

INFLUENCE OF FOOD SUPPLEMENTS ON CHEMICAL COMPOSITION OF RAW SHEEP'S MILK

ORIGINAL SCIENTIFIC ARTICLE

Aida Džaferović¹✉, Huska Jukić², Samira Dedić¹ DOI: 10.51558/2232-7568.2025.18.1-2.11RECEIVED
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2025-08-25¹ Biotechnical faculty, University of Bihać² Faculty of Health Studies, University of Bihaću

✉ aida.btf@gmail.com

ABSTRACT:

The aim of this study was to examine the effect of plant-based fat sources in sheep feed on the chemical composition of raw sheep milk from 210 Pramenka sheep in the Una-Sana Canton area. The research was conducted during three periods: winter, spring, and summer. The flock was divided into experimental and control groups. In each research period, the experimental groups received plant-based fat sources, specifically 3.5% extruded flaxseed added to their diet. The highest milk fat content was recorded during the summer period in the control group (7.66%). The average milk fat content in winter (6.06%) and summer (7.66%) showed higher values in the control group compared to the experimental group, with statistically highly significant differences ($p < 0.001$). In the spring period, the milk fat content was higher in the experimental group (5.31%), also with a statistically highly significant difference ($p < 0.001$). For lactose and dry matter parameters, the dietary period factor showed a highly significant statistical effect ($p < 0.001$). The treatment factor for lactose also showed a highly significant statistical effect ($p < 0.001$), as did the interaction between factors, while no statistical significance was observed for dry matter.

KEYWORDS: sheep milk, chemical analysis, period, nutritional treatment

INTRODUCTION

Sheep milk production is seasonal. Seasonal changes in milk composition are associated with the stage of lactation. Under extensive conditions, milk is produced in spring and summer, while under intensive production, milk can be produced year-round [7]. Sheep milk is white, opaque, pleasant-tasting, and odorless if milking conditions are good; however, it quickly absorbs odors from its surroundings. Sheep milk contains approximately 50% more dry matter than cow's milk due to its higher fat and protein content. The ratio of individual components differs from that of cow's milk, with a higher proportion of fat followed by protein. Due to its higher dry matter content, especially fats and proteins, sheep milk is particularly suitable for cheese production, yielding twice as much cheese as cow's milk. The average composition of sheep milk depends on breed, feeding practices, climatic conditions, and housing methods but is most influenced by the lactation period. The fat in sheep milk slightly differs in composition, physical properties, and degree of dispersion compared to cow's milk fat [9]. Sheep milk fat contains higher amounts of caprylic and capric acids, giving it a characteristic taste and smell. The proteins in sheep milk have the same composition as those in cow's

milk, but the total protein content is higher. During lactation, the proportion of casein in total proteins increases, while the proportion of whey proteins decreases. The lactose (milk sugar) content in sheep milk is the same as in cow milk. Sheep milk contains more vitamins than cow milk. Around 80% of the beta-carotene (provitamin A) in sheep milk is transformed into vitamin A, giving it a white color [7]. It contains two to four times more vitamin C than cow milk. The acidity of sheep milk ranges between 7 and 9.5 °SH. The higher titratable acidity is due to the greater content of casein and salts with buffering effects. The highest acidity occurs at the end of lactation due to the increased casein content. The pH value ranges between 6.64 and 6.73. Sheep milk has a higher density than cow milk, ranging from 1.034 to 1.036. Sheep milk has a much higher energy value than other types of milk due to its significantly higher protein and fat content [17]. Due to its high dry matter content, sheep milk is almost exclusively used for cheese production [3]. Small amounts of yogurt made from sheep milk are produced in Greece, while fresh sheep milk is rarely consumed [16].

MATERIALS AND METHODS

The research was conducted on Pramenka sheep flocks in the Una-Sana Canton area. During all three research periods winter, spring, and summer (each period involving 70 sheep) groups were formed consisting of 35 experimental and 35 control sheep, housed under identical conditions and marked with corresponding ear tags for milk sampling purposes. In addition to their regular diet, the sheep were given concentrate mixtures in a daily amount of 300 g per head. The experimental group (Eg) received a concentrate mixture supplemented with plant-based fat sources (dietary treatment). The control group (Cg) was given a concentrate mixture without plant-based fat sources in addition to their regular meal (dietary treatment). The concentrate mixtures used for this purpose were prepared according to a specified formula at the "JATA EMONA" livestock feed industry in Ljubljana, Slovenia. The chemical composition of the concentrate mixtures is shown in Table 1.

