Qualitative indicators of meat productivity of Zaanen goats when using the probiotic bacillus Amyloliquefaciens VKPM V-11475

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Abstract. The goats of the experimental group from the age of 2 months received, in addition to the basic diet, the probiotic Bacillus Amyloliquefaciens VKPM B-11475 at a dose of 4×10^7 CFU/g 30 minutes before feeding, 1 capsule per head once a day for two months. The experimental goats had 1.5% more moisture in their muscle mass, 9.0% more protein ($p \leq 0.05$), 32.7% less fat ($p \leq 0.001$), and the amount of phosphorus and magnesium was 0.04 and 0.07% higher relative to the control data. In terms of the content of essential amino acids in meat, experimental animals are superior to control ones: lysine is 1.3 times higher ($p \leq 0.001$), threonine is 1.2 times higher ($p \leq 0.01$), valine is 1.1 times higher ($p \leq 0.05$), methionine is 1.2 times higher ($p \leq 0.01$) and tryptophan is 1.2 times higher ($p \leq 0.01$). The number of interchangeable amino acids in experimental animals was higher: aspartic acid 1.6 times ($p \leq 0.001$), alanine 1.3 times ($p \leq 0.01$), glutamic acid 1.14 times ($p \leq 0.001$); arginine 1.5 times ($p \leq 0.001$); histidine 1.4 times ($p \leq 0.001$) relative to the control data. The mass of the paired carcass of experimental goats at 8 months of age was higher than 19% ($p \leq 0.01$), the slaughter yield was 8% higher ($p \leq 0.05$) compared with similar data from control animals.

1 Introduction

The article was written within the framework of a scientific project: "Development and introduction into industrial production of the Samara region of a method for increasing the adaptive and productive indicators of small cattle by prescribing a domestic biological product" № 23-26-10009.

The main focus of agriculture at the present stage is the search for effective production methods to ensure the food independence of the Russian Federation. Goat breeding is one of the most promising and profitable areas of animal husbandry. Gulzhan Mukusheva writes that from 2003 to the present, the indicators of goat breeding have almost doubled. There is a growing interest of consumers, first of all, in healthy and proper nutrition, and favorable conditions are emerging for the development of this market segment. With an annual increase in the number of goats in the country by 7.1%, by 2050 the number will reach 6 million 278 thousand goats. With an increase in livestock, it is expected to achieve a goat meat production

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volume of 17.1 thousand tons [1]. For the successful development of this industry, it is necessary to use biologically active drugs to increase the resistance of the animal body and, as a result, increase their productive indicators

Scientists Sergey Smolentsev, Lyudmila Kholodova and others prescribed Optisaf drug in the amount of 15 g per animal per day along with the basic diet (RR) for 10-day-old calves of the experimental group. Having described it, it was a culture of live dry yeast Saccharomyces cerevisiae (strain NCTC Sc47) with a size of $1.5x10^9$ CFU. The use of Optisaf had a positive effect on the linear growth of calves: the live weight gain was higher by 6.29% and amounted to 8.71 kg; the height at the withers increased by 2.67 cm (2.40%), the chest depth by 4.15 cm (8.64%); The oblique body length is 4.32 cm (3.84%) compared with similar data from the control group [2].

Researchers Alekseev I.A., Egorov R.A. and others. in their scientific work, they showed that the probiotic supplement Basulifor at the rate of 0.4 g/kg of feed in addition to OR had a stimulating effect on the increase in absolute pre-slaughter weight in calves. The mass of offal in animals of the experimental group, compared with control analogues, was higher by an average of 3.34% ($p<0.05$). Basulifor has a positive effect on the chemical composition of meat, as evidenced by normal pH, amino ammonia nitrogen, a positive reaction to peroxidase, a negative reaction with copper sulfate to the products of primary protein breakdown, a decrease in moisture content in muscle tissue, an increase in fat, protein [3].

