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Udder morphology and physicochemical structure of milk in Bafra (Chios × Karayaka) ewes

Tipo de ubre, características de la ubre y del pezón, y estructura fisicoquímica de la leche en ovejas Bafra (Chios × Karayaka)

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ABSTRACT

It was aimed to determine the effects of udder type on udder traits, milk yield and some physicochemical properties of Bafra (Chios × Karayaka) ewes. The lactation length, daily milk yield, lactation milk yield, and daily average milk yield of ewes were determined. In addition the udder type were determined, udder and teat traits were measured. The fat, solid non–fat, protein, lactose, mineral, density, freezing point, and conductivity values of the milk were determined. Type 3 udder was observed at the highest rate (37.5%) and Type 5 udders were not detected in ewes. The lactation length, daily, and lactation milk yield values were calculated as 177.75 days, 868.60 g and 156.86 kg, respectively. Udder circumference, udder width, udder depth, right teat length, left teat length, right teat diameter, left teat diameter, the distance between teats and udder floor height from the ground was calculated as 40.95 ± 0.63, 12.36 ± 0.30, 16.24 ± 0.40, 2.85 ± 0.09, 2.76 ± 0.09, 1.49 ± 0.03, 1.43 ± 0.04, 15.35 ± 0.23, and 31.88 ± 0.70 cm, respectively. Rates of fat, protein, lactose, solid non–fat, mineral and also density, freezing point, and conductivity were calculated at 5.17 ± 0.30, 1039.08 ± 0.31, 6.24 ± 0.05, 11.51 ± 0.10, 0.88 ± 0.009, 1039.08 ± 0.31 g·mL^{-1}, -0.80 ± 0.009°C and 5.26 ± 0.03 mS·cm^{-1}, respectively. It has been determined that Bafra sheep can be a suitable breed for breeding in the conditions of Malatya, Province of Türkiye. However, more scientific research should be done on this topic and the level of milk production should be improved.

Key words: Bafra sheep; milk yield; physicochemical properties of milk; udder traits; udder type

RESUMEN

El objetivo fue determinar los efectos del tipo de ubre sobre las características de la ubre, la producción de leche y algunas propiedades fisicoquímicas de las ovejas Bafra (Chios × Karayaka). Se determinaron la duración de la lactancia, la producción de leche diaria, la producción de leche de lactancia y la producción de leche promedio diaria de las ovejas. Además, se determinó el tipo de ubre y se midieron las características de la ubre y el pezón. Se determinaron los valores de grasa, sólidos no grasos, proteínas, lactosa, minerales, densidad, punto de congelación y conductividad de la leche. La ubre tipo 3 se observó en la tasa más alta (37,5 %) y las ubres tipo 5 no se detectaron en las ovejas. Los valores de duración de la lactancia, diarios y producción de leche de lactancia se calcularon como 177,75 días, 868,60 g y 156,86 kg, respectivamente. La circunferencia de la ubre, el ancho de la ubre, la profundidad de la ubre, la longitud del pezón derecho, la longitud del pezón izquierdo, el diámetro del pezón derecho, el diámetro del pezón izquierdo, la distancia entre los pezones y la altura del piso de la ubre desde el suelo se calculó como 40,95 ± 0,63; 12,36 ± 0,30; 16,24 ± 0,40; 2,85 ± 0,09; 2,76 ± 0,09; 1,49 ± 0,03; 1,43 ± 0,04; 15,35 ± 0,23 y 31,88 ± 0,70 cm, respectivamente. Los niveles o porcentajes de grasa, proteína, lactosa, sólidos no grasos, minerales y también densidad, punto de congelación y conductividad se calcularon en 5,17 ± 0,30; 1039,08 ± 0,31; 6,24 ± 0,05; 11,51 ± 0,10; 0,88 ± 0,009, 1039,08 ± 0,31 g·mL^{-1}; -0,80 ± 0,009°C y 5,26 ± 0,03 mS·cm^{-1}, respectivamente. Se ha determinado que las ovejas Bafra pueden ser una raza adecuada para reproducirse en las condiciones de la provincia de Malatya en Turquía. Sin embargo, se debe hacer más investigación científica sobre este tema y se debe mejorar el nivel de produccion lactea.

Palabras clave: Oveja Bafra; producción de leche; propiedades fisicoquímicas de la leche; características de la ubre; tipo de ubre

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INTRODUCTION

Sheep (*Ovis aries*) breeding is the most important source of livelihood and food security for the majority of the rural population, especially in developing Countries [1].

