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Milk Content and Milk Quality of Sheep of the Kazakh Fat-Tailed Semi-Rough-Haired Breed with Pasture Content

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Abstract: The article presents the results of a study on the effect of top dressing and feed additives based on humic substances on milk productivity, the quality of milk of sheep of the Kazakh fat-tailed semi-coarse breed, and the resulting cheese in pasture conditions. In total, 90 heads of sheep of the Kazakh short-tailed semi-rough-haired breed were used in the experiment. The Control Group (CG) of 30 sheep grazed on pasture grass, while two Experimental Groups (EG) of 60 heads were fed 300 g barley per day of barley, The second experimental group of sheep received a feed additive based on humic substances. As a result, after the first month of feeding, additional feeding had a positive effect on the daily milk yield of ewes, where the experimental group II was statistically significantly superior ($P<0.05$), i.e., it exceeded by 0.08 liters. In total, during lactation, the sheep of the second experimental group exceeded the control group by an average of 10.8% in average daily milk yield. Also, additional feeding affected the quality of milk and cheese, Thus, the indicators of sheep of the II experimental group were superior in terms of the fat content of milk ($P<0.01$) and cheese ($P<0.05$).

Keywords: Sheep, Kazakh Fat-Tailed Semi-Wool Breed of Sheep, Lactation, Feed Additive, Sheep's Milk, Cheese

Introduction

Fat-tailed sheep of the meat-bearing direction of productivity occupies an important place in sheep breeding in Kazakhstan, the share of which currently accounts for more than 70% of the total number of sheep in the republic. Their breeding has long been predetermined by climatic and economic conditions as well as the national traditions of the indigenous population (Smagulov *et al*., 2014). They are characterized by high precocity and adaptability to specific local, often extreme environmental conditions in certain regions. Currently, in Kazakhstan, all research work on sheep breeding aims at producing young mutton and wool. However, for most farms, the production of commercial sheep milk can also become the second or third source of profit in the total annual income (Rubino *et al*., 1999). Sheep's milk is a highly nutritious food product. The nutritional value of sheep's milk for human health, its characteristics, and its role in some people have been widely studied (Boyazoglu and Morand-Fehr, 2001; Flis and Molik, 2021; Balthazar *et al*., 2017). In Kazakhstan, sheep's milk is practically not produced in industrial volumes, though the local population in various regions of the country uses sheep's milk in the form of a drink, or uses it to prepare "kurt" - the national fermented milk product of long-term storage (Ibraev *et al*., 2021).

The composition of macro- and micro-elements of sheep's milk and cheese depends on the main factors of breeding and production technology: Genotype, reproduction, agro-climatic conditions, and farming methods such as feeding and milking (Morand-Fehr *et al*., 2007). Feeding sheep significantly affects both milk yield and milk composition (Never, 2015; Bencini and Pulina, 1997). In the world, most dairy sheep during lactation graze on pastures with additional concentrated top dressing. Therefore, in addition to numerous factors that affect milk productivity, the study of sheep feeding with pasture content is very relevant, as it concerns the composition of milk. Gilbert points out in his practical recommendation regarding the nutritional needs of dairy sheep and recommends that the amount of energy and protein in the diet is sufficient for its content in milk (Gilbert, 1992). Under-feeding in sheep during early lactation disrupts milk secretion (Maxwell *et al*., 1979).

During lactation, a sufficient amount of protein in the late stages of pregnancy of sheep affects the quantity and quality of milk produced. Also, according to Hoon (2010), the intake of a large amount of protein that is not digested in the rumen is important for increasing the colostrum and dairy productivity of sheep. According to some authors, at the end of the lactation period, a decrease in the lactation curve is associated with a hormone-directed decrease in the capacity of the sheep breast. It is proven that feeding has a negligible effect (Kennelly and Glimm, 1998). In countries with insufficient feed resources, some authors recommend humic acid as feed additives to modulate the fermentation process of the rumen and increase the efficiency of the use of nutrients as well as to increase the quantity and quality of milk of small ruminants (El-Zaiat *et al*., 2018). Humic Acid (HA) is the final product of the biodegradation processes of organic soil substances used as a growth stimulant (Galip *et al*., 2010).