Yavnikov N.V. paid attention to the domestic additive STIMVet. The introduction of STIMVet contributes to an increase in the live weight of piglets by 12.25±1.6%, and a gross increase of 20.14±6.03% relative to the control. The safety of livestock in the experimental group was 99.3%, in the control group 82.7%. It was found that the introduction of STIMUli in recommended doses into the diet of piglets during weaning and change of HR does not cause changes in behavior, appetite and physiological rhythms of animals, and is well tolerated by animals [4].

Yakovleva N.S., Nozdrin N.S. and others. In their scientific work, they showed that the administration of the drug Vetom 1.2 at a dose of 12.5 mg / kg of live body weight, containing B. Subtilis and B. Amyloliquefaciens, increases the level of total protein and albumins in the blood of turkeys within the physiological norm [5].New probiotics that were not previously used in industrial animal husbandry are appearing on the market of animal products.

The authors of Matseliukh E. V. and colleagues studied the prothelitic ability of Bacillus Amyloliquefaciens subsp. plantarum UKM B-5139 and UKM B-5140, which are part of the probiotic Endosporin. The isolated proteases are able to lyse living cells of Staphylococcus aureus and Candida albicans. The presence of strains of B. Amyloliquefaciens subsp. plantarum UKM B-5140 and UKM B-5139 proteases capable of cleaving native insoluble proteins (elastin, fibrin, collagen) has been shown. These enzymes have lytic activity against yeast [6].

Experimenters Afrin S., Bhuiyan M.N.I. found that Bacillus Amyloliquefaciens, isolated from the soil of the Sundarbans mangrove forest, exhibits antagonistic activity in a wide range of temperatures, pH and salinity. Antibacterial protein may represent a safe, effective and biodegradable alternative, since their action is focused on cyclic peptides. In doses from 300 to 400 mcg/ml, this protein exhibits antagonistic activity against polyresistant S. Rubidaea, Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, etc. [7].

Balaban N.P., Sharipova M.R. noted that preparations of homogeneous subtilisin-like proteinases B. Intermedius and B. Amyloliquefaciens have fibrinolytic, thrombolytic and anticoagulant properties. The practical use of proteolytic enzymes in various sectors of the national economy and medical practice is possible. Replacing expensive enzymes of animal origin with more affordable and promising bacterial enzymes [8].

Yordanka Gaytanska and colleagues in the course of scientific research proved that B. Amyloliquefaciens M showed pronounced high antibacterial and antifungal activity, which

were comparable for three fermentation media in which it was cultivated. It was found that the strain grew well and sporulated on a medium with malt, a medium with molasses and a medium with nutritious meat-peptone broth and the addition of salts. The sporulation process began at the 12th hour for all three fermentation media and the percentage of sporulation was 97.09%, 96.44% and 98.58%, respectively. When cultivating B. Amyloliquefaciens M in a laboratory bioreactor, the strain grew with a high maximum specific growth rate of 0.138 h-1, sporulation rate constants (0.430 h 1) [9].

One of the important productive indicators of goat breeding is the quality of meat, the characteristics of which can be the chemical, mineral, fatty acid and amino acid composition of muscle tissue.

Sazonova I.A. in the course of her research work, she found out that sheep of the Tsigai and Volgograd breeds had the best biological value of meat protein at the age of 7 months: the protein-quality index of meat was 34.3% higher in sheep of the Tsigai breed and 23.3% higher in the Volgograd breed. The amino acid score, the balance coefficients of amino acids and fatty acids were close to the standard. The sheep of the Edilbaevsky breed had the most nutritionally advantageous amino acid balance coefficients, the optimal ratio of polyunsaturated fatty acids and a more efficient use of the protein potential of muscle tissue (by 16.7%) [10].