Table 1. Chemical Composition of Concentrate Mixtures Added to the Experimental and Control Groups of Sheep

Component	Feed with the Addition of Plant-Based Fat Sources	Feed without Omega Additions from Plant-Based Fat Sources
Dry matter %	88,9	88,9
Water %	11,1	11,1
Crude proteins %	15,7	14,8
Crude fiber	7,4	7,3
Crude fat %	3,4	1,5
Ash %	8,6	11,5
Omega-3 fatty acid groups	26,4	3,9

Analyses of raw sheep milk were conducted using the "MilkoScan™ FT 120" (Foss, Denmark). The "MilkoScan™ FT 120" is an instrument for determining the chemical composition of milk using the infrared spectroscopy method ([12], [13]). This generation of spectroscopic devices for milk analysis employs Fourier transform infrared (FTIR) spectroscopy, enabling measurements across the entire infrared spectrum and the determination of numerous parameters, including fat, protein, lactose, dry matter, fat-free dry matter, freezing point, and density. The research results were processed using appropriate mathematical and statistical tests. Descriptive statistics were presented in tables. Analysis of variance (ANOVA) was used to examine the effects of factors (period and treatment) on the observed properties. Tukey's post-hoc test was applied to identify differences between modalities. Correlation values were expressed using Pearson's coefficient (r-value), while the significance level between the chemical parameters of raw sheep milk was determined by the p-value. All statistical analyses in this study were conducted using the R software v.3.2.1 (R Development Core Team, 2015).

RESULTS AND DISCUSSION

During the experimental research and statistical processing of data from all sampling periods by phases, the significance of differences in milk samples at the end of each research period was established. Analysis of variance (ANOVA) determined the impact of factors (two factors: research period and dietary treatment) on the examined parameters. The results of the analysis are presented in Table 2.

Table 2. Results of statistical analysis of chemical parameters of raw sheep's milk sample.

Milk parameters		Winter ¹	Spring ²	Summer ³	Significance level (<i>p</i>)		
					period	treatm ent	interaction
Milk fat	Eg	5,69	5,31	5,22	*** 3 > 1 > 2	***	***
	Kg	6,06	4,49	7,66			
Proteins	Eg	5,51	5,10	5,13	ns	ns	ns
	Kg	5,93	4,65	6,05			
Lactose	Eg	4,66	4,63	4,66	*** 2 > 3 > 1	***	***
	Kg	3,69	4,72	4,19			
Dry matter	Eg	16,60	16,00	16,60	*** 3, 1 > 2	ns	**
	Kg	16,36	14,06	17,35			
Fat-free dry matter	Eg	10,96	10,76	10,96	* 3 > 1 > 2	ns	ns
	Kg	10,36	10,46	11,35			
Density	Eg	1,035	1,035	1,035	* 2 > 1, 2	**	*
	Kg	1,029	1,036	1,029			
Freezing point	Eg	0,68	0,66	0,68	ns	***	ns
	Kg	0,63	0,62	0,63			

p – Level of significance: **p*<0,05; ***p*<0,01; *** *p*<0,001; ns – no statistical significance

Es – Experimental group

Ks – Control group

1, 2, 3 – Research periods: 1(winter); 2 - (spring); 3 -(summer)

The analysis of variance established a statistically highly significant effect of the first experimental factor (research period) on sheep milk fat, with a very high level of significance ($p < 0.001$), showing greater significance in the summer period compared to winter and spring. The dietary treatment factor also demonstrated a very high level of significance ($p < 0.001$) on milk fat. Additionally, a statistically highly significant interaction effect of the factors on this parameter was determined, with a significance level of 99.9% ($p < 0.001$). In the first research period (winter), milk fat showed a higher value in the control group (6.06%) compared to the experimental group (5.69%). In the third research period (summer), milk fat was lower (5.22%) in the experimental group (with added plant-based fat sources) and significantly higher in the control group of sheep (7.66%). According to the study by Grubić et al. (2005a), a higher amount of unsaturated fatty acids in the diet can have a depressive effect on the total milk fat content. Baumgard et al. (2002) reported that the effect of unsaturated fatty acids on reducing milk fat percentage becomes evident as early as 24 hours after the first intake of unsaturated fatty acids added to the diet. There are numerous trans isomers of mono- or polyunsaturated fatty acids present in food, which result from bacterial biotransformation of unsaturated fatty acids in the rumen of ruminants.