In this study, the aim is to study the effect of top dressing and feed additives based on humic substances on milk productivity and the composition of milk of sheep of the Kazakh fat-tailed semi-coarse breed with pasture content. The results of this study are the basis for the development of technology for the production of sheep milk obtained from sheep of the Kazakh short-tailed semi-wool breed in the conditions of the Karaganda region. The results of the research presented in this study were carried out within the framework of grant financing of the program of the Ministry of Education and Science of the Republic of Kazakhstan within the framework of the project AR08052570 "Development of technology for the production and processing of sheep's milk".

Materials and Methods

The sheep of the Kazakh short-tailed semi-wool breed bred on the farm of Otkanzhar LLP (49°54'47.5"N 70°56'44.9"E) of the Nurinsky district of Karaganda region were the object of scientific research. The territory of the farm is located in a semi-desert zone bordering on the northern side with dry steppe, and on the southern with desert zones. The climate of these zones is sharply continental with harsh winters, hot summers, and low rainfall. The annual precipitation is in the range of 150-250 mm. The average temperature in January is minus 15-20°C, plus 19-22°C in July. The duration of the warm frost-free period is, on average, 110-150 days with slight deviations. The average duration of a stable snow cover is 115-150 days.

The Kazakh short-tailed semi-coarse wool (KGP) is the first domestic breed of short-tailed sheep having semi-coarse wool. The breed was created by the method of the complex reproductive crossing of Kazakh short-tailed rough-haired sheep with rams of the Edilbay, Saradzhinsky, Tajik and Degrees breeds and subsequent breeding of the desired type "in itself". The animals are distinguished by a strong constitution, well-developed bones, and quite satisfactory meat-sucking body shapes. Sheep are gnarled and sheep meet with the rudiments of horns. The live weight of rams is 90-100 kg and queens 58-64 kg. The live weight of the rams for the chop at the age of 4 months is 33-37 kg and the eggs have 32-35 kg (Zhumadilla, 2015; Zhumadillaev *et al*., 2020).

The farm has a stable-pasture sheep-keeping system, which includes the use of pasture grasses available during the growing season for 7 months and in the rest of the winter season, the sheep are fed meadow, wheat-grain hay (November-March), and concentrated feed. The territory of the farm is located between the steppe and semi-desert zones and is characterized by a complex vegetation cover. On light sandy loam soils developed in extensive river areas, sagebrush-tipchak-kovyl steppes with the participation of various types of grass are formed. On light chestnut loamy soils, tipchak (Festuca valesica), Austrian wormwood (Artemisia austriaca), Lessing's feather grass (Stipales singiana), creeping wheatgrass (Elytrigia repens), field wormwood (Artemisia campestris) mainly prevails. Black wormwood (Artemisia pauciflora), kokpek (Atriplex cana), and shrubby kermek (Limonium fruticans, Plumbaginaceae) dominate on the salt flats. The productivity of these pastures is low, within 1.5-3.5 kg/ha of dry weight. In spring and early summer, cereals are readily eaten by sheep from pasture grass, and in autumn – solyanka and wormwood, are represented, in turn, by various types of wormwood and kokpek.

The main waterway of the territories is the Kulan Otpes River, which belongs to the category of snow and snow-ground feeding rivers. Artesian wells drilled for watering pastures are also used for watering sheep.

Our experiment was conducted in 2021 from April to August, where the lambs were with their mothers up to four months of age, i.e., the lactation period lasted 120 days. To conduct the study, three experimental groups of sheep of the III lactation of four years of age were formed. Two experimental groups of queens were fed (60 heads), including feed additives "Al Karal" whereas one group did not receive fertilizing (30 heads). In total, 90 heads of sheep were used in the experiment. All the sheep were in the pasture from 6:00 am to 8:00 pm The Control Group (CG) ate pasture grass without restrictions, while the I and II Experimental Groups (EG) ate pasture grass without restrictions and then the first group of sheep received 300 g of barley a day for 1 head and the second experimental group also received 300 g of barley a day for 1 head barley + 20 mL "Al Karal" (Table 1). The composition of the additive "Al Karal" includes organic components in a balanced proportion of humic acid salts. The proportion of humic acids from the total content of humic substances is 36.5%, the proportion of fulvic acids from the total content of humic substances is 63.5%, amino acids, peptides, polysaccharides, macro and micro-elements (selenium, copper, zinc, etc.) enzymes, proteins, vitamins, and probiotic Bacillus Subtilis. Experimental animals had access to water twice a day, in the morning and the evening.

