Application of feed additive “BioPrimum dry” with probiotic effect in dairy farming

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Abstract. Currently, the search for alternative ways to replace the use of antibiotics in animal husbandry is being intensively conducted all over the world, including in Russia. One of the possibilities for the replacement of antibiotics in feed mixtures is the development and testing of probiotics in production conditions. They are biomass of bacteria in the vegetative or spore form with a clearly expressed antagonistic activity against the pathogenic and conditionally pathogenic microflora of the gastrointestinal tract chyme. The paper presents the results of a study on the use of the BioPrimum Sukhoy (dry) feed additive added in different dosages into cows' diets. It was found that the introduction of the feed additive in the composition of the cows' diets at a dosage of 75 mg/kg of dry matter of feed resulted in an increase of red blood cell count and hemoglobin content in the blood by 11.40 and 6.05%, respectively, compared with analogs of the control group. There was an increase in milk productivity by 13.8%, in the amount of milk fat by 14.8% and milk protein by 14.2%.

1 Introduction

To prevent and treat gastrointestinal diseases of bacterial etiology and reduce economic losses when changing feed, after courses of antibiotic therapy and vaccination, about 10 years ago, after numerous tests, several probiotic preparations of a wide spectrum of action were created. They were based on strains of bacteria B. Bacillus subtilis. They are producers of biologically active substances (BAS), such as enzymes, antibiotics, insecticides, and other substances that regulate and stimulate digestion and have anti-allergenic and antitoxic effects. Bacteria B. Bacillus subtilis are highly adaptable to various conditions of existence (presence or absence of oxygen, growth, and development in a significant temperature range, the use of various organic or inorganic compounds as food sources, etc.). They contribute to the spread of bacilli in soil, water, air, food and other objects of the external environment, as well as in the animal bodies [1–9].

B. Bacillus subtilis strains produce antagonistically active biomass against pathogens, as well as proteolytic, amylolytic, and lipolytic enzymes. The B. Bacillus subtilis strains used for the development of the preparation, multiplying in the intestines of animals, release BAS. Under the influence of BAS the digestion processes are activated, as a result of which the average daily gain in live weight increases, productivity increases together with the safety of the livestock, and feed cost per unit of production is reduced.

2 Materials and methods

The purpose of our study was to evaluate the effect of different levels of the BioPrimum Sukhoy feed additive on morphological and biochemical parameters of blood, quantitative and qualitative indicators of milk produced.
To achieve this goal, we conducted a scientific and economic experiment in the production conditions of Agrosoyuz LLC of the Ruzaevsky municipal district of the Republic of Mordovia. There were cows with the inclusion of different dosages of the BioPrimum Sukhoy feed additive in their diets. To experiment on the principle of pairs of analogs, taking into account the breed, age, live weight, and lactation period, 40 cows were selected on the twentieth day after calving, and 4 groups of 10 heads each were formed. All animals were clinically healthy and kept in the same conditions. The cows were fed three times a day during the experiment. The diets were compiled according to the recommended detailed norms of the Russian Academy of Agricultural Sciences (RASKhN) (2003), taking into account the live weight, physiological state, productivity of the cows, and the chemical composition of feed. The animals of the control group received the basic diet. The analogs of the 1st, 2nd, and 3rd experimental groups, in addition to the basic diet, were fed with the BioPrimum Sukhoy feed additive at the rate of 60; 75; 90 mg/kg of dry matter of

the diet, respectively, or 1,200, 1,500 and 1,800 mg per head per day, respectively (Table 1). The BioPrimum Sukhoy feed additive contains a lyophilized microbial mass of spore-forming bacteria Bacillus subtilis WB3482 (VKPM B-1722) and Bacillus amyloliguefaciens 31 (VKPM B-2336) at least $2x10^9$ colony-forming units (CFU) in 1 g, 15% of chromium picolinate, and up to 100% of filler: calcium carbonate. The chromium content ranges from 0.018 to 0.02 g in 1 g of the preparation. It does not contain genetically modified organisms and products. The content of harmful impurities does not exceed the maximum permissible standards in force in the Russian Federation. In appearance, it is a loose powder from beige to cream color.

Table 1. Scheme of scientific and economic experiment.