Khanbabaev V.V. and co-authors write that after weaning from mothers, there is a sharp decrease in the average daily body weight gain in lambs, which can be explained by abrupt changes in their feeding and maintenance conditions. Lambs are deprived of their mother's milk, transferred to self-feeding and maintenance, as a result, from 4 to 6 months. By age, the body weight gain of the sheep is reduced from 170 g to 70.3 g per day. Subsequently, from 6 to 8 months of age, a slight increase in gains was observed – up to 78.05 grams per day [11].

The amino acid composition of meat proteins is influenced by many genotypic and phenotypic factors: species and breed, sex and age of animals, climate, season and food, various parts of the carcass (thoracic, femoral, longest back muscle, etc.) and much more [12-15].

According to Lkhagvaa L., Oyuun G. and others, with increasing age of the animal, the amount of fat in the muscle tissue increases, and the moisture content decreases. The amount of protein remains almost at the same level. The chemical composition of goat meat differs significantly in different seasons: in spring, the moisture content is 5.2% higher, the fat content is almost 3.5 times lower, but the protein content is 1% higher, probably the decrease in fat content is due to its use by the animal's body in harsh winter conditions [16].

Kekeeva T.S. with co-authors studied the amino acid composition of goat meat bred in Kalmykia. According to scientists, in the protein of the tissue of the longest back muscle of crossbred goats, a number of essential amino acids exceeded in number the indicators of similar muscles of young local goats: lysine – by 13.5%, phenylalanine – by 5.5%, the sum of leucine and isoleucine – by 9.6%, methionine – by 8.1%, valine – by 18.6%, tryptophan – by 19.5%, threonine – by 5.8%. The amino acid score sets the maximum possible level of nitrogen use of this type of protein for plastic purposes at 12% in local livestock and 14% in crossbred goats. The excess of other amino acids present in the protein will be used as a source of non-specific nitrogen or for the energy needs of the body. The maximum speed was observed in lysine in both groups of goats, 48.5% in local and 54% in crossbred animals [17].

Researchers Yadav Sharma Bajagai, Yun Kit Yeoh, Xiuhua Li, Dagong Zhang, Paul G Dennis et all. Bacillus Amyloliquefaciens H57 has been shown to improve the productivity of meat chickens or broilers, significantly alter the functional potential of their caecum microbiome, and increase the potential ability to biosynthesize amino acids and vitamins [18].

Researchers by G T Cao, X A Zhan, L L Zhang, X F Zeng, A G Chen, C M Yang. scientists have also shown that the dietary supplement Bacillus amyloliquefaciens improves growth rates, increases the absorption of nutrients by host organisms and modulates the intestinal microflora of broilers [19].

Scientists Li C, Cai H, Li S, Liu G et all compared the probiotic B. Amyloliquefaciens CGMCC18230 with antimicrobial growth stimulants for its ability to stimulate bone growth and health. The experiment was conducted on 180 male broiler chickens at the age of 1 day, the control group received OR. Experimental group 1 OR with the addition of B. Amyloliquefaciens 2.5×10^{10} CFU/kg; Experimental group 2 OR with antibiotics aureomycin, flavomycin and kitasamycin. At 42 days of age, the broilers of the experimental groups had a higher body weight. The mineralization of tibial bones was improved in broilers taking the B. Amyloliquefaciens supplement. Experimental data show that the B. Amyloliquefaciens CGMCC18320 supplement improves the growth rates of broiler chickens and bone health by enhancing the regulation of intestinal phosphorus transporters, microbiological modulation and increased phosphorus retention [20].

In connection with the above, the study of the use of the new probiotic B. Amyloliquefaciens in goat breeding to increase adaptive and productive indicators is an urgent topic, the solution of which will further increase the meat productivity of goats.

2 Material and methods

A scientific and production experiment was conducted on of the peasant farm (PF) "Semkina O.V." in the Samara region. The groups included 2-month-old goats with 10 heads each. The goats of the control group took the main diet (OR), the animals of the experimental group were additionally prescribed the probiotic Bacillus Amyloliquefaciens VKPM B-11475 at a dose of 4×10^7 CFU/g (B. Amyloliquefaciens) 30 minutes before feeding, 1 capsule per head once a day for two months.