Table 1: Scheme of setting up the experience of the control and experimental groups of ewes of the KGP

Groups of sheep	Number of heads	Types of feed
Control group	30	Pasture grass
I experimental group	30	Pasture grass + barley grass 300 g/head
II experimental group	30	Pasture grass + barley grass 300 g/head+

The accounting of the milk of ewes began 10 days after the lambing of ewes and continued until the launch. Milk accounting was carried out as follows: Lambs were separated from their mothers at midnight h before receiving the morning control milk yield. After that, the lambs were returned to their mothers for 24 h. Then, they separated from the queens again 12 h before the evening control milk yield. All groups of sheep were subjected to machine milking. In total, 12 control milk yields were carried out, where individual milk samples of 100 mL were obtained from each sheep for laboratory studies (protein, fat, lactose, SOMO (skimmed milk residue), density, and several somatic cells). Milk sampling was carried out per the requirements of ST RK ISO 707-2011 (2011, ISO 707:2008, IDT) Milk and dairy products. Sampling Guide (ST RK ISO, 707-2011). Studies of the chemical composition of milk were carried out in the certified testing laboratory of Nutritest LLP (Almaty) and the laboratory of the Department of Technology of Food and Processing Industries of the Kazakh Agrotechnical University named after S. Seifullin (Nur-Sultan). The ultrasonic analyzer ECOMILK-Bond (Bulgaria BULTEH 2000 LT*) was used in the laboratory of the department. The number of Somatic Cells (SCC) was determined using the Fossomatic 5000 device (Foss Electric, Hillerode, Denmark). Based on the accounting, the following indicators were established:

- Daily milk yield of sheep, in liters
- The total amount of milk per lactation, in liters
- The amount of milk consumed by lambs, in liters
- The duration of the suction period, in days
- Duration of lactation, in days

The effect of feeding with top dressing and feed additive was also studied on cheese samples obtained from bulk milk samples collected from three groups at the beginning (June 14, 2021) and at the end of the experimental period (August 13, 2021).

Both at the beginning and the end of the experiment, the cheeses were prepared with the same technology. The method of preparation of sheep cheese included the thermization of sheep's milk at 60-62°C, then it was kept for 5-6 min and cooled to a temperature of 35°C, a dry homofermentative starter and an enzyme preparation "Meito" ("Microbial Meito Rennet", 1 g, Meito Sangyo, Japan) were introduced into the cooled milk, the mass was precipitated the clot was separated from the whey, then the cheese mass was mixed until evenly distributed. Starter cultures and enzyme preparations were introduced into pasteurized sheep's milk. Then, they cooled to the fermentation temperature. In the finished clot, the titrated acidity reached up to 115°T at a pH of 4.3.

The analysis of dairy raw materials and finished products, including cheese, was carried out by the following standard methods:

- Sampling methods and their preparation for analysis were carried out according to GOST 13928-84
- The acidity was determined by titrimetric methods according to GOST 3624-92
- Fat determination was carried out by the methods specified in GOST 5867-90
- Determination of milk density was carried out according to GOST R54758-2011
- According to GOST 23327-98, the Kjeldahl method determined the mass fraction of the total amount of protein (GOST 3624, 1992; GOST 5867, 1990; GOST 54758. 2011, GOST 25179, 2014; GOST 23327, 1998; Tokysheva *et al*., 2022)

Tests on sheep's milk cheese were carried out in the research laboratory for assessing the quality and safety of food products at the Almaty Technological University (Almaty).

All the obtained results were statistically analyzed. The percentage of relative standard deviation was determined for each analysis to assess the accuracy of the data obtained. The statistical significance of the differences between the groups in the quantity and quality of milk was analyzed using the IBM SPSS Statistics 22 software product.

