Caspian Journal of Environmental Sciences
Online ISSN: 1735-3866
Print ISSN: 1735-3033

Coriander cake as a functional component in the diets of lactating goats

Vladimir I. Trukhachev*, Nikolay P. Buryakov, Angelika A. Ksenofontova, Dmitry A. Ksenofontov, Valentina G. Kosolapova, Anastasia S. Zaikina

Russian State Agrarian University, Moscow Timiryazev Agricultural Academy, Moscow, Russian Federation

* *Corresponding author's Email: Vladimir.Trukhachev@mail.ru*

ABSTRACT

One of the most important factors influencing productivity in the dairy goat farming is the balanced animal feeding. The composition and structure of the diet influence not only the level of milk production in dairy goats, but also its functional properties. It is important to search for inexpensive feed products of plant origin that have high nutritional value and contain the biologically active substances with antioxidant, antimicrobial and anti-inflammatory effects. The introduction of by-products of agro-industrial production into the diets of farm animals allows us to expand the range of domestic inexpensive feed resources. Coriander cake can be considered as a feed product that meets all the above requirements, and therefore its use can serve as an effective alternative for providing goats with nutrients. An assessment was made of the digestibility of dietary nutrients, nitrogen balance and productivity in Saanen goats when different levels of coriander cake were introduced into the diet as a functional feed. It has been established that coriander cake can be used as an alternative feed with specified functional characteristics.

Keywords: Alternative feeds, Coriander cake, Digestibility, Goats, Milk productivity, Nitrogen balance.
Article type: Research Article.

INTRODUCTION

Milk has always been considered a valuable food product due to its balanced composition of nutrients, minerals and vitamins. Goat milk, compared to the milk of other types of farm animals, is a good source of complete protein and essential amino acids, and, unlike cow milk, it is better digestible and does not cause allergic reactions. Therefore, it is considered as a high-quality raw material for the production of food products for young children and populations with special physiological needs (Ahmed *et al.* 2015; Clark & García 2017). Goat milk is also becoming increasingly popular due to the wide range of products made from it. One of the most important factors influencing the productive performance of farm animals is the balanced feeding, since at least 70% of the costs of raising them are associated with the formation of a complete feed base, which should provide all nutrients, satisfying the physiological needs of goats. The composition and structure of the diet affect not only the level of milk production in dairy goats, but also its composition, which determines the yield and quality of products, in particular cheese (Goetsch 2019). Diversification of feed resources can help meet the high demand for nutritional feed components for milk production. Currently, the introduction into the diets of farm animals of by-products of agro-industrial production rich in fiber, which is well decomposed in the rumen, vegetable proteins and complete fats (Pinotti *et al.* 2023; Buryakov *et al.* 2023a) especially relevant since feed constitutes the bulk of the production costs of lactating dairy goats, and using local non-traditional feeds can reduce the cost of the diet (Morand-Fehr 2005; Romero-Huelva *et al.* 2017). Of no small importance is the search for inexpensive feed products of plant origin containing biologically active substances (phytobiotics) with antioxidant, antimicrobial and anti-inflammatory effects, which must be used as an alternative to feed antibiotics to improve production performance (Heydari *et al.* 2019; Pandey *et al.* 2023; Kazempour *et al.* 2024; Bakir *et al.* 2024). Developing strategies to make the most efficient use of resources, including industrial waste generated in the food industry, most of which is

Caspian Journal of Environmental Sciences, Vol. 23 No. 4 pp. 991-999 Received: Jan. 22, 2025 Revised: May 16, 2025 Accepted: June 03, 2025
DOI: 10.22124/cjes.2025.9214

