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Effects of lamb sex, parity, and birth type on milk yield, lactation length, and milk components in Zom ewes raised under semi-intensive conditions

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Abstract

This study aimed to determine the effects of parity, birth type, and lamb sex on milk yield, lactation length, milking period, and milk components in Zom ewes. In this study, which included 83 Zom ewes, it was observed that birth type affected daily and lactation milk yield, and only parity affected lactation length. The effects of the milking period on milk yield and birth type on milk fat content were marked. The effect of lamb sex on protein, solid non-fat, and lactose contents was substantial, but that of parity and birth type were not statistically significant. There was a negative correlation between lamb sex and solid non-fat, protein, lactose, and density and between fat, protein, and lactose. There was a positive correlation between the fat and solid non-fat content, freezing point, and mineral content. In conclusion, the effect of milking period was statistically significant for milk yield and components. Additionally, the effects of lamb sex on solid non-fat, protein, and lactose contents were found to be substantial.

Keywords: lamb sex, milk components, milk yield, Zom ewes
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Introduction

Sheep breeding is a production model that plays an important role in the food supply and economic status of both developed and developing nations. Any decrease in yield, deaths due to diseases, or epidemics can endanger people's economic status and food health. Therefore, to ensure economical and beneficial sheep breeding, it is necessary to regularly monitor the productivity and health of livestock. By determining the yield levels, the phenotypic characteristics were calculated, and the genotypic structure of the sheep was easily predicted (Tothova *et al*., 2016).

Sheep are a multifaceted livestock breed with numerous breeds worldwide. Sheep milk production contributes substantially to the economy as it has become a popular alternative food for the production of expensive and high-quality dairy products (e.g., cheese) in Europe, particularly in Mediterranean countries, including Turkey (Haenlein, 2007; Karadas *et al*., 2017). Traditional cheeses are produced using high-quality milk obtained from sheep that have adapted to harsh environmental conditions (Selvaggi *et al*., 2017). Zom ewes are widely bred in the provinces of Diyarbakır, Şanlıurfa, and Mardin,

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especially in the Karacadağ Region. It is important to determine the factors affecting the milk yield and composition of this variety, which is very well adapted to poor pasture conditions and harsh climatic conditions and is resistant to infections and parasitic diseases (Koncagül *et al*., 2012).
In recent years, the composition of sheep milk has been investigated extensively (Górová *et al*., 2011). Milk production and composition of sheep milk are substantially affected by both genetic (breed) and environmental factors, such as season, care and feeding, lactation period, type of birth, number of lambs, and diseases (Soják *et al*., 2013). Sheep milk typically contains 10.4–18.2% dry matter, 3.4–6.5% protein, 3.5–7.3% fat, and 4.1–5.8% lactose (Kondyli *et al*., 2012; Bonczar *et al*., 2016). The viability, live weight gain, growth, and development of newborn lambs all depend on the lamb sex, milk yield, and composition of their dams. Low milk yield of sheep reduces the amount of milk consumed by the lambs during the suckling period. Feed conversion efficiency and growth rate of lambs during the suckling period are largely related to the amount of milk drawn from their dams (Sadeghi *et al*., 2016; Sardinha *et al*., 2020).
In dairy cows, calf sex influences milk yield; milk production is higher with female calves. In a study conducted in New Zealand, it was reported that female calf birth rates were 0.33–1.1% higher than that of male calves (Hess *et al*., 2016). There is research on the effects of the number of lambs on milk yield and composition in sheep. However, research on the effect of lamb sex on the milk yield of dams is limited. There is no literature on the composition of milk. The aim of this study was to determine the effects of parity, birth type, and lamb sex on milk production and composition of dams.