Group	Number of heads per group	Level of feed additive in the diet, mg/kg of dry matter	Qty of feed additive per head per day, mg
Control	10	Basic diet	–
1st experimental	10	60	1.200
2nd experimental	10	75	1.500
3rd experimental	10	90	1.800

To control the physiological state and the course of biochemical processes in the body of dairy cows under the influence of different dosages of BioPrimum Sukhoy (Table 1), we conducted a study of the dynamics of morphological and biochemical parameters of the cows' blood at the beginning and end of lactation.

3 Results and discussion

According to the results of our study, we found that different dosages of the BioPrimum Sukhoy feed additive in the diets of cows at the beginning of lactation had a certain effect on hematological parameters. Thus, in the blood of cows of the 2nd experimental group, there was an increase in the content of red blood cells and hemoglobin by 11.40% and 6.05% compared with the analogs of the control group and by 6.05% and 2.78% compared to the peers of the 1st experimental group. An increase in the feed additive in the diets of cows of the 3rd experimental group to 90 mg/kg of the dry matter of the diet contributed to a slight decrease in the studied indicators compared to the 2nd experimental group. A decrease of 3.95% and 2.03%, respectively, in red blood cells and hemoglobin, was observed (Table 2).

A similar pattern was observed in the morphological parameters of blood at the end of lactation. Thus, in the blood of cows of the 2nd experimental group, there was an increase in the content of red blood cells and hemoglobin by 6.01% and 6.65% compared with analogs of the control group. The number of white blood cells almost did not change, with only a slight increase in the blood of animals of the control group. It can be assumed that all this indicated a more intensive course of redox processes in the body of animals.

Feeding cows with the feed additive “BioPrimum dry” contributed to the transformation of dry matter into milk. So, if the amount of dry matter in the milk of cows of the 2nd experimental group was 12.73%, then it was 0.26% ($P<0.01$) lower in the milk of analogues of the control group.

With a decrease and an increase in the dosage of the probiotic, there was a decrease in the amount of dry matter by 0.10–0.17%. However, the indicators were significantly higher than those that were in the milk of cows of the control group.

An increase of the dry matter in the milk of the cows in the experimental groups, who received the feed additive “BioPrimum dry” as part of the diet, was caused by the consumption of nutrients and mineral elements by cows along with feed mixtures of their digestibility, participation in milk formation.

Experimental studies confirm that the inclusion of a feed additive in the main diet gives an increase in milk sugar (lactose) in milk. The superiority in this value in the milk of cows of the 1st experimental group over the analogues of the control group was by 0.02%, the 2nd – 0.13%, the 3rd – 0.05% with a significant difference. It is important to emphasize that the use of the feed additive “BioPrimum dry” in feeding dairy cows activates the microflora of the rumen, stimulates scar digestion, increases the digestibility of nutrients in the diet improves the use of nutrients, carbohydrate metabolism.

According to the data obtained in our experiments, it was found that the level of calcium and phosphorus in the milk of the experimental groups exceeds the control. In the milk of cows of the 1st experimental group, the calcium content was higher by 0.03 g and phosphorus by 0.05 g, respectively, in the 2nd – by 0.04 g and 0.03 g, and in the 3rd – 0.03 g and 0.11 g.

Feeding a probiotic has a positive effect on the accumulation of carotene in the milk of cows of the 2nd experimental group prevails, who received the feed additive “BioPrimum dry” as part of the diet at a dose of 75 mg/kg of the dry matter of the diet.

The digestibility of nutrients, assimilation and use of mineral elements contributed to an increase in the energy value of milk. So, if the milk of cows of the 2nd experimental group had an energy value of 74.02 kcal per 100 g, which is 0.85 kcal or 1.16% more than that in the control group and 0.20% with the 1st experimental group.

When the dosage increased to 90 mg / kg of the dry matter, it contributed to a slight increase in the energy value of milk.

Thus, the use of a feed additive with a probiotic “BioPrimum dry” in the diet of red-mottled cows contributes to the improvement of the qualitative composition and nutritional value of milk.

The amount of milk fat in milk, the most important cost indicators in the sale of milk, characterizes the nutritional, biological value of milk. The percentage of

fat in milk depends on the cost of milk on sale. The content of milk fat in milk during lactation changes under the influence of the physiological state, lactation period, balanced feeding.

During the lactation period, under the influence of different levels of feed additives, there are spikes and declines in the monthly dynamics of the fat content in milk. It was found that in the first month of lactation, the fat content in the milk of cows of all groups was almost at the same level and amounted to 3.81-3.86%.

Thus, due to different dosages of probiotic supplements, providing beneficial intestinal microflora, stimulating metabolic processes, milk formation, there is an increase in the milk and fat content.