Results and Discussion

The milk content of the queens was determined based on a control milking, which was carried out every ten days. Lambs with uteruses during the suckling (lactation) period (120 days) were constantly in the general group and were separated from their mothers only on the days of registration. The analysis of the milk content of sheep of the Kazakh short-tailed semi-rough-haired breed showed that for four months of the lactation period they had satisfactory milk content (Fig. 1).

The lactation stage is very important for obtaining high-quality milk so, at the beginning and the end of lactation, low-quality milk is produced compared to the middle lactation period. The nutritional status and health of dairy sheep should be appropriate for the production of high-quality milk. All these factors are crucial for the quality of sheep's milk, which directly affects the quality and quantity of products produced (Ali *et al*., 2020).

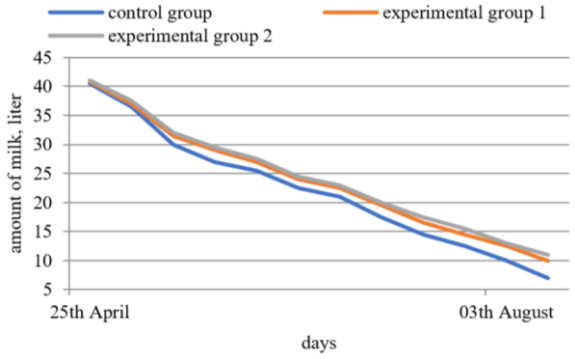

Fig. 1: The distribution of the amount of milk during lactation, n = 30

The amount of milk in all experimental queens in the first month of lactation is quite stable, starting from the second month of lactation there is a gradual decline in the experimental group of ewes and a relatively sharp decline in the control group of ewes. The daily milk yield in the first month of lactation of the control group of ewes was 1.16 liters in the experimental group I and II, respectively: 1.18 and 1.20 liters, thus there were no significant differences at the beginning of the experiment with feed dressing (Table 2). Starting from the second month of lactation, the daily milk yield of ewes of the I and II experimental groups exceeded the control group, respectively, by 0.05 and 0.08 liters, including the II experimental group, significantly exceeded ($P<0.05$), i.e., exceeded by 0.08 liters.

At the end of the experiment, in the 4th month of lactation, the average daily milk yield of the control group of ewes was 0.32 liters, and in the ewes of the I and II experimental groups, 0.41 and 0.43 liters, respectively. The indicators of the experimental groups of sheep were higher than the control group by 0.09 ($P<0.05$) and 0.11 ($P<0.01$) liters or higher by 28.1 and 34.3%. In general, we have found that feed additives can positively affect milk yield. Thus, the sheep in the experimental group showed a less pronounced decrease in milk production than the animals in the control group, similar studies are given in scientific research by Caprioli *et al*. (2020) and Scocco *et al*. (2018). According to the research of Min *et al*. (2005), the increased level of concentrate additives led to an increase in milk yields by 22%. Thus, in the present experiment, the introduction of a feed additive based on humic substances increased the daily milk yield of sheep by an average of 10.8%.

In addition to the amount of milk received, it is also necessary to pay attention to its quality. The qualitative composition of the milk of sheep of the Kazakh fat-tailed semi-coarse breed also changes during lactation. The chemical composition and content of somatic cells were evaluated on milk samples taken from 30 ewes of the control and experimental groups in the middle of each month (Table 3). To determine the physical properties of milk, samples were taken in the first and fourth months of lactation (Table 4). The experimental sheep remained unchanged during different sampling days.