The probiotic B. Amyloliquefaciens VKPM B-11475 was produced in the research laboratory of the PF "Tsirulev E.P.". The standard was taken as a basis, which was sent to the collection of the SRC "Kurchatov Institute". The proposed bacterial strain has fungicidal and bactericidal effects, hydrolyzes gelatin and starch, recycles citrate, reduces nitrate, forms catalase, forms acid from glucose, mannitol and arabinose, has protease and amylase activity and does not have lipase activity. The bacterial strain is highly resistant to enzymes of the gastrointestinal tract, and also suppresses the activity of pathogenic microorganisms. The use of the probiotic B. Amyloliquefaciens helps to improve the digestive process by activating metabolic reactions in the body due to the vital activity of beneficial microflora, improving the overall health of animals and solves the problem of profitability and environmental friendliness of goat products [21, 22].

The drug is a light-brown liquid, the average concentration is 4×10^9 CFU/g. For giving in liquid form, the drug was diluted to 4×10^7 CFU/g. The drug has a positive expert opinion on the toxicological and hygienic assessment of the strain B. amyloliquefaciens dated 06.19.2023 from the Samara Testing Laboratory of the Federal State Budgetary Institution "Federal Center for Animal Health Protection" [23].

At the end of the scientific and economic experiments, a control slaughter was carried out in order to determine the meat productivity of goats (5 animals in each group) according to generally accepted methods. The study material was the longest muscle of baby goats. Tissue samples taken during control slaughter in the area of 9-12 thoracic vertebrae after 24-hour cooling of carcasses. The obtained meat samples were examined in the chemical analytical laboratory at the Federal Research Center for Animal Husbandry - All-Russian Scientific Research Institute of Animal Husbandry named after Academician L.K. Ernst. The content of free amino acids in the blood was determined by ion exchange chromatography on a

ShimadzuLC-20 Prominence liquid chromatograph (HPLC) (Japan) with an automatic reaction module ARM-1000 (Sevko&Co, Russia), using ready-made buffer solutions Sevko&Co, Russia. The concentration was calculated using a standard amino acid sample (Sykam, Germany). The data obtained during the research were processed by biometrics with the calculation of generally accepted constants and using the STADIA program.

3 Results and discussion

The microclimate in the livestock room corresponded to the rules for keeping small cattle (MRC): the average air temperature was 18.60±0.300 C, relative humidity was 73.80±1.5%. The chemical composition and nutritional value of the feed are observed according to all-Russian standards. Felucene salt was freely added to the feeders for small cattle.

All clinical and physiological parameters of the goats corresponded to the norm. However, in the experimental group, morphological and biochemical parameters were higher, which indicates more intensive metabolic processes in the body of 4-month-old goats. The hemoglobin content in the blood of the experimental group of goats was higher by 9.4% ($p \leq 0.01$), hematocrit – by 1.2% ($p \leq 0.05$), the amount by 9.4% ($p \leq 0.01$), relative to these control animals. According to the leukoformula, the number of rod–shaped neutrophils in the experimental group is 3 times lower%; The number of segmented neutrophils is 2.3% higher ($p \leq 0.05$), and monocytes are 0.9% less ($p \leq 0.01$) than in the control. The introduction of the probiotic B. Amyloliquefaciens contributed to the enhancement of hematopoiesis in the body of experimental animals. The indicators of protein metabolism significantly increased: total protein by 6.1% ($p \leq 0.01$), albumin by 14.7% ($p \leq 0.01$), creatinine by 10.6% ($p \leq 0.01$) and the amount of urea decreased by 35% ($p \leq 0.05$), relative to the control. Application B. Amyloliquefaciens had a positive effect on the indicators of carbohydrate-lipid metabolism – the amount of bilirubin decreased by 21.8% ($p \leq 0.05$), cholesterol by 13.7% ($p \leq 0.05$); the number of triglycerides increased by 17.5% ($p \leq 0.05$), relative to the control.