Publisher: University of Guilan,

recycled, is an urgent task in many countries around the world (Boudalia 2024). By-products from food processing plants contain large amounts of nutrients and biologically active compounds (Ancuța & Sonia 2020), which allows their use as feed components in livestock farming. Oilseeds are most often used as a source of vegetable fats in the diet of various types of farm animals. When processing grains and seeds, in addition to oils, protein-rich waste from oil extraction production is obtained - cakes and meal, which are used as feed in livestock farming. When squeezing oil from oilseeds on presses, cakes with a fat content of 4 to 10% are obtained. Also, protein from cakes and meals is a source of essential amino acids for animals. Coriander cakes are characterized by a low content of saturated fatty acids, of which palmitic acid is dominant, and at the same time they are a source of polyunsaturated fatty acids, especially linoleic and linolenic acids, which are essential (Rakita *et al.* 2023). Recently, due to many factors (e.g., overexploitation of global resources, increasing world population, unsustainable consumer behavior, increasing demand for animal products and climate change), there has been increased interest in finding alternative protein feeds that can be produced locally level to replace expensive soybean meal in livestock farming (Rao *et al.* 2021). In this regard, using oilseed by-products in animal nutrition can be considered as a promising solution to provide cheap and environmentally friendly feed. Some herbal plants and essential oil seeds possess appetite stimulating properties, antibacterial effects and antioxidant functions (Smeti *et al.* 2015; Trukhachev *et al.* 2015), which makes them effective feed additives in ruminant diets, exhibiting a positive effect on feed utilization, milk production, and improving its composition due to the activation of fermentation processes in the rumen and increased digestibility of dietary nutrients (Bodas *et al.* 2012). One such product is coriander seed cake, *Coriandrum sativum* L., a by-product from the processing of coriander, which is obtained from an essential oil plant grown to produce fruits containing coriander essential oil in an amount of 0.2 to 1.2%. Coriander contains large amounts of vitamin C, folic acid, vitamins A and B_{12}, polyphenols (ferulic, caffeic, gallic and chlorogenic acids) and other biologically active substances such as linalool, α-pinene, γ-terpinene, etc. (Daly *et al.* 2012). A large amount of waste generated during the production of coriander fruits (for cooking, cosmetology, the manufacture of perfume compositions, fragrances for soaps, cosmetic products and medicine) is concentrated in Russia, Great Britain, the countries of Central and Eastern Europe, Morocco, Egypt and other countries (Anaeigoudari 2024). However, at the same time, a large amount of waste, as a rule, is not in demand in feeding farm animals. Hence, conducting experiments to determine the effectiveness of introducing coriander cake into the diets of different types of productive animals and determining the optimal levels of its input is a current direction in scientific research. In this regard, the purpose of this study was to conduct a comprehensive analysis of the effectiveness of introducing different levels of coriander cake into the feed of lactating Saanen goats. Objectives of the work were to study the digestibility of dietary nutrients in goats, analyze nitrogen balance indicators, and determine the milk productivity of animals.

MATERIALS AND METHODS

The study was carried out on lactating goats. To conduct the experiment, 60 animals were selected, which were divided using the method of analogue pairs (taking into account breed, age, live weight, level of productivity and physiological state) into 4 groups, 15 animals in each: one control and three experimental. Animals were kept loose in sections, in accordance with zoohygienic requirements. Milking was performed twice a day in the milking parlor in a parallel quick exit system. During the study period, all animals were clinically healthy and were kept in the same tethered conditions. The rations formulation was carried out using the Feed Optima program to fulfill the cows' requirements (energy, protein, vitamins, and minerals) during the lactation period. Animals in the control group received a basic diet balanced in accordance with the recommendations for feeding goats, which included 1 kg meadow cereal hay, 1.1 kg legume-cereal haylage, 0.25 kg dry beet pulp, 0.2 kg wheat bran, 0.025 kg sugar, 1.311 kg feed, including mineral additives. In the diets of goats of experimental groups 1, 2 and 3, the feed recipe was adjusted to introduce 10, 15 and 20% (by weight) coriander cake (Table 1). The duration of feeding coriander cake was 150 days. Actual daily milk yield, actual milk yield, mass fraction of protein and fat content in milk were measured at the whole lactation period. Milk samples were collected in one common container and stored in a refrigerator at 4 °C (Trukhachev *et al.* 2015). At 150 days of lactation, representative samples (milk, feces, and urine) were obtained daily for five consecutive days (balance experiment) to study the chemical composition, digestibility, and average daily nitrogen balance. From each group, three goats were selected, uniform in live weight and reflecting the average for the group. The animals were kept in special stalls on a leash with a plank floor. The goats were divided into three diets and fed on an individual feeder, ensuring that the animals consumed only the diet evenly. To compile an average sample, animal feed, leftovers and excrement were taken every day

and stored in glass jars. Feeding was performed several times a day as the feed mixture was distributed and consumed, the remains of the feed from the previous day were weighed one time in the morning of the next day during the entire period of the experiment to calculate nutrient intake. Feed samples and products of the balance experiment were taken in accordance with the ISO 6498:2012 standard "Animal feed". Feces and urine were collected in individual tanks, from which an average sample was subsequently taken two times a day for chemical analyses. To preserve the secretions, a 10% solution of hydrochloric acid and toluene was added to them in the calculation of 10% HCl and 0.5% toluene by weight of the average sample (AOAC 1994; GOST 2008; Buryakov *et al.* 2023b). The added amount of preservatives was taken into account when determining the dry matter content. Determination of chemical indicators of samples of feed, milk, urine and feces was carried out at the educational and scientific center "Service Laboratory for Complex Analysis of Chemical Compounds" of the Russian State Agrarian University Timiryazev Moscow Agricultural Academy: Dry matter (AOAC 930.15); organic matter (AOAC 924.05); crude protein and nitrogen (AOAC 984.13); essential ether extract (crude fat; AOCS approved procedure Am 5-04); crude fiber (AOCS Ba-05 standard procedure); nitrogen in urine according to the Kjeldahl method (AOAC 984.13; ISO 27085:2009). Using nutrients and nitrogen in diets were established based on the results of balance experiments in accordance with the methodological recommendations of the Federal Research Center for Animal Husbandry named after Academician L.K. Ernst (Golovin *et al.* 2016). The digestibility coefficient (DC, %) of each nutrient in the diet was evaluated using the following Equation:

$$DC = \frac{(\text{intake nutrient} - \text{excreted in feces})}{\text{intake nutrient}} * 100\%$$

Statistical processing of the results was performed in Microsoft Excel 2016 with an additional data analysis package. When processing the reliability of the results obtained, the significance criterion (p) was used at a level of less than 0.05.