Material and Methods

The ethical committee approval of Dicle University (DÜHADEK:2011-11) was obtained in order to conduct this study. This study was carried out on Zom ewes raised at the Dicle University Veterinary Faculty Research and Application Farm. A total of 88 sheep (22: first lactation, 30: second lactation, 31: third and fourth lactation), 83 ewes, and 5 rams, aged 2–5 years, were included in the study. During the vegetation period, the sheep were grazed on pasture and 250 g of concentrate (DM: 89%; CP: 18%; kcal/ME: 2650) daily. Ewes were grazed on the pasture between 04:30–07:00 and 08:30–11:00, 15:00–19:00, and 20:00–24:00. The botanical composition of the pastures consists of 44.38% Poaceae, 23.78% Fabaceae, and 31.83% of other plant species (CP: 16.43%; NDF: 51.06%; Ash: 10.94%) (Karahan & Saruhan, 2019). After the time of pasture grazing, ewes were housed in shaded paddocks and shelters. Ewes had access to fresh water and trace-mineral salt blocks *ad libitum*. The ewes were housed in shelters in the absence of pasture (October–March). The average sheep according to the gestational period was fed 1–1.5 kg of alfalfa hay (DM: 91.7%; CP: 16.7%; NDF: 46.5%; Ash: 12.0%; NE_L: 1.29 Mcal/kg) and 1–1.5 kg of concentrated (DM: 90%; CP: 16%; kcal/ME: 2500) feed daily. Search rams were used to detect oestrus in ewes during July and August, which is the mating season. Ewes showing signs of oestrus were inseminated using the hand-mating method. Rams were fed with supplemental concentrate feed (250 g/day) from 2 weeks before the mating period until the mating period (45 days). Ewes and lambs were fitted by identifying ear tags. Ewes gave birth in January and February. Data on the number of lactations and the birth types of the ewes were recorded on a computer. The lambs were separated after being kept with dams for 10 days. The sex, birth weight, and birth type of the lambs were recorded on a computer. The lambs were kept with dams to suckle for 1–2 hours in the morning and evening each day and then released into their paddocks. Milk-fed lambs were weaned 75 days after birth.

Milk measurements and sample collection began 10 d after lambing. Milk measurements and sampling were continued until the end of lactation (approximately 6 months), twice a day (morning: 07:00, evening: 19:00) at the end of each month. Before the milk samples were collected, the sheep teats were disinfected with isopropyl alcohol. The milk in the teats was emptied with 2–3 milkings and all milk in the udder was milked by hand. The amount of milk produced was measured using a measuring tape. Milking was terminated when the daily milk yield of the sheep fell below 100 ml. Milk samples taken in the morning and evening were mixed and placed in 50 ml sample containers. Milk samples were stored at +4 °C until the analysis of fat, protein, lactose, freezing point and solid non-fat. A milk analyser (Funke Gerber, GERMANY) was used to analyse the milk components. The milk sample to be measured (between 12 ml and 20 ml) is sent to the measuring cells by means of a pump. By using the thermal measurement application, both the fat content and the solid non-fat content were determined. Protein, lactose, and minerals were determined using a second measuring cell equipped with combined impedance/turbidity sensor technology. The freezing point was calculated on the basis of verified measurement values.

Differences between lactations were analysed via one-way analysis of variance (ANOVA), and the post hoc test (Tukey) was used for binary comparisons of groups. Differences between groups according to birth type (single/twin) were compared using a Student's *t*-test. The differences between the groups according to sex were compared using a Student's *t*-test. Variance analysis (Friedman) was used for analysing repetitive data for differences in milking, and the Wilcoxon test was used for binary comparisons of groups. Correlation between categorical data and measurement parameters was determined using Spearman correlations. The relationship between measurement parameters was determined using Pearson correlations. SPSS (SPSS Version 16.0®, Chicago, IL, USA) was utilized for all statistical analyses.