Especially in dairy breeds, the morphological structure of the udder and teat structure, as well as milk yield and characteristics are extremely important [2]. The knowledge of the relationships between morphological udder traits would permit to prediction correlated responses in milk oriented selection schemes [3]. On the other hand, the physicochemical characteristics of milk are very important as they affect the quality and determine the processed product/milk ratio and thus the cost [4].

One of the most important dairy breeds on which research has been done in Türkiye is the Bafra sheep (*Ovis aries*). Bafra sheep is a breed obtained by crossing two different native breeds (Chios × Karayaka). It was obtain a new breed by combining the ability of the Karayaka breed to adapt to the conditions of the Black Sea Region and the meat quality and the high progeny and milk yield characteristics of the Chios breed [5].

This study was carried out to determine the udder types, udder traits, milk yield and some physicochemical properties of milk in Bafra ewes under Malatya Province conditions in Türkiye.

MATERIAL AND METHODS

Material

This study was conducted in a sheep farm located in the eastern Province of Türkiye, Malatya Province, between January and September 2020. The animal material of the study was arranged with 40 heads Bafra ewes in 3 years of old with an average weight of 53.7 kg which had a single birth during the 2-3 day period when the births were concentrated. These animals were selected from 350 ewes out of a total of 600 ewes on the farm.

Methods

The sheep which taken out to pasture during the daytime when the weather conditions was fed straw and dry grass as roughage in the last 45 days of pregnancy in addition an average of 500 g barley and corn mix concentrated feed (16% HP, 2600 kcal·kg^{-1} ME) per animal. Also animal were fed 300 g concentrated feed per animal in addition to the roughage during the lactation period until they go out regularly to the pasture (*Medicago sativa, Agropyron* spp., *Poa pratensis, Trifolium repens, Festuca ovina,* among others, mix). Births began in mid-January and were completed in early March. The lambs were kept in the same compartment with their mothers for three days after birth. During the pasture period, ewes and lambs were kept together for 3 h during the day and all night long. Dry alfalfa (*Medicago sativa* L.) and lamb grower feed was started to be given to the lambs from the third week and weaning was applied at the age of 105 days. Ewes were started to be milked one week after birth.

The lactation period and lactation milk yield were followed up with regular control milking every month starting from the 1st month of lactation. Milking was done by hand. Control day milk yields were obtained from the morning and evening milking. The lambs were separated from their mothers on the day before control day at 20:00. Milking done at 08:00 on the control day was measured and recorded, and then this milk was drinked to the lambs with bottles. The lambs were kept apart from their mothers all day to control milking. After the evening milking was measured and recorded the lambs were left with their mothers and this milk was given to the lambs with a bottle. When the ewes started to be milked below 100 mL during the control day milking, the follow-up was terminated.

The lactation milk yield was calculated according to the Trapeze II Method using the daily milk yield values of the control days [6]. The lactation periods of ewes were calculated according to Berger and Thomas [7]. Fat (%), solid non-fat (%), density (g·ml^{-1}), lactose (%), mineral (%), protein (%), conductivity (mS·cm^{-1}), and freezing point (°C) analyses of milk were measured by analyzer (Lactoscan MCCWS 3080, Milkotronic LTD, Bulgaria) in the morning and evening milking on the 30th day of lactation [8]. Measurements of the udder and teat before morning milking on the 30th day of lactation were made according to De La Fuente and Türkyılmaz [9] (FIG. 1), and also udders typing were made using the scheme reported by Epstein [10] (FIG. 2).

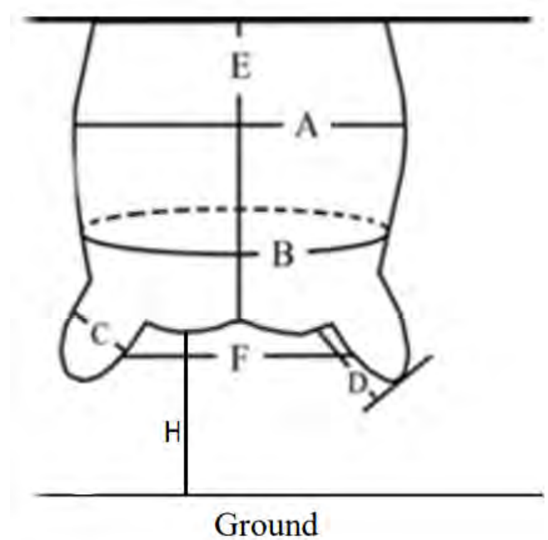

FIGURE 1. Measurement of udder and teat traits in ewes. A: udder width, B: udder circumference, C: teat diameter, D: teat length, E: udder depth, F: distance between teats, H: the udder floor height from ground