RESULTS AND DISCUSSION

One of the main factors determining the productive performance of animals is the nutritional value of diets, which is determined by the chemical composition of its ingredients. The diet energy assessment is a tool for managing animal performance. The basis of the diet energy assessment system is knowledge of all energy losses during the conversion of feed energy into energy for maintaining life and production. As a result of the analysis of the diet of lactating goats of the control group, it was found that its energy nutritional value was 3.04 Energy Feed Unit (EFU). When coriander cake was introduced into the diets of animals, the amount of energy in them increased by 2% and amounted to 3.10, 3.11 and 3.11 EFU in experimental groups 1, 2 and 3, respectively (Table 2), which can be considered as the equivalent of energy nutritional value of the diet of animals in the control group.

The key indicator in feeding dairy cattle is the dry matter content in the diet, the maximum consumption of which ensures an increase in the milk productivity of animals. In the diets of goats in the experimental groups, the dry matter content was 2.9 kg, remaining at the level of the control group.

Table 1. Composition of feed for Saanen goats (Compiled by the authors).

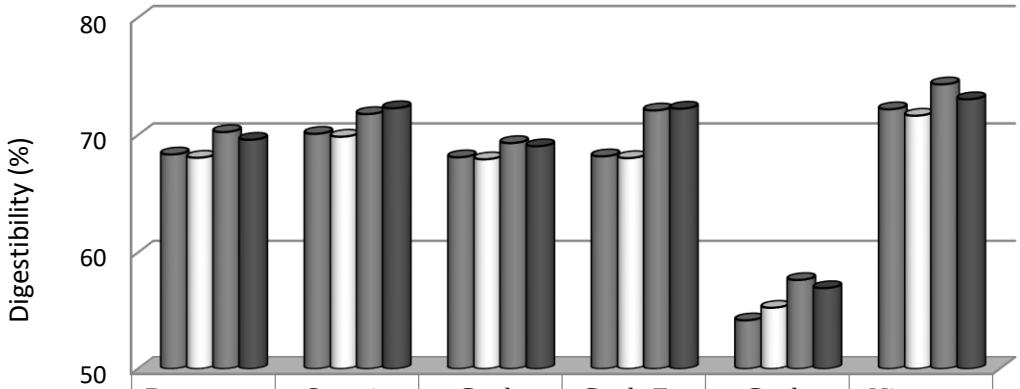
Ingredient	Control group	1 experience group	2 experience group	3 experience group
Wheat	7.2	17.2	12.2	7.2
Corn	39.0	29.0	29.0	29.0
Soybeans	21.0	21.0	21.0	21.0
Soybean meal	8.0	8.0	8.0	8.0
Sunflower meal	20.0	10.0	10.0	10.0
Coriander cake	-	10.0	15.0	20.0
Sodium chloride	1.0	1.0	1.0	1.0
Monocalcium phosphate	1.8	1.8	1.8	1.8
Limestone flour	0.5	0.5	0.5	0.5
Premix	1.5	1.5	1.5	1.5

Table 2. Nutritional value of Saanen goat diets (Compiled by the authors).

Indicators	Diet control group	Diet 1 experience group	Diet 2 experience group	Diet 3 experience group
Quantity (kg)	3.89	3.89	3.89	3.89
Energy feed unit	3.04	3.11	3.11	3.10
Dry matter (kg)	2.90	2.90	2.91	2.90
Crude protein (kg)	472.6	465.7	461.2	456.9
Degradable protein (kg)	293.9	275.4	276.1	276.8
Undegradable protein (kg)	178.7	190.3	185.1	180.1
Undegradable protein of crude protein (%)	37.8	39.4	40.1	40.9
Digestible protein (kg)	322.7	312.6	309.8	307.2
Crude fiber (kg)	566.6	611.7	596.2	580.9
Starch (kg)	473.0	388.1	424.0	459.9
Sugar (kg)	147.4	132.5	133.7	135.3
Crude fat (kg)	133.2	181.0	168.0	155.4

