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Original paper

Comparative Study on Milk Yield and Its Fat Content of Local and Imported Sheep Breeds Reared in Albania

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Abstract

Background and aim: Milk plays a crucial role in the income generation of sheep breeders, particularly in certain regions of Albania. Sheep milk is used in the production of various local dairy products and is highly preferred by consumers. Sheep milk processing also serves as a foundation for agrotourism development in rural and remote areas. The current study aimed to determine the milk yield and milk fat content of three sheep breeds, specifically two Albanian local breeds (Shkodrane and Lara e Polisit) and one imported breed (Awassi).

Materials and methods: The research was conducted at the Centre of Agricultural Technology Transfer in the Korca region located in Southeast Albania. A total of 96 ewes were used in the study. Milk recording and sample collection for fat content analyzing were performed monthly for a period of six months, from April to September. (2022). The study analyzed the average daily milk yield and milk fat content of each breed.

Results: The results indicated that Lara e Polisit breed had an average daily milk yield of 1.06 ± 0.80 kg, Shkodrane breed had 1.32 ± 0.81 kg, and Awassi breed had 1.37 ± 0.81 kg. The breed effect explained 82% of the variation in daily milk yield. The peak milk production for all breeds occurred in April-May. After the peak, milk production gradually declined. In terms of milk fat content, Lara e Polisit breed had the highest content with a mean of $6.61 \pm 1.82\%$, followed by Shkodrane breed with $6.149 \pm 0.70\%$, and the Awassi breed with $6.22 \pm 0.47\%$. The difference in milk fat content between Lara e Polisit and the other two breeds was statistically significant ($P < 0.001$). The lactation periods resulted 257.5 ± 8.69 days for Lara e Polisit, 254.2 ± 8.17 days for Shkodrane, and 270.7 ± 10.14 days for Awassi.

Conclusion: The study contributes valuable information about the milk yield, milk fat content, and lactation periods of Shkodrane, Lara e Polisit, and Awassi sheep breeds in the South East region of Albania. The values of milk yield and milk fat reported are within the range of those typically observed for sheep milk. This indicates that the milk production and fat content are consistent with what is expected for sheep.

Keywords: *Milk yield, Fat, Lactation period, Breed, Month*

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Introduction

Sheep breeding has been practiced for centuries in various regions worldwide, particularly in hilly and mountainous areas. It is considered a profitable livestock farming practice, with low input compared to other husbandry practices [1]. Sheep are known for their ability to utilize vegetation that other livestock, such as cattle, cannot efficiently utilize. This makes sheep farming a valuable source of livelihood, especially in areas with limited agricultural development and feed resources [2], [3].

Currently, sheep are among the most important livestock species, with approximately 1.55 million sheep being farmed in Albania. A significant portion (75.39%) of the total sheep herd in Albania is comprised of milking sheep [4]. The geographical and climatic conditions in Albania have facilitated sheep breeding as a major livestock practice in almost every region. Sheep serve as a valuable source of milk, dairy processing products, and meat. Their productivity varies among different breeds and farming systems. Three important sheep breeds in Albania are Shkodrane and Lara e Polisit breeds, which are autochthonous, and Awassi breed, which is an imported breed. The Shkodrane breed is a dual-purpose breed known for its long and coarse wool, widely used to fill mattresses, although in nowadays wool production has lost its economic value, leading to a decline in the farmers interest in this breed. The Lara e Polisit and Awassi breeds are predominantly used for milk production [5].

Milk plays a crucial role in the income generation of sheep breeders, particularly in certain regions of Albania. Sheep milk is used in the production of various local dairy products and is highly preferred by consumers. Sheep milk processing also serves as a foundation for agrotourism development in rural and remote areas. In some regions, sheep milk and dairy products are used as an alternative to cow milk products, despite their higher fat content compared to cattle milk [6]. Milk characterization is also important because the growth of lambs from birth to weaning depends on the milk produced by the ewes [7]. The live weight of lambs and the milk yield of ewes are highly correlated during the early and middle lactation periods, although this correlation tends to decline as lactation progresses [8]. Park et al. [9] suggested that the composition and physicochemical characteristics of sheep milk are vital for the successful development of dairy industries and the marketing of their products, such as milk and cheese.

The quantity and quality of milk produced by sheep vary among breeds, and information on milk yield and composition is crucial for meeting the energy and nutrient requirements of lactating animals. This knowledge is essential for formulating diets or supplements that can optimize milk production [10].