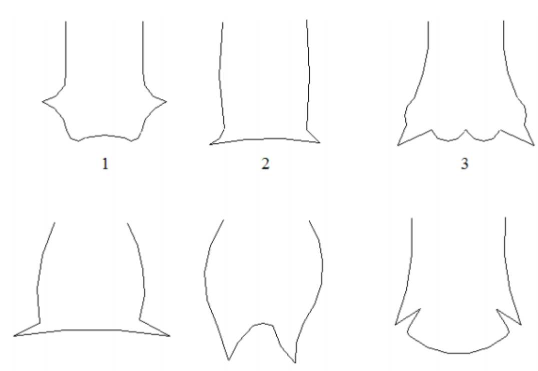

FIGURE 2. Udder types in ewes. 1. Cylindrical udder, teats up and sideways 2. Cylindrical udder, teats down and tilted 3. Pear-shaped udder, teats down and tilted 4. Pear-shaped udder, teats down and horizontal 5. Udder with large, down, and vertical teats 6. Udder with up and tilted teats

Statistical analysis

The descriptive statistics of the traits examined were calculated using the obtained data. Kruskal-Wallis analysis of variance was used for non-parametric properties of data pertaining to daily average milk yield, control day and lactation milk yields, lactation periods, udder and teat characteristics and some physicochemical properties of milk, and Bonferroni Mann-Whitney U test was used to follow up the features determined to be significant. One-way analysis of variance (ANOVA) was used for normally distributed parametric features, followed by Duncan multiple comparison test as a posthoc test. In addition, the correlation coefficients between the lactation period and milk yield values were calculated by Pearson correlation analysis [11]. SPSS 22.0 version program was used for this analysis and calculations [12].

RESULTS AND DISCUSSION

Udder type, lactation length and milk yields of Bafra ewes

Udder type, lactation length and milk yields in Bafra ewes have been presented in TABLE I.

In this study, type 1 (20.0%), type 2 (7.5%), type 3 (37.5%) type 4 (22.5%), and type 6 (12.5%) udders were determined in Bafra ewes, while type 5 was never found (TABLE I).

TABLE I
Udder type, lactation length and milk yields of Bafra ewes (Mean ± SE)

Udder type distributions		
Udder type	**n**	**%**
Type 1	8	20.0
Type 2	3	7.5
Type 3	15	37.5
Type 4	9	22.5
Type 5	-	-
Type 6	5	12.5
Total	40	100
p	**	

Lactation length and milk yields (n=40)			
Lactation length (day)	Lactation milk yield (kg)	Daily average milk yield (g)	Average milk yield (30 day) (g)
177.75±4.74	156.86±10.28	868.60±35.55	1575.35±103.16

**: $P<0.01$

In a study conducted by Kaygısız and Dağ [13] in Awassi ewes, Type 1 (31%), Type 2 (1%), type 3 (42%), type 4 (3%) and type 6 (23%) udder types were determined. In both studies, type 3 udders were found to be high and type 2 udders were found to be a low ratio. In addition, the absence of type 5 udders in Bafra and Awassi sheep is a similar situation. It is thought that this similarity may be related to the fact that both breeds are dairy.

In a study conducted by *Özyürek* [14], it was found that 23.5% of Morkaraman and 25% of Awassi have type I udder, while the others have type 3 udder. Despite the proportional differences between both studies, it was considered an important similarity that type 1 and type 3 udders were detected as the most common types, and type 5 was not found at all. Udder type 3, which was reported to be prevalent in Awassi ewes [13], also was similarly found as the highest rate in this study. This situation was evaluated as positive.

In the study, lactation length (177.75±4.74 days), lactation milk yield (156.86±10.28 kg), daily average milk yield (868.60±35.55 g), and 30. day average milk yield (1575.35±103.16 g) was calculated (TABLE I).