An important role in the complete feeding of ruminant animals is played by the assessment of the protein nutritional value of diets, which is determined by the amount of raw and digestible, degradable and non-degradable protein. It was found that as a result of introducing different amounts of coriander cake into the diets of lactating goats, the level of crude protein decreased by 3.3, 2.4 and 1.55%, and digestible protein by 4.8, 4.0 and 3.1% in experimental groups 1, 2 and 3, respectively. The physiological need of ruminant animals for degradable and non-degradable protein during different lactation periods is established by scientifically based standards. In highly productive animals, especially during the milking period, the content of non-degradable protein in the diet should be higher. A high content of degraded protein will lead to the accumulation of ammonia in the rumen, followed by its absorption into the blood and entry through the portal vein into the liver, which will lead to inhibition of its functions and destruction of hepatocytes. Also, a high concentration of ammonia in the blood of animals leads to disruption of the neurohumoral regulation of the body, increased load on the excretory system and dysfunction of the reproductive organs. In the diet of animals in the control group, the proportion of non-degradable protein from crude protein was 37.8%. The inclusion of coriander cake in diets for goats reduced the level of degradable protein by 5.8, 6.0 and 6.3%, and the content of non-degradable protein, on the contrary, increased by 0.8, 3.6 and 6.5% in 1. 2 and 3 experimental groups, respectively. The noted changes in the ratio of the levels of degradable and non-degradable protein in the diets of animals in the experimental groups will help maintain balance in the goat rumen ecosystem by reducing the production of ammonia by symbiotic microflora. The basis of the dry matter of diets for ruminant animals is carbohydrates, the main structural component of which is fiber. When voluminous feed is consumed in polygastric animals, digestive processes are optimized, including an increase in the volume of saliva secreted, the work of the digestive glands is activated, and the motility of the gastrointestinal tract is improved. In the diets of animals of experimental groups 1, 2 and 3, the content of crude fiber relative to the control group increased by 2.5, 5.2 and 7.1%, respectively. Non-structural carbohydrates, represented mainly by starch and sugar in animal diets, are no less important sources of energy for lactating goats. However, their excess can lead to a decrease in pH in the rumen and, as a consequence, to disruption of the microbiocenosis of its contents. Coriander cake helped reduce the level of easily digestible carbohydrates in the diets of animals in the experimental groups. There was a decrease in the concentration of starch and sugar in the diet of experimental group 1 - by 2.8% and 8.2%, experimental group 2 - by 10.4% and 9.3%, and experimental group 3 - by 18.0% and 10. 1%, which can reduce the likelihood of animals developing subclinical acidosis (Table 2). The lipid nutritional value of a diet is assessed by its crude fat content. This high-energy component of the diet of lactating goats determines the fat content of milk. The replacement of sunflower meal with coriander cake in the feed composition, equivalent in terms of energy nutrition, increased the crude fat content in the diets of lactating goats of the 1st, 2nd and 3rd experimental groups by 16.6, 26.1 and 35.9%, respectively, compared to the control diet. The high content of unsaturated fatty acids in cakes determines their high content in milk fat, which has a positive effect on the functional composition of animal milk. The metabolism of proteins, fats and carbohydrates should be considered in conjunction with the supply of minerals to the body of lactating goats. Animal diets should be

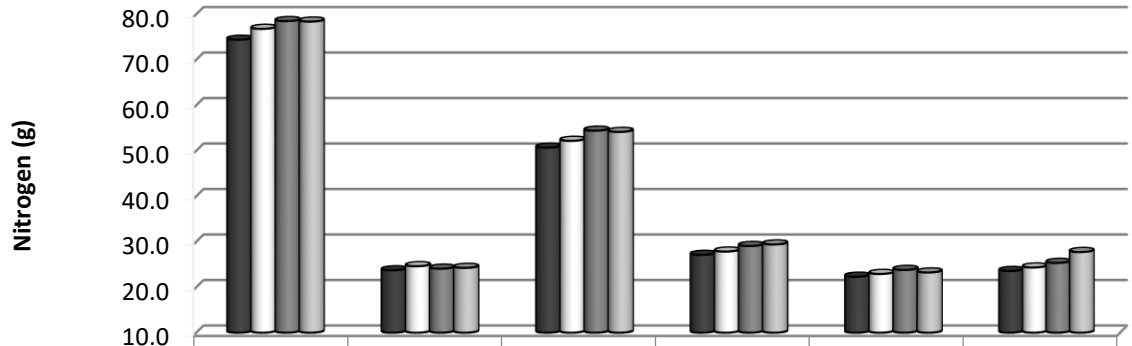
balanced in macro- and microelements, which is especially important in industrial production conditions. Insufficient supply of individual elements or non-compliance with their ratio causes disturbances in mineral metabolism, and, as a consequence, in metabolism, which can adversely affect the productivity of animals. Calcium and phosphorus play an important role in the body of lactating goats, the metabolism of which is closely interconnected. These macronutrients perform many functions in animals, including being used for milk synthesis. The diet of ruminant animals should contain 1.5 - 2.0 times more calcium than phosphorus, this ratio was in the diet of goats in the control group. The introduction of coriander cake into the diets of animals in the experimental groups kept this ratio within acceptable values, increasing it from 1.5:1 to 1.6:1. Thus, an analysis of the diets of lactating goats in the control and experimental groups showed that the introduction of coriander cake made it possible to improve the protein and lipid nutritional values of the diets, as well as balance the content of structural and non-structural carbohydrates. The nutritional value of the diet is assessed by the digestibility of nutrients, which allows us to estimate the amount of nutrients entering the internal environment of the body (Mayulu *et al.* 2019). Nutrient digestibility is influenced by many factors and should be taken into account when feeding productive animals. The digestibility of feed affects the energy content in it necessary to maintain animal life, fetal growth and production. When organizing complete feeding of goats with maximum feed conversion, it is necessary to control the amount of possible dry matter consumption by the animals. It was established that when coriander cake was introduced into the diet of lactating goats of the Saanen breed, in animals of the 2nd and 3rd experimental groups there was a tendency to increase the digestibility of the dry matter of the diet by 1.9 abs.% and 1.3 abs.%, and an increase in the digestibility of organic matter was also noted substances by 1.7 abs.% and 2.2 abs.%, respectively, the difference was significant ($p < 0.01$; Fig. 1). In animals that received coriander cake in the diet in amounts of 15% and 20%, positive dynamics were noted in increasing the digestibility of crude protein by 1.2 abs.% and 1.0 abs.% and nitrogen-free extractives by 2.1 abs.% and 0.9 abs.% respectively. There was also an elevation in the digestibility of crude fat by 3.9 abs.% and 4.1 abs.% ($p < 0.01$) and crude fiber in animals of the 2nd experimental group by 3.5 abs.%, the difference was significant ($p < 0.01$). The increase in nutrient digestibility is probably due to the activation of enzymatic hydrolysis of feed components throughout the entire gastrointestinal tract of lactating goats, both with the participation of enzymes of microbial origin and the own enzymes of digestive juices. Coriander cake, containing a complex of biologically active substances, apparently balanced the metabolic processes occurring in the goat rumen ecosystem.



