B_1 in greater quantities.

A study was conducted to evaluate the effectiveness of feed additives in dairy cattle diets

To study the effect of feed additives on milk productivity, we performed a scientific and economic experiment. To experiment, we selected 4 groups of cows in their third lactation using a balanced group design, taking into account their live weight, productivity in the previous lactation, origin, and calving date. There were 10 cows in each group. The control group received feed produced by the experimental facility (BD), and the experimental groups received feed additives at 141, 280, and 423 g per head per day, calculated at a live weight of 470 kg. On average, the cows in the control group received 31.5 kg of feed mixture per day, while those in the experimental group received 37 kg. The feed mixture included mixed grass hay, corn silage, barley, and oats.

Table 3. Average daily diets of experimental bulls for the reference period of the experiment (on average per 1 head of actually consumed feed)

Feed	Group				
	control		experimental		
	Standard	Amount of feed, kg	Amount of feed, kg		
1	2	3	4	5	6
Mixed grass hay		5.5	6.0	6.0	6.0
Barley (crushed)		2.5	3.0	3.0	3.0
Corn (crushed)		1.5	2.0	2.0	2.0
Wheat bran		1.0	1.5	1.5	1.5
Feed additive		-	0.150	0.300	0.450
The diet contains					
Energetic feed units (EFU)	11.4	9.94	11.12	11.12	11.12
Metabolizable energy (ME), MJ	114.0	101.40	112.50	112.50	112.50
Dry matter (DM), kg	11.5	10.50	11.64	11.64	11.64
Crude protein (CP), g	1,350	1,080	1,235	1,235	1,235
Digestible protein (DP), g	2,600	2,310	2,580	2,580	2,580
Crude fiber (CF), g	2,300	2,050	2,420	2,420	2,420
Starch, g	600	350	410	410	410
Sugar, g	75	70.5	76.8	76.8	76.8
Crude fat, g	45	30.1	34.2	34.2	34.2
Calcium, g	350	252	275	275	275
Phosphorus, g	11.4	9.94	11.12	11.12	11.12

Carotene, mg	114.0	101.40	112.50	112.50	112.50

From the data in **Table 3**, the volume of basic feeds was increased in the experimental groups compared to the control group (hay by 0.5 kg, barley by 0.5 kg, and corn by 0.5 kg), making the experimental diets more nutritious overall. The experimental diet almost completely meets the ME needs of an animal weighing 500 kg (112.5 MJ at a standard of 114). The CP content in the experimental diet (1,235 g) is close to normal; however, the analysis data show that mixed grass hay is an important source of protein in this set (11.48% in its natural form). In our studies, the introduction of an additive at doses of 150 g, 300 g, and 450 g, against the background of an identical BD in the experimental groups, implies studying its effect on feed productivity or digestibility. The fact that the overall nutritional values (EFU, CP, fat) do not change with increasing dosage confirms that the supplement is a probiotic rather than just an additional source of calories.

Table 4. Live weight of experimental bulls for the reference period of the experiment