It is indeed crucial to gather actual or observed information on milk production and composition to develop accurate nutrition models. Since there is limited comparative data available for different sheep breeds, especially in Albania, the study aims to fill this gap by characterizing milk production and composition, fat content, for three important domestic breeds: Lara e Polisit, Shkodrane, and Awassi.

Therefore, assessing the milk yield and fat content of our local sheep breed is essential for farmers and processors to meet market demands and adapt their production practices. It could help also to explore the possibilities for diversification of processing dairy products and agrotourism development. Evaluating milk yield and fat content provides valuable information for breeding and selection programs too aiming to improve the productivity and milk quality of local sheep breeds. It is well known that local sheep breed has a strong ability of adaptation in different climate conditions and very unic genes. There is an increasing of scientific and technical concern regarding conservation of these local/indigenous sheep breeds. Adding information about their capacities on

milk production and fat content helps in preserving and sustainable use of these breeds.

Material and Method

The study was conducted at the Center of Agricultural Technology Transfer in the Korca region of southeastern Albania. A total of 96 sheep from three different breeds were involved in the study: Lara e Polisit, Shkodrane (both Albanian local breed), and Awassi (imported breed). All the sheep were in the third lactation. The ewes gave birth to one or two lambs between January 4 and January 30 (2022).

During the 60-day suckling period, the ewes were not milked. After the lambs weaning, milk measurements were taken twice a day in one fixed day per month, in morning and evening milkings occurring approximately every 12 hours. Milk yields were recorded, and milk samples were collected in the day of milk recording from each animal over a six-month period, from April to September. The collected milk samples were analysed for fat content according Greber method.

The animals were housed during the winter period started from December to beginning of April depending by the weather conditions. During this period they were fed with mixed hays (alfalfa and pasture hays) around 2 kg/head, maize silage 1.2 kg/head and mixed grains (wheat and barley) 500 gr /day/head. During late spring up to November the animals were kept on pasture and no extra feed were given to them. At late pregnancy and during 2 first months of milking period a quantity of 500 gr of maize were given to each female sheep.

The collected data were analysed using IBM SPSS Statistics 20 software package. Descriptive results, including mean and standard deviation (SD), were presented. Several statistical tests were employed for analysis, including one-way ANOVA and Tukey-Kramer test for breed comparisons, general linear models (two-way ANOVA) considering the effects of breed and month, regression analysis, and correlation analysis.

The study aimed to investigate milk production and fat content in different sheep breeds and assess the potential differences among them. The statistical analyses employed allowed for a comprehensive understanding of the data and the exploration of relationships between variables.

Results

The mean values of daily milk yield in sheep from three breeds in different period of lactation are shown in Table 1.

The results of the study indicate that the daily milk yield varied throughout the lactation period, with higher values observed in April (the third month of lactation) and lower values in September (the last month of lactation). In April, the daily milk yield for the Lara e Polisit breed was 1.98 ± 0.27 kg, for the Shkodrane breed it was 2.16 ± 0.11 kg, and for the Awassi breed it was 2.25 ± 0.24 kg. There were no significant differences observed between the breeds in terms of daily milk yield in the third month of lactation.

Significant differences between the breeds were observed in June, July, and August (the sixth and seventh months of lactation) with regards to daily milk yield ($P < 0.01$ and $P < 0.05$).

The differences of milk production during the last month of lactation period between three breeds were not significant ($P > 0.05$).

Table 1. Statistical value of daily milk yield in various period of lactation in Lara e Polisit, Shkodrane and Awassi breed.

Breed		April	May	June	July	August	September
Lara e Polisit	n	21	21	21	21	21	21
	Mean±SD	1.98±0.27	2.00±0.33	1.21±0.61	0.57±0.26	0.39±0.27	0.22±0.09
Shkodrane	n	19	19	19	19	19	19
	Mean±SD	2.17±0.11	2.16±0.13	1.90±0.26	0.96±0.18	0.44±0.13	0.23±0.03
Awassi	n	56	56	56	56	56	56
	Mean±SD	2.25±0.24	2.10±0.26	1.86±0.34	1.22±0.455	0.50±0.16	0.29±0.09
P		NS	NS	**	**	*	NS
Total	n	96	96	96	96	96	96
	Mean±SD	2.17±0.25	2.09±0.26	1.73±0.48	1.03±0.45	0.46±0.19	0.26±0.09
	Min	1.30	1.30	0.40	0.20	0.20	0.14
	Max	2.70	2.60	2.40	2.10	1.50	0.80

NS: Nonsignificant (P>0.05); *: P<0.05, **: P<0.01

The lactation curve, as shown in Figure 1, illustrates the average daily milk yield of the sheep examined during the study period. Lara e Polisit breed reached its highest milk yield in May, with an average value of 2.00±0.33 kg. Shkodrane breed peaked in April (2.17±0.11 kg), but the difference compared to May was minimal and not significant.