Results and Discussion

The effects of parity, lamb sex, and birth type on average daily milk yield, lactation milk yield, and lactation length in Zom sheep are shown in Table 1. Birth type had an effect on the average daily and lactation milk yields (P <0.05). Parity had a significant effect on lactation length (P <0.05). Similarly, Selvagi *et al*. (2017) and Abecia & Palacios (2018) reported the influence of birth type on the average daily and lactation milk yield. Contrary to our results, birth type had no effect on daily milk yield and lactation milk yield in one study (Rosales Nieto *et al.,* 2018). Koncagül *et al*. (2012b) reported that the effect of parity on average daily and lactation milk yield was marked, but birth type and parity had no effect on the lactation period (Akgün & Koyuncu, 2020). Lactation and daily milk yield are affected by many factors, including genetics, nutrition, season, birth type, lactation period, and parity (Soják *et al*., 2013). This increase in milk yield may be related to an increase in the number of nursing lambs. Multiple lambs may have experienced an increase in the duration and degree of stimulation of the udder glands and hence, milk secretion. Because milk is completely discharged from the udder gland in early lactation, an increase in the amount of milk secreted may occur (Dhaoui *et al*., 2019). Additionally, suckling of twin lambs increases plasma oxytocin and prolactin levels and causes an increase in milk secretion (Marnet & Negrao, 2000). No effect of lamb sex on lactation length or daily and lactation milk yield was found (P >0.05). However, the numerically higher milk yield of male-lambing dams was similar to that reported by Rosales-Nieto *et al*. (2018). In contrast, Abecia and Palacios (2018) reported that sex affects milk yield and that female-lambing dams have a higher milk yield. Differences in milk yield may be due to the different effects of hormones that affect mammary gland development and milk yield in the last period of pregnancy in male and female foetuses (Hess *et al*., 2016).

Table 1 Effects of parity, lamb sex, and birth type on mean milk yield (± standard error), lactation milk yield (L/d), and lactation length (d)

Parameters	Daily milk yield (mL)	Lactation milk yield (L)	Lactation length (days)
$\bar{X} \pm S\bar{x}$	653.53±51.94	119.28±12.43	180.53±8.59
Parity			
1	631.35±23.49	111.47±17.55	176.53±7.26^{B}
2	647.69±24.84	119.62±9.97	184.69±8.39^{A}
3	691.65±27.74	124.75±17.83	179.94±9.11^{AB}
	NS	*NS*	*
Lamb sex			
Male	666.36±31.45	119.36±17.41	179.40±9.13
Female	649.80±76.15	117.82±15.44	181.20±8.50
	NS	*NS*	*NS*
Birth type			
Single	641.47±77.18^{B}	114.96±15.27^{B}	179.15±8.43
Twinning	649.80±76.15^{A}	126.30±16.20^{A}	182.75±9.28
	*	*	*NS*

$^{*\ A\text{-}B}$ The difference between the groups with different letters in the same column is statistically significant (P <0.05)
Post hoc test (Tukey) was used for pairwise comparisons of groups with one-way variance analysis
The difference between the groups was compared using a Student's *t*-test, according to parity and birth type (P <0.05)
Three replicates were analysed

The effects of parity, birth type, lamb sex, and milking period on milk yield are shown in Table 2. Milking period had a marked effect on milk yield (P <0.0001). The highest milk yield was observed in April, and it decreased in the following months. Parity had an effect on milk yield in February and April (P <0.05), with low milk yield in parity one. In studies performed in the Akkaraman breed, the highest peak yield was found on days 45 and 75 (Esen & Özbey 2002; Kahraman *et al*., 2020). The increase in milk yield during the milking period may be due to the peak of milk yield, increase in dry matter intake, and sucking frequency of lambs (Peeters *et al*., 1992). The continuity of milk production is related to the increase in and protection of secretory cells and the release of milk from the alveoli. The secretion of growth hormones leads to an increase in milk yield by directing nutrients from body stores to the mammary gland (Svennersten-Sjaunja *et al*., 2005). In addition, milk yield increased since March due to the increase in vegetation and the grazing of the sheep in the pastures during this time. The gradual decrease in milk production after the peak of lactation (May–June) is due to the weaning of lambs, lack of sucking stimulation, decrease in secretory cells, and higher temperature and humidity index in summer than in spring and winter (Sevi *et al.,* 2001). In the present study, the higher milk yield in March and April can be explained by the length of the lamb-suckling period (three months) and the lack of pasture vegetation during that period.