The chemical and mineral composition of the meat of 8-month-old goats is shown in Table 1.

Table 1. The chemical and mineral composition of goat meat, %

Indicators	Control	Experience
Chemical composition of meat		
Moisture	68.99±2.07	70.00±2.1
Protein	22.15±0.66	26.66±0.49*
Fat	6.91±0.24	2.15±0.10***
Ash	1.95±0.03	1.19±0.02***
Mineral composition of meat		
Calcium	0.05±0.01	0.04±0.01
Phosphorus	0.14±0.02	0.18±0.02
Magnesium	0.016±0.01	0.023±0.01

All Analyzing the indicators of the chemical composition of meat, it can be concluded that the moisture in the muscle mass of the goats of the experimental group was 1.5% more, protein by 9.0% ($p < 0.05$) compared with the results of the control group. The fat content in the muscle mass of goats that took the probiotic B. Amyloliquefaciens for 2 months was 32.7% lower ($p=0.001$) compared with control animals. There were no significant differences in the mineral composition of meat between the control and experimental small cattle. However, it should be noted that the amount of phosphorus and magnesium in the muscle

mass of the goats, who received the probiotic Amyloliquefaciens in addition to OR, was 0.04 and 0.007% higher, respectively, than in the control.

The amino acid composition of the longest back muscle of the goats of the experimental and control groups of 8 months of age is presented in Table 2.

Table 2. Amino acid composition of the longest back muscle of goats

Amino Acids. g/100 g	Control	Experience
essential amino acids		
lysine	3.21±0.12	4.23±0.13***
threonine	2.04±0.05	2.36±0.08***
valine	1.28±0.02	1.43±0.03**
leucine	4.06±0.12	4.47±0.18
phenylalanine	1.54±0.05	1.54±0.09
methionine	0.93±0.05	1.15±0.03**
isoleucine	1.37±0.08	1.45±0.15
tryptophan	1.67±0.1	2.01±0.08**
interchangeable amino acids		
Glutamic acid	9.02±0.23	10.24±0.31*
Aspartic acid	4.11±0.09	6.65±0.17***
glycine	2.23±0.07	2.47±0.10
alanine	3.20±0.10	4.05±0.11**
arginine	2.25±0.05	3.42±0.08***
histidine	1.65±0.03	2.23±0.04***

According to Table 2, it can be seen that in terms of the quantitative content of essential amino acids in meat, experimental animals are superior to control ones: lysine is 1.3 times more ($p \leq 0.001$), threonine is 1.2 times more ($p \leq 0.01$), valine is 1.1 times more ($p \leq 0.05$). The amount of methionine and tryptophan in experimental animals was 1.2 times higher ($p \leq 0.01$) compared with similar indicators in control goats. This indicates that in animals taking probiotic B for 2 months. Amyloliquefaciens metabolism is more intense, protein digestibility is better, and muscle mass growth in the body is higher, since the amino acids lysine, methionine and valine are responsible for these processes.

The amount of interchangeable amino acids in the muscle tissue of the experimental animals was also higher. Aspartic acid, which accelerates nitrogen metabolism in the body, was 1.6 times higher ($p \leq 0.001$), alanine was 1.3 times higher ($p \leq 0.01$) in experimental goats compared with similar data in the control. Glutamic acid, which helps to eliminate toxins from the liver and strengthen the immune system, was 1.14 times higher ($p \leq 0.001$); arginine, which controls the condition of joints, muscles, and skin, was 1.5 times higher ($p \leq 0.001$); histidine was 1.4 times higher ($p \leq 0.001$), relative to the indicators of control animals. The growth dynamics of baby goats from 2 months of age to slaughter is shown in Table 3.