At the beginning of the study (May 15, 2021), in the analyzed milk samples of the control group of sheep, the fat content was 7.10%, protein 4.46%, lactose 4.24%, and in the I and II experimental groups, respectively, the fat content was 7.36 and 7.12%, protein 4.84 and 4.62% and lactose 4.36 and 4.26%. At the end of the study (August 13, 2021), these indicators tended to be higher in the milk of the experimental groups (8.59 and 9.05; 6.06 and 6.28; 4.44 and 4.48%, respectively) than in the milk of the control group (7.64, 5.42 and 4.23%). The difference was statistically significant for the second experimental group in terms of fat and protein, where a feed additive based on humic substances was also added with top dressing ($P < 0.05$). Wang *et al*. (2008) found that the addition of humic acid improves the intestinal health of animals, nutrient absorption, and nutritional status. In general, studies with the addition of concentrates are consistent with the data of Morand-Fehr *et al*. (2007), where it is reported that usually the fat content in both cow's and sheep's milk is less dependent on the type of farming system and more dependent on the diet of animals, in particular, pasture grasses supplemented with a high content of concentrates. In the literature of Min *et al*. (2005), it is indicated that the protein content in milk is more stable than the fat content. According to the literary data of Rimikhanov, the percentage of fat in the milk of Romanov breed queens is subject to significant fluctuations and depends both on feeding and maintenance and on genealogical diversity (Rimikhanov *et al*.,2006).

The average milk density in the control group at the beginning of the experiment is 1.0364 g/cm3 and in the experimental groups I and II, respectively, is 1.0373 and 1.0378 g/cm^3. The milk density of all experimental ewes decreases slightly by the end of lactation and is in the range of 1.0347 – 1.0355g/cm^3. Similar decreases in milk density at the end of lactation are also reported in the studies of Kostylev *et al.* (2015). The acidity level of milk, both at the beginning and at the end of the experiment, remained in the range of 22.3 - 23.6 °T. The pH level in milk was in the range of 6.50 – 6.63, which also meets the requirements of the norms.

The effect of top dressing and feed additive "Al Karal" were also obtained by the physico-chemical parameters of cheese. Cream cheese samples obtained from the milk of the control and experimental groups of ewes studied at the beginning of the study (June 14, 2021) showed a fat content of 19.87% and protein of 16.29% in the control group of ewes and amounted to 20.05 and 20.39% fat content and 17.02 and 16.35% protein content in the experimental group I and II, respectively%. At the end of the study (August 13, 2021), the mass fraction of fat, as a

rule, was higher in the samples of cream cheese from sheep milk of ewes of experimental groups, where the fat content was 22.80 and 24.76, respectively than in the samples of cheese of the control group of 21.50%, but the difference was statistically significant for the II experimental group of ewes (P <0.05) (Table 5). The data obtained are consistent with the studies of Caprioli *et al*. (2020); Addis *et al*. (2015), who reported that the percentage of fat in sheep cream cheese tends to increase during the summer season.

According to Table 5, in general, the research results show that the production of cream cheeses from sheep milk of the Kazakh fat-tailed semi-coarse breed is promising and expedient. Therefore, the novelty of the proposed technology will be based on the production of dairy products, from the natural milk of sheep.

Table 2: The daily average milk yield of sheep with pasture content, l

	Daily milk yield		
Group of sheep n = 30	Morning milk yield	Evening milk yield	Average yield
1-month lactation			
Control group	0,52±0,06	0,66±0,04	1,18±0,08
Experimental group 1	0,53±0,05	0,68±0,03	1,21±0,07^{ns}
Experimental group 2	0,54±0,03	0,68±0,05	1,22±0,08^{ns}
2-month lactation			
Control group	0,35±0,04	0,48±0,02	0,83±0,03
Experimental group 1	0,38±0,02	0,50±0,01	0,88±0,02^{ns}
Experimental group 2	0,40±0,03	0,51±0,03	0,91±0,02*
3-month lactation			
Control group	0,23±0,03	0,35±0,04	0,58±0,02
Experimental group 1	0,28±0,02	0,37±0,04	0,65±0,02*
Experimental group 2	0,30±0,03	0,37±0,03	0,67±0,04*
4-month lactation			
Control group	0,14±0,02	0,18±0,01	0,32±0,02
Experimental group 1	0,18±0,02	0,23±0,01	0,41±0,03*
Experimental group 2	0,18±0,02	0,25±0,02	0,43±0,03**

ns – P>0.05; * - P<0.05; ** - P<0.01

Table 3: Chemical composition (fat, protein, and lactose data expressed in %) and somatic cell content (data expressed in n in mlx 000) of sheep's milk