	Dry matter	Organic matter	Crude Protein	Crude Fat	Crude fiber	Nitrogen-free extractives
control group	68.36	70.12	68.12	68.20	54.18	72.21
1 experience group	68.08	69.87	67.95	68.05	55.26	71.66
2 experience group	70.27	71.80 **	69.33	72.11 **	57.65 *	74.33
3 experience group	69.61	72.30 **	69.06	72.26 **	56.95	73.06

Fig. 1. Digestibility of diet nutrients in goats, % (* The difference is significant in comparison with the control, p< 0.05; ** The difference is significant in comparison with the control, ($p < 0.01$), Compiled by the authors).

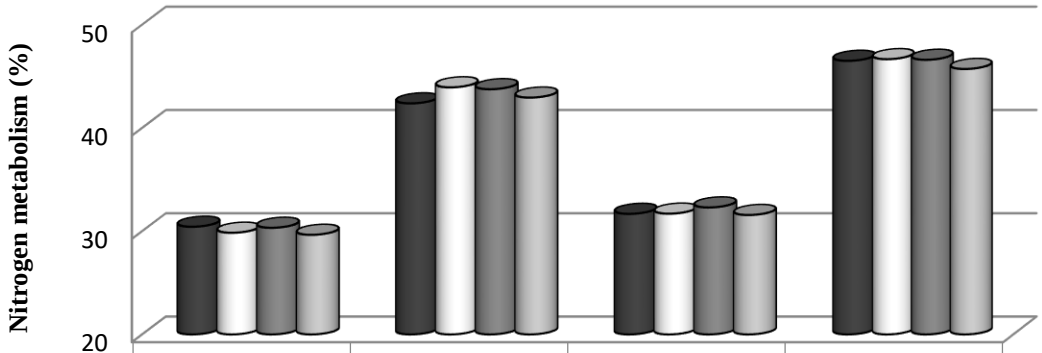
One of the indicators of protein metabolism in ruminants is the nitrogen balance, which reflects the efficiency of using nitrogenous feed components. This indicator is especially important to consider for lactating goats, since milk synthesis requires additional nitrogen input. Animals in the control and experimental groups had a positive nitrogen balance, which indicates that the goats' diets were balanced.



	Taken with a feed mixture		Excreted in feces	Overcooked		Excreted in urine	Excreted with milk	Learned (retention)	
control group	74.4		23.7	50.7		27.1	22.3	23.6	
1 experience group	76.8	*	24.6	52.2	*	27.8	22.9	24.3	
2 experience group	78.5	*	24.1	54.4	*	29.1	23.8	25.4	**
3 experience group	78.4	**	24.3	54.1	*	29.4	23.2	27.7	**

Fig. 2. Nitrogen balance in lactating goats (g; Compiled by the authors).

It was found that in animals of experimental groups 1, 2 and 3, the amount of nitrogen taken with food significantly increased compared to the control group by 3.2, 5.5 and 5.4%, respectively. At the same time, there was a tendency to increase the amount of nitrogen excreted in feces, as a result of which the digestibility of nitrogenous substances in the diet increased by 3.0, 7.4 and 6.8% relative to the control, the difference was significant ($p < 0.01$). The coefficient of protein digestibility tended to elevate in experimental groups 2 and 3 by 1.2 abs.% and 0.9 abs.%. There was also an upraise in the amount of nitrogen deposited in the body in goats of the 2nd and 3rd experimental groups by 7.6% and 17.7%, the difference was significant ($p < 0.01$; Fig. 2). A higher level of nitrogen excretion in urine from the body of goats in the experimental groups by 2.7, 7.2, and 8.4% compared to control animals indicates an intensive metabolism of nitrogen-containing substances aimed at maintaining balance with a significant increase in the levels of digested and assimilated nitrogen. It was found that using nitrogen for milk production was higher in animals that received coriander cake as part of the diet, and its amount excreted in milk increased in animals of experimental groups 1, 2 and 3 by 2.7, 6.7 and 4.2% in comparison with the control (Fig. 3).