Starting from the third month of lactation, there was a gradual decrease in the production of milk fat obtained from cows of all the experimental groups. This decrease depended primarily on the amount of milk received during a certain period of lactation. Since the dairy productivity of cows and the fat content of the milk obtained are inversely related, the lower the milk yield by the end of lactation, the higher the fat content of milk. The smallest amount of milk fat was obtained from the cows of all the experimental groups in the last month of lactation.

The use of different dosages of the probiotic supplement “BioPrimum dry” in the diets of dairy cows significantly contributes to an increase in the quantity and quality of milk fat. Along with an increase in the amount of milk fat, the yield of milk protein steadily increases, which directly depends on the protein intake from the feed.

It can be argued that the protein content tends to decline in the first months of lactation with a slight increase from the middle of lactation and an increase to a maximum by the end of lactation in the milk of cows of the studied groups. In the cows of the control group, the average protein content in milk for 305 days of lactation was 3.15%, which is 0.01–0.04% lower than that in the peers of the experimental groups.

An increase in the protein content in the milk of cows receiving a probiotic supplement is an indicator of stimulating protein metabolism in the body, which is confirmed by the biochemical status of the blood.

Among the cows of the experimental groups, the superiority in the amount of milk fat for the entire lactation period was on the side of the peers of the II and III-experimental groups, their superiority over the animals of the I-experimental group was 14.41 kg (6.81%; $P<0.001$) and 14.53 kg (6.87%; $P<0.001$), respectively.

It should be noted that the use of different doses of the feed probiotic supplement “Bioprimum dry” in the diets of dairy cows significantly contributes to an increase in the quantity and quality of milk fat.

So, in the period from the first to the third month inclusive, the decrease in protein concentration in the milk of cows of the control group was 0.02%, I experimental – 0.02%, II experimental – 0.01% and III experimental group – 0.02%. It should be noted that starting from the fifth month of lactation, there was an increase in the protein content in the milk of cows of all groups. So, in the period from the fifth month to the end of lactation in the milk of cows of the control group, the value of the studied indicator increased by 0.06%, the experimental groups – 0.05–0.08%.

Thus, it can be argued that reliable data were obtained on the protein content in milk during the lactation period of experimental cows of the red-mottled breed. They indicate the fruitful effect of the feed additive with the probiotic “Bioprimum dry” on the presented indicators.

Table 2. Morphological parameters of cows' blood.

Group	Red blood cells, 10^{12} g/l	White blood cells, 10^{9} g/l	Hemoglobin, g/l
Beginning of lactation			
Control	6.14±0.03	9.22±0.12	104.17 ±0.81
1st experimental	6.45±0.05	8.98±0.06	107.47 ±1.60
2nd experimental	6.84±0.04	8.32±0.10	110.46 ±1.31
3rd experimental	6.58±0.10	8.54±0.06	108.26 ±1.04
End of lactation			
Control	6.06±0.09	9.03±0.03	101.98 ±1.14
1st experimental	6.13±0.13	8.81±0.11	105.34 ±1.55
2nd experimental	6.42±0.10	8.32±0.10	108.77 ±0.90

3rd experimental	6.24±0.09	8.54±0.07	106.37 ±1.12

An important indicator of the state of protein metabolism in the body is the content of total protein and its fractions in the blood. In our studies we used the BioPrimum Sukhoy feed additive in the diets of cows of the 2nd experimental group at the rate of 75 mg/kg of dry matter of the diet. This led to an increase in the amount of total protein in their blood compared to analogs from the control group by 5.87% and 4.25% compared to the 1st experimental group (P<0.001). A similar pattern was observed for the albumin and globulin count. In the blood of cows of the 2nd experimental group, the content of albumins is by 9.86% and globulins by 2.31% higher compared to the peers of the control group and, respectively, by 6.47 and 2.19% compared to the animals of the 1st experimental group. Being of the globulin fraction, gamma globulins occupy the largest share, and their lowest concentration in all age periods was observed in the animals of the 2nd experimental group. The number of alpha- and beta-globulins in the 2nd experimental group was also higher compared to the experimental animals of the control, 1st, and 3rd experimental groups.