	15 May			14 June			14 July			13 August		
Indicators	CG, n = 30	I EG, n = 30	II EG, n = 30	CG, n = 30	I EG, n = 30	II EG, n = 30	CG, n = 30	I EG, n = 30	II EG, n = 30	CG, n = 30	I EG, n = 30	II EG, n = 30
Fat	7,10±0,16	7,36±0,17	7,12±0,23^{ns}	7,2±0,11	7,53±0,10	8,19±0,14	7,44±0,22	8,18±0,18	9,15±0,21	7,64±0,13	8,59±0,20	9,05±0,11**
Protein	4,46±0,15	4,84±0,18	4,62±0,16^{ns}	5,43±0,20	5,58±0,16	5,89±0,22	5,21±0,18	5,72±0,22	5,90±0,27	5,42±0,24	6,06±0,18	6,28±0,23*
Lactose	4,24±0,08	4,36±0,11	4,26±0,13	4,54±0,14	4,28±0,08	4,30±0,12	4,20±0,11	4,37±0,08	4,54±0,12	4,23±0,10	4,44±0,11	4,58±0,09^{ns}
Dry skimmed milk residue	10,15±0,19	11,08±0,15	11,54±0,18	10,42±0,11	10,68±0,13	11,20±0,15	10,26±0,10	10,71±0,19	11,22±0,08	11,04±0,16	11,86±0,20	11,37±0,12
Number of somatic cells	516	505	536	452	428	395	415	320	341	341	296	305

ns – P>0.05; * - P<0.05; ** - P<0.01

Table 4: Some physical properties of sheep's milk

	15 may			13 august		
Indicators	CG, n = 30	I EG, n = 30	II EG, n = 30	CG, n = 30	I EG, n = 30	II EG, n = 30
Specific gravity (density), g/cm3	1,0364	1,0373	1,0378	1,0347	1,0351	1,0355
Acidity, °T	22,3	22,8	23,2	22,5	23,4	23,6
pH	6,55	6,56	6,52	6,50	6,63	6,62

Table 5: Physical and chemical parameters of sheep cheese

	14 June			13 August		
Name of indicators, units of measurement	CG, n = 6	I EG, n = 6	II EG, n = 6	CG, n = 6	I EG, n = 6	II EG, n = 6
Acidity, °T	94	92	93	93	94	94
Mass fraction of moisture, %	58,85±0,63	55,65±0,84	56,78±0,72	56,18±1,91	54,28±1,60	53,85±1,67
Mass fraction of protein, %	16,29±1,40	17,02±1,28	16,35±0,56	15,11±1,37	15,35±1,31	15,92±1,18
Mass fraction of fat, %	19,87±1,12	20,05±1,60	20,39±1,05	21,50±1,22	22,80±1,59^{ns}	24,76±0,83*
Salt content, %	1,6±0,05	1,7±0,08	1,6±0,05	1,5±0,09	1,6±0,09	1,7±0,11

Conclusion

Based on the obtained results of this study, the effect of top dressing and feed additives on the quantity and quality of milk and cheese from sheep grazing on dry pastures of central Kazakhstan with low yields was established. The analysis of milk samples taken from experimental sheep of Otkanzhar LLP shows that the content of the main components of milk is within the physiological norm. The introduction of a feed additive based on humic substances improved daily milk yield, the quality of sheep milk, and the resulting cream cheese. At the same time, it was found that the reaction to humic substances as a natural additive may depend on the dose. However, further research is needed on the growth and development rate of lambs without any adverse effects on sheep health. In general, the use of feed additives as an improver of the quantity and quality of milk is quite justified, since in the first month of lactation of sheep there is a positive effect, that is, a significant difference.

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Author's Contributions

Dulat Ibrayev: Conceived and planned the study. Revised the manuscript.

Saukymbek Shauyenov: Conceived and planned the study.

Gulmira Zhakupova and Narzhan Zhumadillayev: Conducted lab work and drafted the manuscript.

Aknur Muldasheva: Did statistical analysis of data.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and there are no ethical issues involved.

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