The Awassi sheep achieved its highest milk yield in April (the third month of lactation), with an average peak value of 2.25±0.24 kg.

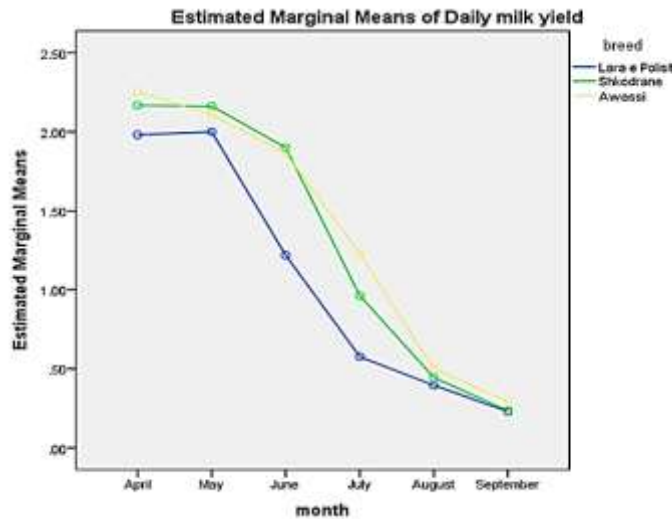


Figure 1. Lactation curve in Lara e Polisit, Shkodrane and Awassi sheep.

The milk production is influenced by various factors, including both intrinsic factors related to the genetic characteristics of the animals (such as breed) and extrinsic factors related to the environment and management practices. These factors can also affect the composition of milk.

In Table 2, the average daily milk yield and the fat content are presented. The average daily milk yield for the entire lactation period was 1.06±0.80 kg for Lara e Polisit breed, 1.32±0.81 kg for Shkodrane breed, and 1.37±0.81 kg for Awassi breed. Statistical analysis revealed significant differences between Lara e Polisit breed and both Shkodrane breed (P=0.046) and Awassi breed (P=0.001).

Table 3. Average daily milk yield and fat in breeds.

		N	Mean±SD	SE	Min	Max
Daily milk yield (kg)	Lara e Polisit	126	1.06±0.80	0.07	0.15	2.50
	Shkodrane	113	1.32±0.81	0.07	0.14	2.40
	Awassi	336	1.37±0.81	0.04	0.17	2.70
	Total	575	1.29±0.82	0.03	0.14	2.70
Fat (%)	Lara e Polisit	126	6.61±1.82	0.15	5.70	7.60
	Shkodrane	113	6.149±0.70	0.02	5.50	7.40
	Awassi	336	6.22±0.47	0.02	5.30	7.30
	Total	586	6.29±1.00	0.04	5.30	7.60

The study found that there was no significant difference in the average daily milk yield between the Shkodrane and Awassi breeds ($P>0.05$). The regression analysis showed that the breed effect explains 82% of the variation in daily milk yield ($R^2 = 0.82$).

Regarding the content of fat in the milk, Lara e Polisit breed had a higher mean value of $6.61\pm 1.82\%$ during the lactation period compared to Shkodrane breed ($6.149\pm 0.70\%$) and Awassi breed ($6.22\pm 0.47\%$). Statistical analysis showed a significant difference between Lara e Polisit and both Shkodrane and Awassi breeds ($P<0.001$), as well as between Shkodrane and Awassi breeds ($P<0.001$). The breed effect explained 6% of the variation in fat content ($R^2 = 0.06$).

The proportion of fat in the milk varied during different periods of lactation, with the peak value observed in September, the last month of lactation. Lara e Polisit breed had the highest fat content in September ($7.24\pm 0.20\%$), followed by Awassi ($7.00\pm 0.18\%$) and Shkodrane ($6.76\pm 0.43\%$) breeds. The difference in fat content between Lara e Polisit and Shkodrane breeds was statistically significant ($P<0.01$).