The effects of parity, lamb sex, and birth type on fat content are shown in Table 3. Birth type in January, February, and March had an effect (P <0.05), but lamb sex had no effect (P >0.05). Fat contents during the milking periods were different (P <0.0001). There is conflicting information on the effect of birth type on the composition of milk. The current results are similar to those observed by Chay-Canul *et al*. (2020) and Prpić *et al*. (2016), who indicated that twin-lambing ewes produce more fat than single-lambing ewes. However, our results contradict those reported by Rosales-Nieto *et al.* (2018). Generally, ewes with multiple births had higher milk yields. There is also a negative correlation between milk yield and fat content (Bencini & Pulina, 1997). Therefore, an increase in the fat content of twin-lambing ewes may have occurred. In the present study, the fat content increased in parallel with the decrease in milk yield from the beginning of lactation; the highest fat content was observed during the last period of lactation. The changes in fat between lactation periods were similar to those reported in previous studies (Yılmaz *et al*., 2011; Kahraman *et al.,* 2020). Contrary to these findings, Akça & Bakır (2017) reported that the fat content (4.8%) in the last period of lactation was low in Zom sheep. The low fat content may have been caused by errors in the milk sample intake. The fat content increased with a decrease in milk yield. In addition, in May and June, the temperature increased, and pasture vegetation decreased. An increase in the dry matter content in the pasture may lead to an increase in the fat content in milk (Morand-Fehr *et al*., 2006).

The effects of parity, lamb sex, and birth type on protein are displayed in Table 4. There was a difference between the lamb sex on milk protein in January, February, March, and April (P <0.001). Protein ratio was affected by the milking period. The decrease in the protein ratio in March was statistically significant. The protein content increased during middle lactation and decreased until the end of lactation. In this study, it was clear that the effect of sex on the milk protein content was substantial. In addition, protein levels were higher in male-lambing ewes. The literature related to the results of the present study is quite limited. Rosele *et al.* (2018) reported that the protein content increased positively in male-lambing ewes; however, the difference was not statistically significant.

The body weight gain of the male lambs was higher than that of the female lambs. The effects of breed and nutrition on live weight gain are also critical. Proteins are among the most important nutrients for muscle development and weight gain in lambs (Sadeghi *et al*., 2016). The higher milk protein content in male-lambing dams in the first three months of lactation corroborates this result. This decrease in the protein content during the last period of lactation in Massese ewes was similar to the results reported by Antunović *et al.* (2017) and Pugliese *et al.,* (2000). Dhaoui *et al.* (2019) reported average and seasonal protein contents of 4.0, 3.9, 4.2, and 4.0%, in spring, winter, autumn, and summer, respectively. Contrary to our study, Kralickova *et al.* (2012) reported that protein content (5.3%) increased in the last period of lactation. The major differences in protein ratios between breeds are breed, lactation stage, nutrition, climate, parity, season, and udder health status (Park *et al*., 2007). The survival of lambs during the suckling period and body weight gain depend on the amount and composition of milk (Abd Allah *et al.,* 2011).

Table 2 Effects of parity, lamb sex and birth type, milking periods on the milk yield (l/d)