In a study, the overall means were detected in sheep from Akkaraman, Bafra and Bafra × Akkaraman (F1) as 683.61, 849.76 and 753.17 g for daily milk yield, 99.57, 126.40, and 112.52 kg for lactation milk yield, 133.12, 135.84 and 133.80 days for lactation duration, respectively [15]. The lactation length and also daily and lactation milk yield calculated in our study was found to be higher than the values reported for that study. The differences between the lactation lengths between the two studies were 45, 43 and 44 days, respectively for Akkaraman, Bafra and Bafra × Akkaraman (F1) and their rates were considered to be significant (25.28, 24.16 and 24.72%, respectively). The differences between daily milk yields were 184.99, 18.84, and 115.43 g, respectively, the differences between lactation milk yields were 57.29, 30.46 and 44.34 kg, respectively for Akkaraman, Bafra and Bafra × Akkaraman (F1). These differences were considered to be significant. It is thought that the differences between researchs may have arisen due to possible differences in genotype, age, and birth type among sheep, as well as changes in care and feeding conditions due to climatic differences.

In a study, the average daily milk yield, lactation milk yield, and lactation length were determined as 677 g, 102.90 kg, and 150 days in Awassi ewes, respectively [16]. The lactation length and also daily and lactation milk yield calculated in the present study was found to be higher than the values reported for that study. The differences between the two studies were obtained as 191.60 g in daily milk yield, 53.96 kg in lactation milk yield and 27.75 days in lactation length. These values were considered to be significantly. Milk yield on the day of the observation, total milk yield, and days in milk were assessed significantly correlated with nine farmers who were invited by Iñiguez *et al.* [17] to independently estimate the hand-milked milk yield performance.

In a study conducted with Lacaunea ewes, it was established that the studied sheep had a very good milk yield. Ewes had average 220.12 kg of milk for the 150 day milking period [18]. In another study on different breeds was conducted, average daily milk yields were 0.604±0.279 kg (Tsigai), 0.595±0.243 kg (Improved Valachian), and 1.053±0.475 kg (Lacaune) [19]. The milk yield calculated in our study was found to be higher than the values reported in these studies except for Lacaune. This may be due to the different breeds, genotype characteristics of the sheep, and the possibility of better care, and feeding conditions. Because, various environmental factors such as breed, age, lactation number, year, birth type, lambing season, lambing frequency, rearing system, care and feeding conditions affect significantly milk yield and lactation period in sheep [20].

Characteristics of udder and teats in Bafra ewes

Characteristics of udder and teats in Bafra ewes have been presented in TABLE II.

In this study, udder circumference (40.95±0.63 cm), udder width (12.36±0.30 cm), udder depth (16.24±0.40 cm), distance between teats

(15.35±0.23 cm), udder floor height from ground (31.88±0.70 cm), teat length–right (2.85±0.09 cm), teat length–left (2.76±0.09 cm), teat diameter–right (1.49±0.03 cm) and teat diameter–left (1.43±0.04 cm) was calculated (TABLE II).

Özyürek [14] reported that the measurements of Awassi ewes were as follows: udder circumference 37.61 cm, udder width 11.33 cm, udder depth 12.13 cm, the distance between teats 12.33 cm, right teat length 1.47 cm, left teat length 1.46 cm, right teat diameter 1.38 cm and left teat diameter 1.36 cm. In another study conducted by Seker *et al.* [16], udder circumference 40.70 cm, udder depth 14.40 cm, the distance between teats 16.10 cm, right udder length 4.20 cm, and right teat diameter 2.30 cm were determined in Awassi ewes. Panayotov *et al.* [18] concluded that udder circumference 41.46 cm, udder width 12.35 cm, udder depth 16.85 cm, the distance between teats 15.78 cm and teat length was 2.70 cm in Lacaune ewes.

In the current study, the measures determined factors [udder circumference, udder depth, the distance between teats, udder floor height from the ground, right teat length, left teat right, right teat diameter and left teat diameter) discussed were found to be higher than *Özyürek* [14]. The measures of the distance between teats, right teat length and right teat diameter were found to be less than Seker *et al.* [16]. Udder width, udder depth, the distance between teats, right teat length and left teat right measures were found approximately in the current study and Panayotov *et al.* [18].

It is thought that the differences detected between the findings of the current study, and other studies' findings may be due to genotype, age, lactation number, birth type, lactation period, and the care and feeding conditions.