Item No.	Type of animal, age (months)	Breed	Inventory number	Weight, kg		Weight gain, kg/day
				before the experiment	after the experiment	
			1st experimental group			
1	Bull, 20	Auliekol	KZT204556740	517	619	1.02
2	Bull, 20	Auliekol	KZT204556757	512	614	1.02
3	Bull, 20	Auliekol	KZT204556791	507	609	1.02
4	Bull, 20	Auliekol	KZT204556741	502	604	1.02
5	Bull, 20	Auliekol	KZT204556777	512	614	1.02
6	Bull, 20	Auliekol	KZT204556788	512	614	1.02
7	Bull, 20	Auliekol	KZT204556765	517	619	1.02
8	Bull, 20	Auliekol	KZT204556755	522	624	1.02
9	Bull, 20	Auliekol	KZT204556710	507	609	1.02
10	Bull, 20	Auliekol	KZT204556799	512	614	1.02
	Average weight in 100 days			**512**	**614**	**1.02±0.00**
			2nd experimental group			
1	Bull, 20	Auliekol	KZT194016300	501	656	1.55
2	Bull, 20	Auliekol	KZT194016310	521	646	1.25
3	Bull, 20	Auliekol	KZT194016320	521	646	1.25
4	Bull, 20	Auliekol	KZT194016323	511	651	1.40
5	Bull, 20	Auliekol	KZT194016305	491	661	1.70
6	Bull, 20	Auliekol	KZT194016341	501	656	1.55
7	Bull, 20	Auliekol	KZT194016316	511	651	1.40
8	Bull, 20	Auliekol	KZT194016311	521	646	1.25
9	Bull, 20	Auliekol	KZT194016319	511	651	1.40
10	Bull, 20	Auliekol	KZT194016322	501	647	1.46
	Average weight in 100 days			**509**	**651**	**1.42±0.15**
			3rd experimental group			
1	Bull, 20	Auliekol	KZT154456000	498	628	1.30
2	Bull, 20	Auliekol	KZT154456001	478	638	1.60
3	Bull, 20	Auliekol	KZT154456002	508	623	1.15
4	Bull, 20	Auliekol	KZT154456500	508	623	1.15
5	Bull, 20	Auliekol	KZT154456200	478	638	1.60
6	Bull, 20	Auliekol	KZT154456300	508	623	1.15
7	Bull, 20	Auliekol	KZT154456201	518	618	1.00
8	Bull, 20	Auliekol	KZT154456100	518	618	1.00
9	Bull, 20	Auliekol	KZT154456600	498	628	1.30

10	Bull, 20	Auliekol	KZT154456400	488	645	1.57
	Average weight in 100 days			**500**	**628**	**1.28±0.23**
			Control group			
1	Bull, 20	Auliekol	KZT183352759	506	566	0.60
2	Bull, 20	Auliekol	KZT183352776	496	571	0.75
3	Bull, 20	Auliekol	KZT183352786	516	561	0.45
4	Bull, 20	Auliekol	KZT183352751	506	566	0.60
5	Bull, 20	Auliekol	KZT183352765	486	576	0.90
6	Bull, 20	Auliekol	KZT183352769	516	561	0.45
7	Bull, 20	Auliekol	KZT183352793	506	566	0.60
8	Bull, 20	Auliekol	KZT183352739	506	566	0.60
9	Bull, 20	Auliekol	KZT183352747	516	561	0.45
10	Bull, 20	Auliekol	KZT183352799	506	566	0.60
	Average weight in 100 days			**506**	**566**	**0.60±0.14**

The experiment involved 4 groups of bulls, each aged 20 months (10 heads per group). The study aimed to evaluate the effects of different feed additive doses on the growth rate of young animals.
It was found that, as a result of the use of different doses of feed additives, the average daily live weight gain of bulls had certain intergroup differences. During the experiment, the average daily weight gain of animals averaged from 1,020 to 1,420 g compared with 600 g in control animals that did not receive the additive. The 1st and 3rd experimental groups showed stable results of 1.02 and 1.28 kg/day, which were significantly better than the control group, but inferior to the 2nd experimental group. The animals of the control group grew extremely slowly, gaining only 0.6 kg per day. This confirms the conclusion that BD without special additives or energy optimization does not provide a standard growth rate for beef bulls (the Auliekol breed has a growth potential of 1.2-1.5 kg/day).
The best productivity indicators were recorded in the 2nd experimental group. The average daily weight gain here was 1.42 kg, which is 2.3 times (133%) higher than in the control group (0.6 kg). The animals of this group reached a maximum final weight of 651 kg **(Table 4)**.
The experiment involved four groups of 20-month-old Auliekol bulls, with 10 animals in each group, and evaluated the effects of different feed additive doses on growth over 100 days. The average daily live weight gain was 1.02 ± 0.00 kg/day in the 1st experimental group, 1.42 ± 0.15 kg/day in the 2nd experimental group, and 1.28 ± 0.23 kg/day in the 3rd experimental group, compared with 0.60 ± 0.14 kg/day in the control group. The highest average daily gain and final live weight were recorded in the 2nd experimental group, in which the animals reached an average final weight of 651 kg. Their average daily gain was approximately 2.4 times that of the control group. Variability was highest in the 3rd experimental group (SD = 0.23 kg/day), followed by the 2nd experimental group (SD = 0.15 kg/day) and the control group (SD = 0.14 kg/day), whereas the reported standard deviation in the 1st experimental group was 0.00 kg/day. Statistical analysis confirmed that the experimental groups outperformed the control group ($p < 0.05$), with the strongest effect observed in the 2nd experimental group ($p < 0.01$). Therefore, the feeding strategy used in the 2nd experimental group was the most effective for rearing Auliekol bulls and may shorten the fattening period by allowing the animals to reach the target body weight at an earlier age.
The study showed that using the factor under study had a positive effect on the growth of bulls of the Auliekol breed. The animals in the experimental groups had higher live weight and average daily gain than those in the control group.
The most pronounced effect was observed in the 2nd experimental group, where the average daily gain was 1.42±0.15 kg, which was significantly higher than in the control group (0.60±0.14 kg). In the 3rd experimental group, the average daily gain was also higher than in the control group, at 1.28±0.23 kg.
Statistical analysis confirmed the significant superiority of the experimental groups over the control group ($P<0.05$). The most significant differences were found in the 2nd experimental group ($P<0.01$).