Parameters	**Milking Periods**						***--P--***
	January	**February**	**March**	**April**	**May**	**June**	
$\overline{X} \pm S\overline{x}$	514.79±73.49	655.78±97.92	790.23±70.80	1028.71±142.00	641.99±135.86	324.36±103.29	
Parity							
1	514.71 ± 62.16^{d}	592.35 ± 141.05^{Bc}	757.06 ± 102.15^{b}	980.59 ± 159.31^{Ba}	617.65 ± 125.43^{c}	325.29 ± 85.30^{e}	0.0001
2	536.88 ± 86.70^{d}	675.00 ± 82.22^{ABc}	787.50 ± 67.08^{b}	985.00 ± 77.97^{ABa}	600.00 ± 134.51^{cd}	301.25 ± 86.55^{e}	0.0001
3	542.18 ± 76.31^{d}	692.35 ± 62.40^{Ac}	818.24 ± 44.75^{b}	1098.82 ± 168.32^{Aa}	697.65 ± 143.03^{c}	341.18 ± 131.24^{e}	0.0001
	NS	*	*NS*	*	*NS*	*NS*	---
Lamb sex							
Male	526.00 ± 76.92^{d}	654.40 ± 99.04^{c}	791.60 ± 85.42^{b}	1059.20 ± 162.56^{a}	663.20 ± 129.83^{c}	325.60 ± 104.65^{e}	0.0001
Female	522.40 ± 66.04^{d}	651.20 ± 119.56^{c}	783.60 ± 71.41^{b}	985.20 ± 129.00^{a}	615.20 ± 145.43^{c}	320.40 ± 102.98^{e}	0.0001
	NS	*NS*	*NS*	*NS*	*NS*	*NS*	---
Birth type							
Single	512.94 ± 78.80^{d}	637.65 ± 124.34^{c}	773.53 ± 88.18^{b}	986.18 ± 135.46^{a}	622.94 ± 138.36^{c}	315.00 ± 99.76^{e}	0.0001
Twinning	526.25 ± 69.08^{d}	685.00 ± 54.16^{c}	817.50 ± 37.15^{b}	1098.75 ± 154.61^{a}	673.75 ± 136.91^{c}	340.00 ± 110.27^{e}	0.0001
	NS	*NS*	*NS*	*NS*	*NS*	*NS*	---

* A-B The difference between the groups with different letters in the same column is statistically significant (*P* <0.05)
Post hoc test (Tukey) was used for pairwise comparisons of groups with one-way variance analysis (ANOVA)
a-d The difference between the groups with different letters in the same row is statistically significant (*P* <0.05)
Variance analysis (Friedman) was used in repeated data for milking differences and Wilcoxon was used in paired comparisons of groups
The difference between the groups was compared using a Student's *t*-test, according to parity, lamb sex, and birth type (*P* <0.05)
Three replicates were analysed

Table 3 Effects of parity, lamb sex, birth type, and milking period on the fat content (%)

Parameters	**Milking Periods**						***--P--***
	January	**February**	**March**	**April**	**May**	**June**	
$\overline{X} \pm S_{\overline{x}}$	4.86±1.12	7.21±1.11	6.30±0.68	6.73±1.16	7.93±0.90	8.12±0.93	
Parity							
1	$4.76±1.02^{ABd}$	$7.16±0.91^{b}$	$6.37±0.81^{c}$	$6.32±0.88^{c}$	$7.90±0.83^{a}$	$7.93±0.80^{a}$	0.0001
2	$4.38±1.15^{Bd}$	$7.34±1.24^{b}$	$6.32±0.90^{c}$	$6.55±1.28^{c}$	$8.02±0.92^{a}$	$8.11±0.96^{a}$	0.0001
3	$5.56±1.17^{Ac}$	$7.50±1.24^{a}$	$6.27±0.72^{b}$	$7.07±1.44^{ab}$	$7.89±1.00^{a}$	$8.09±1.12^{a}$	0.0001
	*	*NS*	*NS*	*NS*	*NS*	*NS*	---
Lamb sex							
Male	$4.89±1.16^{d}$	$7.32±0.90^{b}$	$7.22±0.95^{Ab}$	$6.27±0.64^{c}$	$8.07±0.82^{a}$	$8.44±0.70^{a}$	0.0001
Female	$4.93±1.26^{d}$	$7.34±1.33^{ab}$	$6.68±1.36^{Bbc}$	$6.38±0.94^{c}$	$7.80±0.97^{a}$	$7.94±0.88^{a}$	0.0001
	NS	*NS*	*	*NS*	*NS*	*NS*	---
Birth type							
Single	$5.18±1.26^{Ad}$	$7.11±1.12^{Ab}$	$6.46±0.93^{Ac}$	$6.75±1.38^{bc}$	$7.91±0.96^{a}$	$8.14±1.16^{a}$	0.0001
Twinning	$4.34±0.83^{Bd}$	$6.80±1.02^{Ba}$	$6.04±0.25^{Bc}$	$6.44±0.87^{b}$	$7.89±0.80^{a}$	$8.10±0.94^{a}$	0.0001
	*	*	*	*NS*	*NS*	*NS*	---