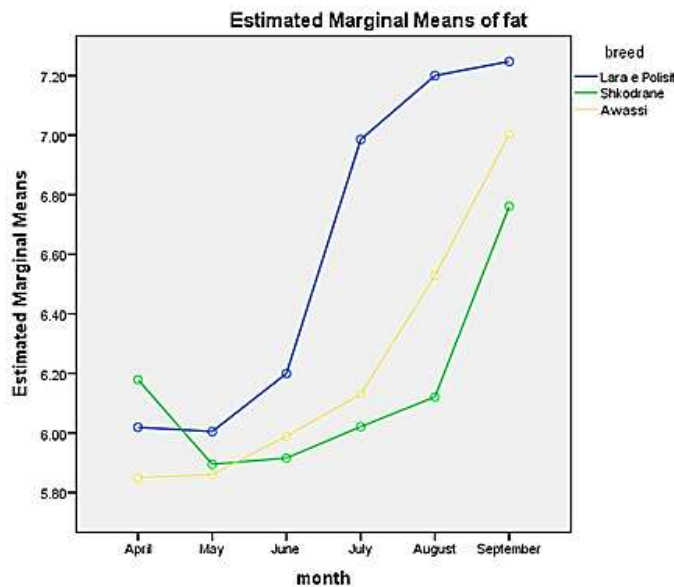


Figure 2. The proportion of fat of the three sheep breeds during different periods of lactation

The study examined the effects of the month on milk fat proportion during the lactation period. Table 3 shows the proportion of fat for each month from April to September for all individuals of the three breeds. The highest content of fat was observed in September (6.79±1.24%), while the lowest was in May (5.77±0.87%). The proportion of fat started to increase from May and reached its maximum in September. Statistical analysis indicated a significant difference between months (P<0.0001). The month effect explained 50% of the variability in fat values (R²= 0.50).

Table 3. Proportion of fat in different months of lactation period

		N	Mean±SD	SE	Min	Max
Fat %	April	96	5.95±0.30	0.03	5.40	6.80
	May	96	5.77±0.87	0.08	5.30	6.40
	June	96	5.89±0.90	0.09	5.60	7.20
	July	96	6.16±0.99	0.10	5.50	7.50
	August	96	6.46±1.03	0.10	5.70	7.50
	September	96	6.79±1.24	0.12	5.90	7.60
	Total	586	6.17±1.00	0.04	5.30	7.60

It was found a negative and significant correlation (P<0.01) between daily milk yield and fat percentage (r= -0.788). This means that as milk yield increases, the fat percentage tends to decrease.

In table 4 are shown the mean values of the milk yield in the morning and the milk yield in the evening for Lara e Polisit, Shkodrane and Awassi breed during different months of lactation.

Table 4. Milk yield in the morning (MYM) and milk yield in the evening (MYE) for Lara e Polisit, Shkodrane and Awassi breed during different months of lactation.

	Breed	n		April	May	June	July	August	September
Milk yield in the morning (MYM)	Lara e Polisit	21	Mean±SD	1.00±0.17	0.91±0.32	0.58±0.33	0.36±0.18	0.24±0.19	0.13±0.04
	Shkodrane	19	Mean±SD	1.11±0.08	1.11±0.09	0.97±0.12	0.59±0.13	0.26±0.08	0.13±0.02
	Awassi	56	Mean±SD	1.22±0.14	1.10±0.15	0.96±0.18	0.65±0.23	0.29±0.09	0.16±0.05
	P			NS	NS	**	**	NS	NS
	Total	96	Mean±SD	1.15±0.16	1.06±0.21	0.87±0.27	0.58±0.23	0.27±0.12	0.15±0.05
Milk yield in the evening (MYE)	Lara e Polisit	21	Mean±SD	0.97±0.13	0.90±0.33	0.52±0.35	0.21±0.10	0.14±0.09	0.10±0.05
	Shkodrane	19	Mean±SD	1.05±0.06	1.03±0.05	0.92±0.14	0.36±0.10	0.18±0.06	0.10±0.01
	Awassi	56	Mean±SD	1.02±0.12	0.99±0.12	0.90±0.16	0.56±0.23	0.20±0.09	0.12±0.02
	P			NS	NS	**	**	*	Ns
	Total	96	Mean±SD	1.10±0.12	0.98±0.19	0.81±0.27	0.45±0.24	0.19±0.09	0.11±0.03

Average value of MYM for April was 1.15±0.16 kg. No significant differences was observed between breeds in this month, they have similar values. Also the same is the situation for May, Based on the information provided, the average values for milk yield in the morning (MYM) for different months and breeds are as follows: April: MYM: 1.15±0.16 kg (no significant differences between breeds); May: MYM: Slightly decreased compared to April, but no specific value is mentioned. No significant differences between breeds; June: MYM: Decreased significantly compared to previous months (exact values not provided). Significant difference observed between breeds (P<0.01). September (last month of lactation): MYM: Lara e Polisit: 0.13±0.04 kg,

Shkodrane: 0.13 ± 0.02 kg, Awassi: 0.16 ± 0.05 kg. The average values for milk yield in the evening (MYE) for the different breeds in April are as follows: Lara e Polisit: 0.97 ± 0.13 kg; Shkodrane: 1.05 ± 0.06 kg; Awassi: 1.02 ± 0.12 kg.