	Highlighted from Accepted	Separated from Digested	Learned from the accepted	Digested
control group	30.42	42.37	31.67	46.49
1 experience group	29.84	43.92	31.69	46.65
2 experience group	30.32	43.74	32.29	46.59
3 experience group	29.64	42.93	31.56	45.70

Fig. 3. Nitrogen metabolism indicators (%; Compiled by the authors).

Thus, a change in the architecture of protein nutrition in the diets of goats in the experimental groups, towards an elevation in the proportion of non-digestible protein, led to an upraise in the absorption of feed nitrogen, part of which was used not only to meet the physiological needs of the body, but also to the synthesis of milk proteins.

The genetic potential of productive animals can only be revealed with balanced feeding. The results of assessing the quantitative and qualitative indicators of productivity of lactating goats should be considered as one of the indicators of adequate feeding of animals. In the course of the study, it was established that the average daily milk yield of natural fat milk in goats of all experimental groups tended to elevate, which naturally led to an upraise in the gross milk yield of natural fat milk over 150 days of lactation by 1.2, 2.6 and 2.4%, respectively (Fig. 4).

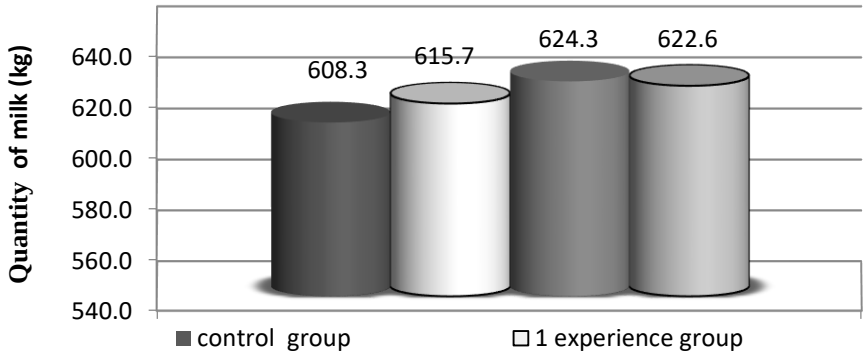


Fig. 4. Milk productivity of goats for 150 days of lactation, kg (Compiled by the authors).

There was also an increase in the concentration of fat by 1.1, 2.6 and 1.85% and protein by 0.3, 2.1 and 1.2% in the milk of goats of the 1st, 2nd and 3rd experimental groups, respectively. When recalculating the quantitative indicators of productivity of Saanen goats into milk with 4% fat content, a tendency was established to increase both the average daily and gross milk yield in animals of all experimental groups by 1.8, 4.1, 3.3% compared to the control group. Naturally, in the animals of the experimental groups, whose feed was supplemented with 10, 15 and 20% coriander cake, the yield of milk fat and protein increased over 150 days of lactation by 2.1, 5.3, 4.2% and 1.5, 4.7, 3.5% respectively (Fig. 5).

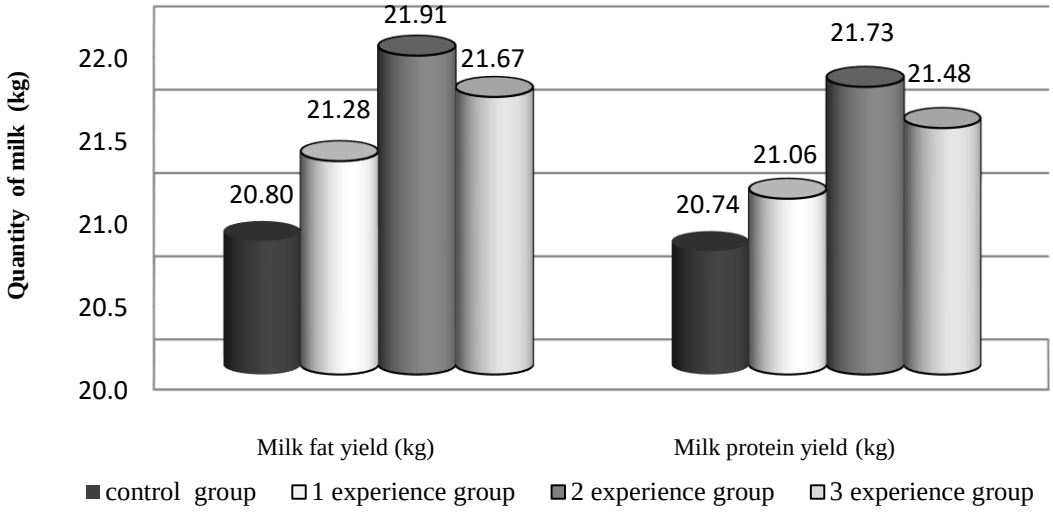


Fig. 5. Yield of milk fat and protein (kg; Compiled by the authors).