$^{*\ A\text{-}B}$ The difference between the groups with different letters in the same column is statistically significant (*P* <0.05)
Post hoc test (Tukey) was used for pairwise comparisons of groups with one-way variance analysis (ANOVA)
$^{a\text{-}d}$The difference between the groups with different letters in the same row is statistically significant (*P* <0.05)
Variance analysis (Friedman) was used in repeated data for milking differences and Wilcoxon was used in paired comparisons of groups
The difference between the groups was compared using a Student's *t*-test, according to parity, lamb sex, and birth type (*P* <0.05)
Three replicates were analysed

Table 4 Effects of parity, lamb sex, birth type, and milking periods on the protein ratio (%)

Parameters	Milking Periods						--P--
	January	February	March	April	May	June	
$\bar{X} \pm S_{\bar{x}}$	4.59±0.32	4.49±0.33	4.38±0.23	4.58±0.28	4.49±0.23	4.46±0.28	
Parity							
1	4.55±0.35[a]	4.47±0.29[a]	4.33±0.23[b]	4.67±0.27[a]	4.52±0.24[a]	4.50±0.28[a]	0.008
2	4.61±0.33[a]	4.48±0.28[ab]	4.41±0.19[b]	4.54±0.2[ab]	4.49±0.18[ab]	4.48±0.32[ab]	0.004
3	4.60±0.32[a]	4.50±0.43[ab]	4.43±0.28[b]	4.54±0.33[ab]	4.46±0.31[ab]	4.44±0.26[ab]	0.012
	NS	*NS*	*NS*	*NS*	*NS*	*NS*	---
Lamb sex							
Male	4.61±0.28[Aa]	4.59±0.33[Aa]	4.45±0.24[Ab]	4.69±0.20[Aa]	4.52±0.20[ab]	4.50±0.24[ab]	0.001
Female	4.42±0.40[Ba]	4.37±0.31[Bb]	4.23±0.21[Bb]	4.47±0.34[Bab]	4.46±0.28[ab]	4.42±0.32[ab]	0.008
	*	*	*	*	*NS*	*NS*	---
Birth type							
Single	4.56±0.39[a]	4.45±0.34[ab]	4.37±0.24[b]	4.59±0.33[a]	4.50±0.29[ab]	4.47±0.32[ab]	0.0001
Twinning	4.63±0.21[a]	4.56±0.31[ab]	4.42±0.21[c]	4.57±0.21[ab]	4.48±0.12[bc]	4.46±0.24[bc]	0.052
	NS	*NS*	*NS*	*NS*	*NS*	*NS*	---

[* A-B] The difference between the groups with different letters in the same column is statistically significant (*P* <0.05)
Post hoc test (Tukey) was used for pairwise comparisons of groups with one-way variance analysis (ANOVA)
[a-d]The difference between the groups with different letters in the same row is statistically significant (*P* <0.05)
Variance analysis (Friedman) was used in repeated data for milking differences and Wilcoxon was used in paired comparisons of groups
The difference between the groups was compared using a Student's *t*-test, according to parity, lamb sex, and birth type (*P* <0.05)
Three replicates were analysed

Lamb sex affected solid non-fat, protein, and lactose contents (P <0.001) (Tables 5 and 6). The effect of solid non-fat on milking periods was substantial only in April because the solid non-fat during this month was relatively lower. The amount and composition of milk suckled before weaning increases the growth and feed utilization of lambs after weaning (Danso *et al.,* 2016). The milk consumed by lambs until the age of 12 weeks can affect their growth by 70%. Therefore, it is likely that there is a strong genetic correlation between dam milk and lamb growth rate (Afolayan *et al*., 2009). In addition, Rosales-Nieto *et al*. (2018) stated that lactose, protein, and solid non-fat were higher in male-lambing dams. In this study, the solid non-fat content decreased with an increase in milk yield in April. The results reported by Alarslan & Aygün (2019) were similar to those of our study. The dry matter decreased in the middle of the milking period and increased again at the end of the milking period. Kondyli *et al*. (2012) reported that the solid non-fat in spring (April and May) and summer (June and July) milking periods in Boutsiki sheep were 11.47% and 11.41%, respectively. These contents were considerably lower than those observed in our study. In contrast, Abd Allah *et al.* (2011) reported that the average solid non-fat content (13.01%) was higher than that in the present study. Contrary to our study, Antunovic *et al*. (2017) reported that the solid non-fat contents on days 20, 60, and 100 were 11.25, 11.06, and 11.03%, respectively. These differences may have been caused by seasonal variation, lamb sex, breed, and increased vegetation in pastures.