Trans fatty acids naturally occur most abundantly in the fats and milk of ruminants [9]. Specific intermediate fatty acid isomers produced by microbial

activity in the rumen (trans-10 C18:1 and trans-10, cis-12 CLA) are strong inhibitors of milk fat synthesis. A strong correlation has been established between the decrease in milk fat percentage and the proportion of trans-10, cis-12 CLA in animals fed high-concentrate or diets with a higher proportion of vegetable oils [5]. Their potency is evident from the fact that an increase of just 3–4 g of trans-10, cis-12 can reduce milk fat production by 25% [6]. During the spring period, milk fat values were higher in the experimental group (5.31%) than in the control group of sheep (4.49%). Gomez et al. (2009) conducted studies in which they added extruded flaxseed to sheep feed and observed lower milk fat values in the experimental flock (6.10%) compared to the control (6.51%), which aligns with our results. In the studies conducted by Addis et al. (2005), where different types of medicinal herbs were added to sheep diets during the winter period, the obtained milk fat values were 5.17%, 5.97%, and 5.49%, which align with our findings for that period. The same authors conducted research in the spring and reported milk fat values of 5.96%, 6.02%, and 5.71%, which are slightly higher than our results. In their studies, Kholif et al. (2012) added flaxseed oil to goat feed and recorded milk fat values of 3.96% in control samples and 4.27% in experimental samples, while protein content was 3.16% in control milk samples and 3.32% in experimental samples. In both cases, these values were lower than our results in any research period. The lactose values reported by these authors were

consistent with our findings, with control samples at 4.65% and experimental samples at 4.84%. However, the dry matter values reported 12.8% for control and 13.6% for experimental samples did not align with our research results. For protein, no statistical significance (ns) was established for any of the examined factors or their interactions, which aligns with the findings of Gomez et al. (2009), who observed no significant changes in milk protein (5.38%; 5.36%) when extruded flaxseed was added to sheep feed. Regarding lactose and dry matter parameters, the research period factor showed a highly significant statistical effect ($p < 0.001$). Lactose values were higher in the spring compared to the summer and winter feeding periods, whereas dry matter was more influenced by summer and winter feeding than by spring feeding. The lactose values reported in the study by Gomez et al. (2009) were 4.91% in the control group and 5.05% in the experimental group, which were higher than our results. The dry matter content in their study was 17.97% in the control group, while the experimental group, which received extruded flaxseed in their diet, had values of 17.25% and 17.20%, aligning with our findings during the old grass period.

The dietary treatment and sampling period factors in their study showed a statistically significant effect

Table 3. Pearson's correlation coefficient (r-value) and significance level between chemical parameters of raw sheep's milk

	Milk fat	Proteins	Lactose	Dry matter	Non-fat dry matter	Density	Point of hate
Milk fat	-	0.59***	0.94***	0.21***	-0.66***	0.30***	1.00***
Proteins		-	0.74***	0.66***	-0.31***	0.59***	0.59***
Lactose			-	0.48***	-0.49***	0.50***	0.94***
Dry matter				-	0.43***	0.81***	0.21***
Fat-free dry matter					-	0.18***	-0.66***
Density						-	0.30***
Freezing point							-

* $p < 0,05$; ** $p < 0,01$; *** $p < 0,001$

Examining the relationship between sheep milk parameters, a positive correlation coefficient (r-value) was established between lactose content, milk fat, and protein. The obtained values indicate a strong correlation ($r = 0.94$; $r = 0.74$). Positive correlation coefficients were also found between milk fat and protein content ($r = 0.59$) and between dry matter and protein ($r = 0.66$), while a negative correlation was observed between fat-free dry matter and milk fat content ($r = -0.66$). The analysis of raw sheep milk parameters revealed certain variations, which are considered acceptable given the influence of various factors such as diet, sampling period, and lactation stage.

($p < 0.05$). For fat-free dry matter, the significance level of the sampling period factor was 99.5% ($p < 0.05$), while no statistical significance (ns) was found for the dietary treatment factor or their interaction. Regarding density, a significant effect ($p < 0.05$) was observed for the sampling period factor, whereas the dietary treatment factor showed high statistical significance ($p < 0.01$). The interaction between factors also had a significant effect ($p < 0.05$). For freezing point, the dietary treatment factor showed a very high statistical significance ($p < 0.001$), while no statistical significance (ns) was established for the second factor or their interaction. The freezing point of milk in our study was slightly higher than the value of -0.56°C reported by Pavić et al. (2002) for Travnik Pramenka sheep milk and by Antunac (2004) for Pag sheep milk. Throughout all research periods, the freezing point of milk remained very consistent, varying from -0.62°C to -0.68°C , which aligns with the values reported by Assis et al. (2004) for Portuguese sheep milk (-0.61°C). The correlation coefficients (r-values) and significance levels between the chemical parameters of raw sheep milk are presented in Table 3.

CONCLUSION

Chemical analyses of sheep milk have shown certain variations due to dietary treatment as well as variations during different research periods. The variability in milk composition is a result of genetic, physiological, nutritional, and environmental factors. Fat is the most variable component of sheep milk and is significantly influenced by the structure of the diet. This study addresses the complex process of finding new nutrients that would provide additional physiological functions to animal feed, alongside its basic nutritional purpose, improving the overall condition of the animal's body. This understanding of

food has emerged from numerous scientific findings that nutrition can modify specific bodily functions, health status, and animal development.

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