The introduction of coriander cake into the feed in amounts of 10, 15 and 20% increased the milk productivity of Saanen goats due to the chemical composition of the diets being more physiological for polygastric animals, which made it possible to improve the nitrogen balance and digestibility of feed nutrients.

CONCLUSION

The introduction of different levels of coriander cake into the diets of lactating Saanen goats contributed to an elevation in both quantitative and qualitative indicators of milk productivity. Maximum productivity was observed in goats of the 2nd experimental group, in whose diet coriander cake was introduced in the amount of 15% per 100 g of feed. In animals of the 3rd group, despite the high rates of nutrient digestibility and nitrogen absorption, the level of milk production was lower than in goats of the 2nd group, probably due to the high content of fiber and

crude fat, as well as the low level of easily digestible carbohydrates in the diet, which leads to the functional deficiency of the rumen microflora.

AKNOWLEDGEMENTS

This study was carried out with the support of the Priority 2030 program

REFERENCES

Ahmed, AS, El-Bassiony, T, Elmalt, LM & Ibrahim, HR 2015, Identification of potent antioxidant bioactive peptides from goat milk proteins. *Food Research International*, 74: 80–88, https://doi.org/10.1016/j.foodres.2015.04.032.

Anaeigoudari, A 2024, Therapeutic effects of Coriandrum sativum extracts. *Asian Pacific Journal of Tropical Biomedicine*, 14(5): 181-186, https://doi.org/10.4103/apjtb.apjtb_160_24.

Ancuța, P, Sonia, A 2020, Oil press-cakes and meals valorization through circular economy approaches. *Applied Sciences.* 10(21): 7432, https://doi.org/10.3390/app10217432.

Bakir, SMHM, Al-Hiti Sdiq MA, Al-Naimi Rajiha AS, Ali Dina T 2024, Antidiabetic and antioxidant effects of sage tea, Salvia officinalis in male rats exposed to hydrogen peroxide as a source of reactive oxygen species. *Caspian Journal of Environmental Sciences*, 22(2): 453-457, https://doi.org/10.22124/CJES.2024.7478.

Bodas, R, Prieto, N, García-González, R, Andrés, S, Giráldez, FJ, López, S 2012, Manipulation of rumen fermentation and methane production with plant secondary metabolites. *Animal Feed Science and Technology*, 176: 78-93, https://doi.org/10.1016/j.anifeedsci.2012.07.010.

Boudalia, S, Smeti, S, Dawit, M, Senbeta, EK, Gueroui, Y, Dotas, V, Bousbia, A, Symeon, GK 2024, Alternative approaches to feeding small ruminants and their potential benefits. *Animals*, 14(6): 904. https://doi.org/10.3390/ani14060904.

Buryakov, NP, Aleshin, DE, Buryakova, MA, Zaikina, AS, Medvedev, IK; Zemyachkovskaya, DA, Laptev, GY, Ilina, LA, El Sheikh, AI, Fathala, MM *et al.* 2023a, An investigation on the effects of partial replacement of rapeseed cake in Ayrshire Dairy heifers' diets with by-product source of animal protein on body weight dynamics, nutrient balancing, and blood biochemical markers. *Animals*, 13: 1856. [in Russ.] https://doi.org/10.3390/ani13111856.

Buryakov, NP, Sycheva, LV, Trukhachev VI, Zaikina, AS, Buryakova, MA, Nikonov, IN, Petrov, AS, Kravchenko, AV, Fathala, MM, Medvedev, IK *et al.* 2023b, Role of Dietary Inclusion of Phytobiotics and Mineral Adsorbent Combination on Dairy Cows′ Milk Production, Nutrient Digestibility, Nitrogen Utilization, and Biochemical Parameters. *Veterinary Sciences*, 10(3): 238. https://doi.org/10.3390/vetsci10030238.

Clark, S & García, MBM 2017, A 100-year review: Advances in goat milk research. *Journal of Dairy Science*, 100(12): 10026–10044, https://doi.org/10.3168/jds.2017-13287.

Daly, T, Jiwan, MA, O'Brien, NM, Aherne, SA 2010, Carotenoid content of commonly consumed herbs and assessment of their bio-accessibility using an in vitro digestion model. *Plant Foods for Human Nutrition*, 65(2):164-169, https://doi.org/10.1007/s11130-010-0167-3.

Goetsch, AL 2019, Recent advances in the feeding and nutrition of dairy goats. *Asian-Australasian Journal of Animal Sciences*, 32(8): 1296-1305, https://doi.org/10.5713/ajas.19.0255.

Golovin, AV, Anikin, AS, Pervov, NG, Nekrasov, RV, Strekozov, NI, Duborezov, VM, Chabaev, MG, Fomichev, YP, Gusev, IV 2016, Recommendations on detailed feeding of dairy cattle: A reference manual. L.K. Ernst Federal Research Center for Animal Husbandry: Moscow, Russia.

GOST R 2008, Natural Cow's Milk: Raw Materials. Technical Conditions (52054-2003), Introduction, 22.05.2003, Moscow: Standard Form, Russia.