In the study, left teat length and right teat length; left teat diameter and left teat length, right teat diameter; udder circumference and right teat length, left teat length, right teat diameter, left teat diameter; udder width and right teat length, left teat length, udder circumference; udder depth and right teat length, udder circumference; distance between teats and right teat length, udder circumference, udder width, udder depth correlations coefficients were observed to be positive and statistically significantly ($P<0.05$, $P<0.01$). Also, right teat length and udder type; left teat length and udder type; udder depth and udder type; distance between teats and udder type; udder floor height from the ground and right teat length, right teat diameter, udder depth correlations coefficients were observed to be negative and statistically significantly ($P<0.05$, $P<0.01$) (TABLE II).

In a study conducted on Tuj sheep, significant positive correlations ($P<0.05$, $P<0.01$) were established between udder circumference and udder depth, udder circumference and teat diameter, udder

TABLE II

Characteristics of udder and teats in Bafra sheep

Udder and teat traits (Mean ± SE)

UC (cm)	UW (cm)	UD (cm)	DBT (cm)	UFHG (cm)	RTL (cm)	LTL (cm)	RTD (cm)	LTD (cm)
40.95±0.63	12.36±0.30	16.24±0.40	15.35±0.23	31.88±0.70	2.85±0.09	2.76±0.09	1.49±0.03	1.43±0.04

Correlation coefficients between udder type, udder and teat traits (n=40)

Traits	UT	RTL	LTL	RTD	LTD	UC	UW	UD	DBT
RTL	-0.48**								
LTL	-0.33*	0.74**							
RTD	-0.14	0.31	0.19						
LTD	-0.04	0.31	0.38*	0.74**					
UC	-0.19	0.46**	0.49**	0.42**	0.44**				
UW	-0.17	0.43**	0.45**	0.06	0.15	0.65**			
UD	-0.40*	0.42**	0.18	0.27	0.20	0.37*	0.29		
DBT	-0.31*	0.32*	0.20	0.23	0.26	0.48**	0.42**	0.69**	
UFHG	0.27	-0.42**	-0.26	-0.36*	-0.25	-0.17	-0.21	-0.38*	–0.25

Udder and teat traits according to udder type (Mean ± SE)

UT	RTL	LTL	RTD	LTD	UC	UW	UD	DBT	UFHG
Type 1	$3.13±0.07^{B}$	$2.89±0.11^{B}$	1.58±0.06	1.44±0.08	41.00±1.44	$11.94±0.59^{AB}$	17.94±1.08	16.06±0.33	$28.63±1.34^{A}$
Type 2	$2.73±0.32^{B}$	$2.50±0.29^{AB}$	1.37±0.15	1.30±0.11	40.00±2.52	$12.33±0.67^{AB}$	15.33±0.33	15.00±1.00	$38.00±1.73^{B}$
Type 3	$3.00±0.14^{B}$	$2.91±0.15^{B}$	1.50±0.04	1.51±0.06	42.20±1.16	$13.00±0.55^{B}$	16.63±0.57	15.53±0.35	$31.07±0.85^{A}$
Type 4	$2.84±0.18^{B}$	$2.82±0.18^{B}$	1.41±0.06	1.36±0.08	40.78±0.97	$12.78±0.57^{B}$	15.33±0.80	15.06±0.68	$33.11±0.95^{A}$
Type 6	$2.06±0.26^{A}$	$2.12±0.12^{A}$	1.50±0.13	1.42±0.12	38.00±1.45	$10.40±0.24^{A}$	14.50±0.84	14.40±0.40	$33.60±3.19^{AB}$
p	*	*	–	–	–	*	*	*	*
Total	2.85±0.09	2.76±0.09	1.49±0.03	1.43±0.04	40.95±0.63	12.36±0.30	16.24±0.40	15.35±0.23	31.88±0.70

UC: Udder circumference (cm), UW: Udder width (cm), UD: Udder depth (cm), DBT: Distance between teats (cm), UFHG: Udder floor height from ground (cm), RTL: Right teat length (cm), LTL: Left teat length (cm), RTD: Right teat diameter (cm), LTD: Left teat diameter (cm). ^{A,B}: Differences between means with different letters in the same column are significant ($P<0.05$). –: $P>0.05$, *: $P<0.05$, **: $P<0.01$

circumference and udder width, udder depth and teat diameter, udder depth and udder width, teat length and teat diameter, teat diameter and udder width, udder bottom height and udder upper height, udder upper height and udder width at the 70th and 100th days of lactation [21].