These MYE values are smaller than the corresponding values reported for milk yield in the morning (MYM) for the same period of lactation (April). The difference between MYM and MYE is statistically significant ($P < 0.05$). Additionally, it is mentioned that smaller values of MYE compared to MYM are observed for all different periods of lactation. The difference between MYM and MYE is consistently statistically significant ($P < 0.01$) throughout the lactation period.

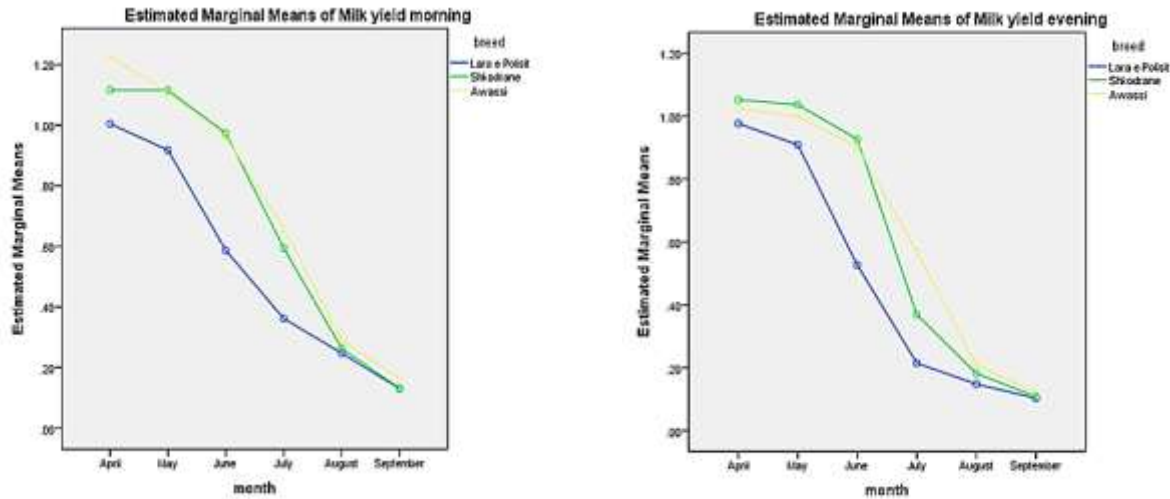


Figure 3. Means of MYM and MYE during lactation period.

Below is provided the information on the calculated day of lactation for each breed. Based on the data in Table 5, the average duration of lactation for each breed is as follows: Lara e Polisit breed 257.5 ± 8.69 days, Shkodrane: 254.2 ± 8.17 days, Awassi breed: 270.7 ± 10.14 days.

Table 5. Days of lactation

		N	Mean \pm SD	SE	Min	Max
Days of lactation	Lara e Polisit	21	257.5 ± 8.698	1.898	234.00	270.00
	Shkodrane	19	254.2 ± 8.177	1.876	240.00	270.00
	Awassi	56	270.7 ± 10.143	1.355	240.00	287.00
	Total	96	264.5 ± 11.943	1.218	234.00	287.00

Based on the data provided, the statistical analysis shows the following: there were no significant differences in lactation days between Lara e Polisit and Shkodrane breeds ($P=0.542$), indicating that their lactation lengths were similar. However, when comparing Awassi breed with both Lara e Polisit and Shkodrane breeds, there was a highly significant difference ($P < 0.001$).

Discussion

In this study, in addition to the lactation data of Lara e Polisit, Shkodrane and Awassi breed, fat proportion also was determined. Higher values of daily milk yield were observed in April (third month of lactation) in Awassi sheep with an average peak value of 2.25 ± 0.24 kg. This value was higher than that reported by Daş et al. [1], in their study on Awassi sheep (1.63 ± 0.76 kg). The

difference in values may be attributed to various factors such as diet, the composition of the pasture, and other environmental factors. Nevertheless, the peak value was reached in the same period of lactation (third month).

The study provides insights into the variations in daily milk yield among different sheep breeds throughout the lactation period.