As a result of the conducted study, it was found that the inclusion of different dosages of the BioPrimum Sukhoy feed additive in the diets of cows had a positive effect on the quantitative and qualitative indicators of milk. We found that during the first lactation, 8.806.6 kg of milk was obtained from the first-calf cows of the 2nd experimental group, which is 13.8% (P<0.001) and 5.0% (P<0.001) more compared to the analogs of the control and the 1st experimental group. The increase of the dosage of the BioPrimum Sukhoy feed additive to 90 mg/kg of the dry matter of the diet did not contribute to a further increase in milk productivity. However, the milk yield for the first lactation was higher by 443.2 kg or 5.7% (P<0.001) compared to the analogs in the control group [10–12].

The qualitative indicators of milk are directly dependent on the intake of nutrients and BAS into the body and their ratio in the diet and bioavailability.

In general, 326.7 kg of milk fat was obtained from cows of the 2nd experimental group during lactation, which is 42.1 or 14.8% (P<0.001) more than analogs of the control group and 13.1 or 4.2% (P<0.01) compared to the 1st experimental group.

A similar trend was observed in the yield of the amount of milk protein. Thus, from cows of the 2nd experimental group we obtained 295.9 kg of protein during the lactation, while the amount of protein obtained from peers of the control group was less than that by 14.2% (P <0.001) and 5.0% (P <0.01) less than from the 1st experimental group. Significant differences in the qualitative composition of milk were observed after the first days of feeding the BioPrimum Sukhoy feed additive to animals of the 2nd experimental group. Thus, the amount of dry matter increased by 0.58%, the non-fat milk solids (NFMS) by 0.37%, fat content by 0.03%, protein content by 0.01% compared to analogs of the control group [10–17].

4 Conclusion

Based on the above, it was found that the inclusion of the BioPrimum Sukhoy feed additive in the amount of 75 mg/kg of dry matter in the diets of cows contributed to the normalization of the blood composition and an increase in quantitative and qualitative indicators of milk productivity.

References

1. A. P. Kalashnikov, V. I. Fisinin, V. V. Shcheglov (Eds.), *Norms and rations of feeding of farm animals* (Moscow, 2003).
2. F. S. Khaziakhmetov, A. F. Khabirov, R. Kh. Avzalov, Results of the use of Vitafort probiotic in the diets of young farm animals, *Bulletin of Orenburg State University. Agrarian University* **3,** 140–143 (2019)
3. I. M. Mikolajchik, L. A. Morozova, I. V. Arzin, The effect of yeast probiotics on the digestibility of nutrients in the diet and the level of dairy productivity of cows, *Dairy and Beef Cattle Breeding* **7,** 28–31 (2017)
4. I. M. Mikolajchik, L. A. Morozova, N. M. Kostomakhin, I. V. Arzin, Features of digestion in highly productive cows when using yeast probiotic additives, *Chief Animal Technician* **12,** 27–33 (2017)
5. N. G. Makartsev, *Feeding of Farm Animals* (Kaluga: SUE Oblizdat, 1999)
6. Ya. Barta, G. Bergner, J. Buchko, et al., *Non-traditional feed in the diets of farm animals* (Moscow: Kolos, 1984)
7. L. K. Ernst, Z. M. Naumenko, *Fodder resources of the forest* (Moscow: RASKHN, 2006)
8. V. K. Pestis, M. A. Kavrus, A. N. Mikhalyuk, *Probiotics in animal husbandry and veterinary medicine* (Grodno: GGAU, 2006)
9. I. V. Petrukhin, *Feed and feed additives* (Moscow: Rosagropromizdat, 1989)
10. B. V. Tarakanov, On the types of fermentation in the rumen, *Animal Science* **6,** 8–9 (2001)
11. M. T. Taranov, *Biochemistry and productivity of animals* (Moscow: Kolos, 1976)
12. A. I. Ovsyannikov, *Fundamentals of experimental business in animal husbandry* (Moscow: Kolos, 1976)
13. G. I. Goncharova, A. B. Smolyanskaya, K. Ya. Sokolova, Microbial ecology in norm and pathology, *Antibiotics and Chemotherapy* **6,** 462–466 (1989)

14. N. V. Danilevskaya, V. V. Subbotin, Probiotics in calves' diets: animal health and food safety for humans, *Milk and feed. Management* **2,** 16–20 (2008)
15. A. A. Aliyev, *Metabolism in Ruminants* (Moscow: Engineer, 1997)
16. I. Artemov, R. Chernykh, V. Pepelina, The use of zeolite-containing rocks in the diets of cows, *Dairy and Beef Cattle Breeding* **2,** 22–24 (2011)