In another study conducted in Bafra ewes, correlation coefficients were generally high and positive for udder depth, width and circumference; were found to be high and negative for the distance between the teats height from the ground [22].

In the present study, the correlation coefficients between the factors determined on udder type, udder and teat traits were found not to be same as Sarı *et al.* [21] but the correlation coefficients for udder depth, width and circumference were found higher and positive than Ünal *et al.* [22].

It is thought that there are differences detected because udder morphology characteristics are affected by various factors such as race, age, lactation period, season, milking system, and nutrition.

In the study, it was determined that the effect of udder types (type 1, type 2, type 3, type 4 and type 6) on the udder width, udder floor height from the ground, right teat length and left teat length were found to be significantly ($P<0.05$). But, the effect of udder types on the udder circumference, udder depth, distance between teats, right teat diameter and left teat diameter were not found to be significant ($P>0.05$) (TABLE II).

In a study conducted Ünal *et al.* [22], the effect of udder type on udder width, udder circumference and distance between teats were found to be significant ($P<0.01$, $P<0.05$). Also in another study conducted Sarı *et al.* [21], the effect of the udder type on udder width was found statistically important ($P<0.05$). It can be said that the lactation period and duration, the mechanical effects of milking or sucking on the udder and changing hormonal effects are the main factors that play a role in the udder and teat traits.

In the study, it was determined that type 1 udder had the highest measurement in terms of udder depth, the distance between teats, right teat length, right and left teat diameter. Also, type 3 udder had the highest measurement in terms of udder circumference, udder width and left teat lengt. On the other hand, type 6 udder had the lowest measurement in terms of udder circumference, udder width, udder depth, and the distance between teats, right and left teat length. Also, type 2 udder had the lowest measurement in terms of right and left teat diameter (TABLE II).

In a study conducted by Özbaşer and Akçapınar [20] to determine some yield characteristics of Acıpayam (25% East Friesian + 50% Awassi + 25% Dağlıç) sheep under Central Anatolian conditions in Türkiye, four udder types (Type1, Type 2, Type 3 and Type 4) was determined and their rates were respectively 8.86, 59.49, 26.58, and 5.07%. However, a study conducted by Kaygısız and Dağ [13] was determined the most common udder type being Type 3 in Awassi ewes. In Acıpayam sheep, although Type 2 is the most common udder type in the herd, the highest milk yield was obtained from sheep with Type 4 udder.

In terms of the means of udder and teat traits, it can be said that the most suitable udders are type 1 and type 3, and the most unsuitable udders are type 6 in Bafra ewes.

Physicochemical properties of milk

Physicochemical properties of milk in Bafra ewes have been presented in TABLE III.

In these study, fat (5.17 ± 0.30%), protein (1039.08 ± 0.31%), lactose (6.24 ± 0.05%), solid non–fat (11.51 ± 0.10%), mineral (0.88 ± 0.009%), dencity (1039.08 ± 0.31 g·ml^{-1}), freezing point (–0.80 ± 0.009°C) and conductivity (5.26 ± 0.03 mS·cm^{-1}) were calculated (TABLE III).

In a study, the overall means in sheep from Akkaraman, Bafra and Bafra × Akkaraman (F1) were found as 5.85, 5.44 and 5.67% for fat; 5.09; 5.02 and 5.03% for protein; 4.89; 5.04 and 5,02% for lactose; 16.81; 16.42 and 16.67% for dry matter, respectively [15]. It was established that in a study, the milk of Lacaune ewes had a very high content of fat (7.60%), protein (7.09%) and dry matter (20.06%) [18]. In another study conducted on Awassi sheep, the fat was 6.06 ± 0.21%, the protein was 3.77 ± 0.05%, the lactose was 5.73 ± 0.07%, the dry matter was 10.66 ± 0.13%, the mineral was 0.79 ± 0.01%. In addition, it was calculated that density was 1.035 ± 0.00 g·mL^{-1}, freezing point -0.75 ± 0.02°C, and conductivity 5.04 ± 0.02 ms·cm^{-1} [8]. In addition, protein, fat, lactose, and solid non–fat were found at 5.20–5.30, 5.70–6.10, 4.90–5.30, and 11.00–11.40%, in Awassi ewes, respectively [23]. Also in Dorper sheep, protein, fat, lactose, solid non–fat, and freezing point were 5.45%, 8.09%, 5.22%, 11.13%, and -0.58°C were reported, respectively [24].