The findings of the study indicate that the sheep reached their maximum daily milk yield in April and May, which corresponds to the third and fourth months of lactation. The milk production during these two periods did not show significant differences ($P > 0.05$), suggesting a relatively stable level of milk production during that time.

Subsequently, the lactation curve gradually decreased over time typically for lactation sheep animals. Furthermore, a strong negative correlation was observed between daily milk yield and the advancement of lactation month, with a Pearson correlation value of $r = -0.899$ ($P < 0.01$). The negative correlation suggests a clear association between the stage of lactation and milk production, with a consistent decline in milk yield over time.

These findings highlight the importance of considering the stage of lactation when evaluating milk production in sheep. The study provides valuable insights into the dynamics of milk yield throughout the lactation period and emphasizes the need for appropriate feeding practices to optimize milk production and maintain the well-being of the animals.

The results presented on table 2 indicate that the breed of the sheep has a significant impact on daily milk yield, with Shkodrane and Awassi breeds exhibiting higher daily milk production compared to Lara e Polisit breed. The observed differences suggest variations in genetic potential and physiological characteristics among the breeds, leading to variations in milk production.

It is important to consider these breed-related differences in milk yield when making management decisions in sheep farming, as it can have implications for overall productivity and farmers income from sheep husbandry.

The average daily milk yield for Awassi sheep in this study was higher compared to values reported in previous studies by Das et al., [1] and Merkhani [11] for Awassi sheep in different regions. It was also higher compared to Turkish Awassi reported by Al-Samarai et al. [12]. The average milk yield of the Lara e Polisit breed and other breeds in this study was similar to values reported by Nudda et al. [13] and Ferro et al. [14] for different breeds of sheep.

An important element of the study was also the determination of fat content. Where higher values were found in Lara e Polisit breed compared with two other breeds. The differences in fat content among the breeds may be attributed to genetic factors.

The mean fat value for Awassi breed in this study was similar to that reported by Das et al. [1]. Other studies by Raynal-Ljutovac et al. [6] and Ferro et al. [14] have reported varying fat content in sheep milk across different breeds.

These findings highlight the influence of breed on daily milk yield and fat content in sheep milk, as they are kept in the same conditions of housing and feeding. The genetic factor may play a role in these differences. Understanding these variations can assist in making informed decisions regarding breed selection and management practices to optimize milk production and composition in sheep farming.

Behind the breed effect in this study was examined also the effect of the month on milk fat proportion during the lactation period. The results presented in table 3 suggest that the month of lactation has a significant influence on the proportion of fat in sheep milk. This information can be valuable for farmers and researchers in understanding the dynamics of milk fat production and planning management practices accordingly.

It is generally expected that fat percentages in milk will be higher towards the end of lactation. As milk production decreases, the concentration of total solids, including fat, tends to increase. This relationship has been observed in previous studies, as mentioned by Merkhan [11].

This is explained also with the strong and negative correlation ($r = -0.788$) between daily milk yield and fat percentage. Similar correlations have been reported in other breeds, including specialized milk production breeds, as noted by Pulina et al. [15], Bencini et al. [16] and Pulina et al. [17].

It's worth noting that higher total solids and fat contents are associated with lower quality milk, as mentioned by Hinde et al. [18]. This suggests that milk with lower fat percentages may be considered of higher quality.

Overall, these findings provide valuable insights into the relationship between milk yield, fat percentage, and milk quality, which can be important for dairy farmers in managing their herds and optimizing milk production.

The study provide additional information regarding the comparison of lactation days between different breeds. Awassi breed had a longer lactation length compared to both Lara e Polisit and Shkodrane breeds. The longer lactation length in Awassi breed compared to the other two breeds could be attributed to genetic factors since all the animals were raised in the same farm and in the same conditions of housing and feeding and similar environmental factors. Genetic differences among breeds can influence various traits, including lactation duration.

Conclusion

The maximum values of milk production were obtained in April, which is the third month of lactation. Afterward, there is a constant and gradual decrease in milk production as the lactation progresses. The minimum values were observed in September, which is the last month of lactation. The proportion of fat in the milk increases over time. This suggests that as the lactation progresses, the milk becomes richer in fat content. The values of milk yield and milk fat reported are within the range of those typically observed for sheep milk. This indicates that the milk production and fat content are consistent with what is expected for sheep. Additionally, other factors such as breed, management practices, and environmental conditions can also influence milk production and composition.

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Conflict of interests

The authors declare that there are no competing interests.

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