Table 3. Dynamics of baby goats' body weight

Age. month	Control			Experience		
	Body weight. kg	Absolute gain. kg	The average. gain. kg	Body weight. kg	Absolute gain. kg	The average. gain. kg
2	11.64±0.56			11.82±0.47		
4	21.32±0.85	9.68	0.16	24.75±0.77*	12.93	0.21
6	25.8±0.64	4.48	0.07	28.7±0.76*	3.95	0.07
8	31.6±0.66	4.8	0.08	34.15±0.75*	5.45	0.09

The average daily live weight gain in experienced goats from 2 to 4 months of age was 30% higher and amounted to 0.21 kg per day compared with control animals. Then, after weaning from mothers and changing the type of nutrition, all animals have a decrease in the average daily gain to 0.07 kg in both groups. From the age of 6 to 8 months, the goats of the experimental groups show an average daily increase of 12.5% higher than the animals of the control group. Body weight in goats that received probiotic B in addition to the staple diet for two months. Amyloliquefaciens was 34.15±0.75 kg and was significantly higher by 8% ($p \leq 0.05$) compared with the values in the control. The quantitative characteristics of the meat productivity of goats are presented in Table 4.

Table 4. Meat productivity of baby goats at 8 months

indicator	control	experience
Pre-slaughter live weight. kg	31.6±1.10	34.15±0.95*
Weight of the steamed carcass. kg	13.8±0.15	16.5±0.22**
Carcass yield. %	43.7±0.72	48.43±0.69**
Internal fat mass. kg	0.72±0.04	0.54±0.03**
Slaughter weight. kg	14.52±0.32	17.08±0.53**
Slaughter yield. %	45.9±1.12	50.0±1.32*

The weight of the paired carcass of goats at 8 months of age in the control group was at the level of 13.8± 0.15 kg, in the experimental group 16.5±0.22 kg, which was higher than 19% ($p \leq 0.01$) compared with the control. Animals taking the probiotic B. Amyloliquefaciens accumulated less internal fat by the time of slaughter, so in the experimental group the indicator was at the level of 0.54 ± 0.03 kg, in the control group it was 25% more, which amounted to 072±0.04 kg. Thus, the slaughter yield of experimental goats at 8 months was 8% higher ($p \leq 0.05$) compared with similar data from control animals. The conducted studies have shown that the use of the probiotic B. Amyloliquefaciens VKPM B-11475 for little cattle can significantly improve the qualitative and quantitative indicators of goat meat productivity.

4 Conclusion

The conducted studies have shown that the use of the probiotic B. Amyloliquefaciens VKPM B-11475 for little cattle can significantly improve the qualitative and quantitative indicators of goat meat productivity.

The experimental goats had 1.5% more moisture in their muscle mass, 9.0% more protein ($p<0.05$), 32.7% less fat ($p<0.001$), and the amount of phosphorus and magnesium was 0.04 and 0.007% higher relative to the control data. In terms of the content of essential amino acids in muscle tissue, experimental animals surpass control ones: lysine is 1.3 times more ($p \leq 0.001$), threonine is 1.2 times more ($p \leq 0.01$), valine is 1.1 times more ($p \leq 0.05$), methionine is 1.2 times more ($p \leq 0.01$) and tryptophan is 1.2 times ($p \leq 0.01$). The number of interchangeable amino acids in experimental animals was higher: aspartic acid 1.6 times ($p \leq 0.001$), alanine 1.3 times ($p \leq 0.01$), glutamic acid 1.14 times ($p \leq 0.001$); arginine 1.5 times ($p \leq 0.001$); histidine 1.4 times ($p \leq 0.001$) relative to the control data. The mass of the paired carcass of experimental goats at 8 months of age was higher than 19% ($p \leq 0.01$), the slaughter yield was 8% higher ($p \leq 0.05$) compared with similar data from control animals.

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