In the current study, the calculated fat was found to be lower but the lactose was higher than the values reported by Şeker *et al.* [8], Kahraman and Yüceer Özkul [15], Panayotov *et al.* [18], Çelik and Özdemir [23] and also Tarazona *et al.* [24]. Protein was found to be lower than the values reported by Kahraman and Yüceer Özkul [15], Panayotov *et al.* [18], Çelik and Özdemir [23] and also Tarazona *et al.* [24] but rate was to be higher than the value reported by Şeker *et al.* [8]. Solid non–fat rate was found to be lower than the values reported by Kahraman and Yüceer Özkul [24] and Panayotov *et al.* [18] but the rate was found higher than the values reported by Şeker *et al.* [8], Çelik and Özdemir [23] and also Tarazona *et al.* [24]. In addition, mineral, density and conductivity calculated in the present study were found to be higher than the values reported by Şeker *et al.* [8]. The freezing point was found to be higher than the values reported by Şeker *et al.* [8] and Tarazona *et al.* [24]. Some researchers reported that the lactation period, like many genetic and environmental factors, affected some physicochemical properties of milk [4]. The fat content of milk is a component that changes the most in milk composition depending on environmental factors such as care and nutrition [25]. There is a negative correlation between milk fat and lactose and between milk protein and lactose [23]. Considering the literature information, it is thought that the differences between researches may have arisen due to possible differences in genotype, age, and birth type among sheep, as well as changes in care and feeding conditions due to climatic differences.

In the study, solid non–fat and fat; density and solid non fat; protein and fat, solid non–fat; lactose and fat, solid non–fat, density, protein; mineral and solid non–fat, density, protein, lactose; freezing point and fat, solid non–fat, density, protein, lactose, mineral; conductivity and fat, solid non–fat, protein, lactose, mineral, freezing point correlations coefficients were observed to be positive and statistically significantly ($P<0.05$, $P<0.01$) (TABLE III).

Contrary to these findings, in a study conducted by Sarı *et al.* [21] in Tuj ewes, significant correlations were found between solid non–fat and density, solid non–fat and lactose, solid non–fat and mineral,

TABLE III
Physicochemical properties of milk in Bafra ewes (n=40)

Physicochemical properties of milk (Mean ± SE)								
Correlations								
Traits	**F**	**SNF**	**D**	**P**	**L**	**S**	**FP**	
F								
SNF	0.50**							
D	0.07	0.87**						
P	0.48**	0.99**	0.86**					
L	0.49**	0.99**	0.87**	0.99**				
S	0.22	0.83**	0.84**	0.84**	0.84**			
FP	-0.67**	-0.97**	-0.72**	-0.96**	-0.96**	-0.75**		
C	-0.50**	-0.42**	-0.19	-0.41**	-0.42**	-0.36*	0.51**	
Correlations								
Trait	**F**	**SNF**	**D**	**P**	**L**	**S**	**FP**	**C**
RTL	0.34*	0.28	0.33*	0.33*	0.25	-0.34*	-0.34*	-0.26
LTL	0.46**	0.53**	0.46**	0.47**	0.44**	-0.38*	-0.38*	-0.13
RTD	-0.13	-0.13	-0.17	-0.13	-0.16	0.12	0.12	-0.06
LTD	0.05	0.12	0.02	0.06	0.02	-0.01	-0.01	-0.08
UC	-0.06	0.12	-0.07	-0.03	-0.01	0.16	0.16	0.12
UW	0.23	0.40*	0.21	0.24	0.33*	-0.11	-0.11	0.06
UD	0.02	-0.18	-0.01	0.03	-0.01	-0.12	-0.12	-0.10
DBT	-0.14	-0.15	-0.16	-0.12	-0.10	0.13	0.13	-0.01
UFHG	-0.15	0.04	-0.11	-0.14	0.01	0.23	0.23	0.22
Milk physicochemical properties according to udder type (Mean ± SE)								
UT	**F**	**SNF**	**D**	**P**	**L**	**S**	**FP**	**C**
Type 1	6.06±0.53^{B}	11.44±0.12	1038.18±0.48	4.09±0.04	6.19±0.06	0.88±0.02	-0.81±0.01	5.23±0.06^{AB}
Type 2	3.63±0.24^{A}	11.20±0.17	1038.77±0.79	4.00±0.06	6.07±0.09	0.87±0.03	-0.77±0.01	5.40±0.06^{B}
Type 3	6.00±0.58^{B}	11.77±0.20	1039.71±0.64	4.19±0.08	6.38±0.11	0.90±0.02	-0.83±0.02	5.13±0.06^{A}
Type 4	3.66±0.21^{A}	11.32±0.18	1039.17±0.68	4.04±0.06	6.13±0.10	0.88±0.02	-0.78±0.02	5.42±0.04^{B}
Type 6	4.90±0.60^{AB}	11.38±0.16	1038.64±0.37	4.06±0.07	6.16±0.07	0.86±0.02	-0.79±0.02	5.34±0.04^{B}
p	**	–	–	–	–	–	–	**
Total	5.17±0.30	11.51±0.10	1039.08±0.31	4.11±0.04	6.24±0.05	0.88±0.01	−0.80±0.01	5.26±0.03