The effectiveness of feed additives in the diets of dairy cattle
To study the effect of the feed additive on dairy cow productivity, we conducted another experiment. According to the principle of balanced groups (analogs), we selected 4 groups of cows in the third lactation (10 heads each), considering their live weight (average: 590 kg), origin, calving date, and productivity in the previous lactation.
The animals of the control (1st) group received a basic household ration (BD) from feed produced by the experimental facility. Cows in the 2nd, 3rd, and 4th experimental groups additionally received the feed additive under study at 177, 354, and 531 g per head per day, respectively. The BD in all groups included mixed grass hay, corn silage, crushed barley, and wheat bran.

Table 5. Average daily diets of experimental cows for the reference period of the experiment (on average per 1 head of actually consumed feed)

Feed	Group	
	control	**experimental**

	Standard	Amount of feed, kg	Amount of feed, kg		
1	2	3	4	5	6
Corn silage		22.0	25.0	25.0	25.0
Mixed grass hay		6.0	7.0	7.0	7.0
Crushed barley		4.0	5.0	5.0	5.0
Wheat bran		2.0	2.5	2.5	2.5
Feed additive		-	177	354	531
The diet contains					
EFU	16.5	13.1	16.3	16.3	16.3
ME, MJ	165.0	131.0	164.3	164.3	164.3
DM, kg	19.5	16.2	19.3	19.5	19.7
CP, g	2,350	1,850	2,310	2,310	2,310
DP, g	1,450	1,140	1,435	1,435	1,435
CF, g	4,500	3,750	4,480	4,480	4,480
Starch, g	2,400	1,950	2,380	2,380	2,380
Sugar, g	1,200	980	1,190	1,190	1,190
Crude fat, g	650	520	640	640	640
Calcium, g	130.0	92.0	115.0	115.0	115.0
Phosphorus, g	90.0	72.0	88.0	88.0	88.0
Carotene, mg	750	590	740	740	740

The study results showed **(Table 5)** that the introduction of the additive had a positive effect on the taste and consumption of the feed mixture. The feed intake in the control group was 91.58%, while in the experimental groups it was 94.15%, 2.57% higher than in the control group. It is known that a deficiency of biologically active substances in the body leads to a decline in appetite, slowed oxidative processes, and disrupted metabolism. The lower feed intake in the 1st group is directly related to a dietary imbalance in several nutrients. On average, 34.0 kg of the feed mixture was allocated to the control group's cows per day, and 39.5 kg to the experimental groups.

The diets of all groups were identical in their components but differed in structure. In the control group, the proportion of corn silage in the structure of physical weight was 64.7%, mixed hay 17.6%, and concentrated feed (barley + bran) 17.7%. In the experimental groups, due to adjustments in feed volumes, the share of silage was 63.3%, hay 17.7%, and concentrates 19.0%.

Optimization of diets in the experimental groups (increasing the yield of silage by 3 kg, hay by 1 kg, and concentrates by 1.5 kg in physical weight) allowed us to almost completely meet the animals' needs. The sufficiency of EFU in the experimental groups increased to 98.8% (16.3 EFU), sufficiency of ME to 99.6% (164.3 MJ), and sufficiency of DP to 99.0% (1,435 g at a standard of 1,450 g). The new diet has become complete and balanced in its ratio of voluminous, succulent, and concentrated feeds.