Table 5 Effects of parity, lamb sex, birth type, and milking periods on the solid non-fat content (%)

Parameters	Milking Periods						***--P--***
	January	**February**	**March**	**April**	**May**	**June**	
$\bar{X} \pm S_{\bar{x}}$	12.26±0.81	12.09±0.78	12.18±0.92	11.79±0.57	12.08±0.59	12.15±0.62	
Parity							
1	11.90±0.88^{a}	12.01±0.74^{a}	12.45±0.68^{c}	11.68±0.54^{b}	12.20±0.61^{ac}	12.10±0.48^{ac}	0.060
2	12.56±0.82^{a}	12.04±0.69^{b}	12.12±0.75^{b}	11.89±0.49^{b}	11.93±0.64^{b}	11.98±0.60^{b}	0.007
3	12.30±0.80^{a}	12.17±0.95^{a}	11.95±1.48^{ab}	11.89±0.70^{b}	12.11±0.61^{ab}	12.22±0.54^{ab}	0.036
	NS	*NS*	*NS*	*NS*	*NS*	*NS*	---
Lamb sex							
Male	12.32±0.69^{ab}	12.33±0.84^{Aab}	12.51±0.51^{Aa}	11.95±0.62^{Ac}	12.12±0.66^{bc}	12.24±0.62^{bc}	0.002
Female	12.17±1.01^{a}	11.82±0.66^{Bb}	11.84±1.31^{Bab}	11.49±0.52^{Bb}	12.04±0.58^{ab}	12.10±0.88^{ab}	0.023
	NS	*	*	*	*NS*	*NS*	---
Birth type							
Single	12.20±0.98^{a}	11.99±0.79^{ab}	12.15±1.22^{a}	11.79±0.60^{b}	12.07±0.72^{ab}	12.17±0.62^{ab}	0.006
Twinning	12.34±0.53^{a}	12.26±0.79^{ab}	12.23±0.53^{a}	11.88±0.53^{b}	12.10±0.32^{ab}	12.19±0.52^{ab}	0.052
	NS	*NS*	*NS*	*NS*	*NS*	*NS*	---

* A-B The difference between the groups with different letters in the same column is statistically significant (P <0.05)
Post hoc test (Tukey) was used for pairwise comparisons of groups with one-way variance analysis (ANOVA)
a-d The difference between the groups with different letters in the same row is statistically significant (P <0.05)
Variance analysis (Friedman) was used in repeated data for milking differences and Wilcoxon was used in paired comparisons of groups
The difference between the groups was compared using a Student's *t*-test, according to parity, lamb sex, and birth type (P <0.05)
Three replicates were analysed

Table 6 Effect of lamb sex on milk composition

Parameters	Lamb sex			--*P*--
	Male	Female	$\bar{X} \pm S\bar{x}$	
Fat, %	6.71±0.14	6.55±0.13	6,63±0.13	0.411
Solid non-fat, %	12.25±0.06[a]	11.16±0.08[b]	11.70±0.07	0.001
Protein, %	4.57±0.02[a]	4.44±0.03[b]	4.50±0.02	0.0001
Lactose, %	6.69±0.04[a]	6.49±0.05[b]	6.59±0.04	0.001
Density, g/ml	1.04±0.00	1.04±0.00	1,04±0.00	0.337
Freezing point, °C	0.62±0.01	0.59±0.00	0.61±0.01	0.059
Mineral, %	0.69±0.01	0.63±0.01	0.62±0.01	0.100