UT: Udder Type, RTL : Right teat length (cm), LTL: Left teat length (cm), RTD: Right teat diameter (cm), LTD: Left teat diameter (cm), UC: Udder circumference (cm), UW: Udder width (cm), UD: Udder depth (cm), DBT: Distance between teats (cm), UFHG: Udder floor height from ground(cm), F: Fat (%), SNF : Solid non–fat (%), D: Density (g·ml^{-1}), P: Protein (%), L: Lactose (%), S: Mineral (%), FP: Freezing point (°C), C: Conductivity (mS·cm^{-1}). A,B: Differences between means with different letters in the same column are significant (P<0.05). –: P>0.05, *: P<0.05, **: P<0.01

density and lactose, density and mineral, and lactose and mineral. The findings obtained in our study are also different from those obtained in the study of Karakuş and Ilyas [26]. In Karakuş and Ilyas [26] study on Awassi ewes, a negative and weak correlation was determined between fat and solid non–fat. The correlations of fat and protein, and lactose were positive but weak. On the other hand, solid non–fat had positive and significant (P<0.05), and the content of protein was correlated with lactose (P<0.01).

In this study, right teat length and fat, density, protein; left teat length and fat, solid non–fat, density, protein, lactose; udder width and solid non–fat, lactose correlations coefficients were determined to be positive and statistically significant (P<0.05, P<0.01) Also, teat lengths (right and left) and mineral, freezing point were determined to be negative and statistically significant (P<0.05) (TABLE III).

In a study conducted by Karakuş and Ilyas [26] on Awassi sheep, positive and negative but very weak correlations were found between udder measurements and milk composition characteristics. Similar to our study, a high correlation was found between left teat length and solid non–fat of milk (P<0.05).

In a study conducted by Türkyılmaz *et al.* [27] in Morkaraman sheep, similar to the findings in the present study, a positively correlation was observed between the udder dept and solid non–fat, density, protein, lactose, ash, and also udder width and fat, solid non–fat, lactose, density, protein, lactose, ash (P<0.05, P<0.01).

In the study, it was determined that the effect of udder types (type 1, type 2, type 3, type 4 and type 6) on fat and conductivity was found to be significant (P<0.05). But, the effect of solid non–fat, density, protein, lactose, mineral, and freezing point were not found to be significant (P>0.05) (TABLE III).

In this study, the effect of udder types on milk physicochemical properties except fat and conductivity were not found to be significant, similar to studies of Şeker *et al.* [8], Özyürek [14], Sarı *et al.* [21].

CONCLUSIONS

In conclusion, the limited research available on udder type, udder and teat characteristics, and milk physicochemical structure in Bafra ewes allowed limited comparison of these research findings with other studies of the same race. However, it can be said that Bafra sheep bred under the conditions of the Eastern Anatolia Region, show better characteristics, especially in terms of milk yield and lactation period, compared to many different breeds in which the findings are compared. Detection of the highest number of Type 3 udders in Bafra sheep is considered favorable in terms of milking characteristics. In addition to these, albeit limited, important positive and negative correlations among some of the udder and teat characteristics and milk's physicochemical components were determined.

As a result; it has been concluded that Bafra sheep are a breed that can be recommended for breeding in terms of the udder traits, milk yield and some physicochemical properties of milk in the conditions of the Malatya province of Türkiye. As well as more scientific research and improving milk yield should be done.

Ethical statement

The study was approved by the Local Ethics Committee of the Experimental Animals of the Malatya Provincial Directorate of Agriculture and Forestry in Türkiye (2020/73919507–280.01.01–E.907632).

Conflict of interest statement

The authors declare there is no conflict of interest.

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