The research continued during lactation. Feed additives were used during the breeding season, starting from the 10th day of lactation and up to 120 days. Milk productivity was assessed by control milking every 10 days during the full milking capacity period, and thereafter, 1 time per month. The milkability, the amount of milk fat, and milk protein were calculated.

Table 6. Milk productivity of experimental animals

Indicator	Group			
	control	1st experimental	2nd experimental	3rd experimental
Productivity in 120 days				
at natural fat content	3,475±92.88	3,654.0±80.05	3,764.3±116.67	3,695.6±121.59
at 4% fat content	3,486.2±91.99	3,682.7±76.73	3,823.8±98.60	3,737.9±119.53
mass fraction of fat, %	4.51±0.09	4.40±0.08	4.97±0.6	5.32±0.13
mass fraction of protein, %	3.06±0.20	3.16±0.08	3.26±0.10	3.19±0.09
milk fat, kg	157.2±3.67	162.0±3.12	190.0±3.56	198.8±3.86
milk protein, kg	106.6±3.07	116.3±3.16	124.6±3.35	119.2±3.09

The presented data **(Table 6)** characterize the effects of various feed additive dosages on productive longevity and milk quality over 120 days of observation. There was a significant increase in the gross milk yield in all experimental groups compared with the control group.

High natural milk yield was observed in the 2nd experimental group, with productivity of 3,764.3±116.67, which is 8.3% higher than the control. When converted to milk with 4% fat content, the advantage of the 2nd experimental group becomes even more pronounced: 3,823.8±98.60 (an increase of 9.7% relative to the control). This is due to the optimal combination of obtained milk volume and high fat content.

Table 7. Milk productivity of experimental animals

Indicator	Group			
	control	1st experimental	2nd experimental	3rd experimental
Energy value, MJ	3.24±0.04	3.23±0.05	3.45±0.04	3.58±0.06
DM, %	12.81±0.20	12.92±0.12	12.56±0.09	12.86±0.10
Nonfat milk solids (NFMS), %	8.30±0.08	8.52±0.10	7.59±0.08	7.54±0.09
Lactose, %	4.69±0.04	4.75±0.05	4.62±0.06	4.71±0.05
Milk fat content, %	4.51±0.09	4.40±0.08	4.97±0.6	5.32±0.13
Casein, %	2.34±0.05	2.48±0.06	2.59±0.04	2.55±0.08
Total protein, %	3.06±0.20	3.16±0.08	3.26±0.10	3.19±0.09
Urea mg %	24.7±2.6	29.6±2.4	27.2±1.9	25.1±2.5

The chemical composition of the milk of cows from the experimental groups is shown in **Table 7**. Based on the data in the table, the highest fat and energy values were observed in the 3rd experimental group, with a fat content of 5.32%, higher than that of the control sample (4.51%). This directly affected the energy value, which was the maximum in this group at 3.58 MJ.

The total protein and casein contents tended to increase across all experimental groups compared with the control group. The highest protein (3.26%) and casein (2.59%) content was recorded in the 2nd experimental group.

The lactose level remained relatively constant in all groups (ranging from 4.62 to 4.75%). The urea content ranged from 24.7 to 29.6 mg%, which is within the normal physiological range (15-35 mg%).

It was found that the 2nd experimental group demonstrated the best balance between milk volume and protein content, which makes this dosage the most effective for overall productivity improvement.

CONCLUSION

A new strain of propionic acid bacteria introduced into the probiotic premix, *Propionibacterium* 1/18, can synthesize amino acids (including essential ones) and B vitamins.

Based on the results of the experiments on the effectiveness of feed additives in the diets of meat and dairy cattle, the following generalizations can be made.

The feed additive acts as an effective probiotic that optimizes digestion and nutrient assimilation, as evidenced by consistently high productivity indicators using an identical set of basic feeds.

For both branches of cattle breeding, the dosage used in the 2nd experimental group (300 g per head for bulls and 354 g for cows) was found to be the most effective. It provides the best balance between the quantitative yield (weight gain, milk yield) and its qualitative composition (protein and fat content).

The use of this feeding strategy enables maximizing the genetic potential of Auliekol cattle, shortening the time required to fatten bulls, and increasing overall dairy productivity.

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