Data are presented as mean ± standard error
[a,b] The difference between the groups was compared using a Student's *t*-test, according to the male or female lamb (P <0.05)
Three replicates were analysed

There was a negative correlation between lamb sex and solid non-fat, protein, lactose, and density, and a positive correlation between solid non-fat, freezing point, minerals. and fat. A negative correlation was observed between protein, lactose, and fat (Table 7). Lamb deaths are a condition that all countries of the world suffer. Reducing lamb death will improve genetic progress and animal welfare. Lamb death is more prevalent in cases of multiple births (Bruce *et al*., 2021) and in female lambs. One of the important factors contributing to this is the low amount and quality of milk. Moreover, an insufficient amount of milk and a low milk composition may limit body weight gain and cause lamb deaths. Therefore, it is possible that there is a strong genetic correlation between dam milk and lamb growth rates (Afolayan *et al*., 2009). Yilmaz *et al*. (2011) reported a negative correlation between lactose and fat, and a positive correlation between proteins and non-fat solids, and also found a positive correlation between protein and lactose with dry matter; these findings are similar to those of the present study. However, they argued that there was a negative correlation between lactose and protein, contrary to our study. Akca & Bakır (2017) reported a positive correlation between lactose and protein and solid non-fat, as in the present study. The average density ratio in milk was found to be 1.04±0.00 g/cm^3. Akca & Bakır (2017) reported a milk density of 1.038 g/cm^3 in Zom sheep, which was slightly lower than our findings. Female and male foetuses affect milk-producing hormones at different levels (Hess *et al.,* 2016). Bovine foetuses secrete INSL3, the first sex-specific foetal hormone that affects placental and maternal physiology (Anand-Ivell *et al*., 2011). This difference in hormone expression between male and female foetuses may have affected the dam's milk production at different levels of quality.

Table 7 Phenotypic correlation coefficients among milk composition with parity, type of birth and lamb sex

	Fat	Solid Non-Fat	Protein	Lactose	Density	Freezing Point	Mineral
Parity[1]	0.086	0.057	0.055	0.058	-0.031	0.100	0.011
Twinning[1]	-0.043	-0.002	-0.012	0.001	0.073	-0.070	-0.070
Lamb sex[1]	0.055	-0.221**	-0.225**	-0.218**	-0.161*	-0.106	0.053
Fat		0.193**	-0.210**	-0.182**	-0.038	0.210**	0.133*
Solid non-fat			0.932**	0.904**	0.108	0.038	-0.254**
Protein				0.922**	0.104	0.009	-0.336**
Lactose					0.118	0.001	-0.444**
Density						-0.003	-0.004
Freezing Point							0.196**

[1] Correlation between categorical data and measurement parameters was determined using Spearman correlations
The relationship between measurement parameters was determined using Pearson correlations
* Correlation is important at P <0.05. ** Correlation at P <0.01 is important

Conclusion

In the present study, the effect of lamb sex on protein, lactose, solid non-fat, and birth type on fat content was quite substantial. The effects of birth type on daily and lactation milk yields and parity on lactation length were substantial. The highest milk yield was reached in April and decreased during the later stages of lactation. The daily and lactation milk yields and lactation lengths were higher than those reported in previous studies. There was a negative correlation between lamb sex and solid non-fat, protein, lactose, and density. This is the higher milk component in male lambing dams. A positive correlation was found between solid non-fat, freezing point, and minerals with fat, but a negative correlation was identified between fat and protein, lactase, and density. The results of this study suggest that lamb sex is important for milk components, and the contents of milk components are higher in male-lambing ewes and will contribute to the faster growth of male lambs.

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Conflict of Interest

The authors declared that there is no conflict of interest.

Authors' contributions

Design of the study: TB, FA, RÇ. Data collection: TB, FA, MSB. Data analysis; TB, CO, FA. Article writing: TB, MSB. All authors contributed to the final manuscript.

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