Heydari, P, Yavari, M, Adibi, P *et al.* 2019, Medicinal properties and active constituents of Dracocephalum kotschyi_ and its significance in Iran: a systematic review. *Evidence-Based Complementary and Alternative Medicine*, article 9465309:1-14. https://doi.org/10.1155/2019/9465309.

ISO 27085 2009, Animal feeding stuffs-determination of calcium, sodium, phosphorus, magnesium, potassium, iron, zinc, copper, manganese, cobalt, molybdenum, arsenic, lead and cadmium by ICP-AES. International Organization for Standardization: Geneva, Switzerland.

Kazempour, MS, Shahangian, S & Sariri, R 2024, *Dracocephalum kotschyi*: Inhibition of critical enzyme relevant to type-2 diabetes, essential oil composition, bactericidal and anti-oxidant activity. *Caspian Journal of Environmental Sciences*, 22(2): 289-303. https://doi.org/ 10.22124/CJES.2023.6256.

Pinotti, L, Mazzoleni, S, Moradei, A, Lin, P & Luciano, A 2023, Effects of alternative feed ingredients on red meat quality: a review of algae, insects, agro-industrial by-products and former food products. *Italian Journal of Animal Science*, 22(1): 695-710, https://doi.org/10.1080/1828051X.2022.2039562.

Mayulu, H, Fauziah, N, Christiyanto, M, Sunarso, S, Haris, MI 2019, Digestibility Value and Fermentation Level of Local Feed-Based Ration for Sheep. *Animal Production*, 20: 95-102, DOI: http://dx.doi.org/10.20884/1.jap.2018.20.2.706.

OAC. Official Methods of Analysis 1994, 16th ed. Arlington, VA: Association of Official Analytical Chemists.

ISO 27085 2009, Animal feeding stuffs—Determination of calcium, sodium, phosphorus, magnesium, potassium, iron, zinc, copper, manganese, cobalt, molybdenum, arsenic, lead and cadmium by ICP-AES. International Organization for Standardization: Geneva, Switzerland.

Morand-Fehr, P 2005, Recent developments in goat nutrition and application: A review, *Small Ruminant Research*, 60(1–2): 25-43, DOI: https://doi.org/10.1016/j.smallrumres. 2005.06.004

Pandey, S, Kim, ES, Cho, JH, Song, M, Doo, H, Kim, S, Keum, GB, Kwak, J, Ryu, S, Choi, Y, Kang, J, Choe, J, Kim, HB 2023, Cutting-edge knowledge on the roles of phytobiotics and their proposed modes of action in swine, *Frontiers Veterinary Science*, 20(10) https://doi.org/10.3389/fvets.2023.1265689.

Puthusseri, B, Divya, P, Lokesh, V, Neelwarne, B 2013, Salicylic acid-induced elicitation of folates in coriander (*Coriandrum sativum* L.) improves bio-accessibility and reduces pro-oxidant status, *Food Chemistry*, 136(2): 569-575, https://doi.org/10.1016/j.foodchem.2012.09.005.

Rakita, S, Kokić, B, Manoni, M, Mazzoleni, S, Lin, P, Luciano, A, Ottoboni, M, Cheli, F, Pinotti, L 2023, Cold-pressed oilseed cakes as alternative and sustainable feed ingredients: A review, *Foods*, 12(3): 432. https://doi.org/10.3390/foods12030432.

Rao, M, Bast, A, de Boer, A 2021, Valorized food processing by-products in the EU: Finding the balance between safety, nutrition, and sustainability. *Sustainability*, 13(8): 4428. ,https://doi.org/10.3390/ su13084428.

Romero-Huelva, M, Ramírez-Fenosa, MA, Planelles-González, R, García-Casado, P, Molina-Alcaide, E 2017, Can by-products replace conventional ingredients in concentrate of dairy goat diet?, *Journal of Dairy Science*, 100: 4500-4512, https://doi.org/10.3168/jds.2016-11766.

Smeti, S, Jo, M, Hajji, H, Alabart, JL, Muñoz, F, Mahouachi, M, Atti, N 2015, Effects of *Rosmarinus officinalis* L. essential oils supplementation on digestion, colostrum production of dairy ewes and lamb mortality and growth, *Animal Science Journal*, 86(7): 679-88, https://doi.org/10.1111/asj.12352.

Trukhachev, VI, Oleinik, SA, Zlydnev, NZ, Morozov, VYu, 2015, Adaptation of the recommendations of the International Committee for Animal Recording (ICAR) in evaluating the quality of milk. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*,6(6):1317-1320.

Trukhachev, VI, Chmykhalo, VK, Belanova, AA *et al.* 2021, Probiotic biomarkers and models upside down: From humans to animals. *Veterinary Microbiology*, 261: 109156-109156 https://doi.org/10.1016/j.vetmic. 2021.109156.

Bibliographic information of this paper for citing:

Trukhachev, VI, Buryakov, NP, Ksenofontova, AA, Ksenofontov, DA, Kosolapova, VG, Zaikina, AS 2025, Coriander cake as a functional component in the diets of lactating goats. Caspian Journal of Environmental Sciences, 23: 991-999.