https://doi.org/10.52973/rcfcv-e34368 Revista Científica, FCV-LUZ / Vol. XXXIV, rcfcv-e34368

Determination of udder and teat linear morphological traits in Awassi and Bafra (Chios × Karayaka) Ewes

Determinación de rasgos morfológicos lineales de ubre y pezón en Awassi y Bafra (Quíos × Karayaka) Ovejas

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ABSTRACT

This study was carried in order to evaluate the linear morphological characteristics of the udder and teats in the breeder conditions of Awassi and Bafra (Chios × Karayaka) ewes (*Ovis aries*) and to determine the udder types, lactation milk yield and the lactation period of the ewes. One hundred two Awassi and 61 Bafra ewes were included in the study. The means of the linear scores of udder depth, udder furrow, udder attachment, teat shape, teat angle and teat placement in Awassi ewes were determined as 6.10 ± 0.27, 6.33 ± 0.27, 4.49 ± 0.27, 6.49 ± 0.33, 3.98 ± 0.29, and 1.47 ± 0.14, respectively. The same parameters were determined as 6.31 ± 0.28, 6.77 ± 0.32, 5.72 ± 0.24, 1.20 ± 0.11, 1.72 ± 0.26, and 1.20 ± 0.11, respectively, in Bafra ewes. Significant differences were found between Awassi and Bafra breeds in terms of udder types (P<0.01). The type 3 udder, suitable for milking, was determined at the highest rate in both breeds, but type 2 udder was not detected in Awassi ewes. Statistically significant differences were found between Awassi and Bafra ewes in terms of linear morphological characteristics of udder and teat, udder attachment, teat shape, teat angle and 60th day milk yield, daily average milk yield and lactation period (P<0.01). Lactation milk yield and lactation period were calculated as 139.85 ± 5.31 kg and 208.53 ± 4.471 days, respectively, in Awassi ewes and 145.91 ± 9.97 kg and 175.23 ± 4.635 days in Bafra ewes, respectively. As a result, in order for linear udder characteristics to be used safely as an indirect selection criterion, there is a need for studies with a higher number of ewes and to calculate the repeatability and heritability.

Key words: Ewe; milk yield; lactation period; linear score; teat placement; udder shape

RESUMEN

Este estudio se llevó a cabo para evaluar las características morfológicas lineales de la ubre y los pezones en las condiciones reproductivas de las ovejas (*Ovis aries*) Awassi y Bafra (Chios × Karayaka) y para determinar los tipos de ubre, la producción de leche en lactancia y el período de lactancia de las ovejas. En el estudio se incluyeron 102 ovejas Awassi y 61 ovejas Bafra. Las medias de las puntuaciones lineales correspondieron a de profundidad de ubre, surco de ubre, inserción de ubre, forma de pezón, ángulo de pezón y colocación de pezón. En ovejas Awassi se obtuvieron valores de 6,10 ± 0,27; 6,33 ± 0,27; 4,49 ± 0,27; 6,49 ± 0,33; 3,98 ± 0,29 y 1,47 ± 0,14, respectivamente. Mientras que en la raza Bafra los índices correspondieron a 6,31 ± 0,28; 6,77 ±0,32; 5,72 ± 0,24; 1,20 ± 0,11; 1,72 ± 0,26 y 1,20 ± 0,11, respectivamente. Se encontraron diferencias significativas entre ambas razas Awassi y Bafra en cuanto al tipo de ubre (P<0,01). La ubre tipo 3, apta para ordeño, fue encontrada en mayor proporción en ambas razas; la ubre tipo 2 no fue detectada en las ovejas Awassi. Se encontraron diferencias estadísticamente significativas entre las ovejas Awassi y Bafra en términos de características morfológicas lineales de ubre y pezón, inserción de la ubre, forma del pezón, ángulo del pezón y producción de leche a los 60 días, producción de leche promedio diaria y período de lactancia (P<0,01). La producción de leche en lactancia y el período de lactancia se calcularon en 139,85 ± 5,31 kg y 208,53 ± 4,471 días, respectivamente, en las ovejas Awassi y 145,91 ± 9,97 kg y 175,23 ± 4,635 días en las ovejas Bafra, respectivamente. Como resultado, para que las características lineales de la ubre puedan usarse de manera segura como criterio de selección indirecta; no obstante, es necesario realizar estudios con un mayor número de ovejas y calcular la repetibilidad y heredabilidad de estas caracteristicas.

Palabras clave: Ewe; producción de leche; período de lactancia; puntuación lineal; colocación de pezones; forma de ubre

Received: 19/12/2023 Accepted: 05/02/2024 Published: 11/05/2024

INTRODUCTION

In selection application within the context of breeding studies in sheep (*Ovis aries*), it is important to consider morphological properties, in particular the udder and teat characteristics besides yield registries and pedigree data [1]. Awareness of the udder and teat morphology affects sheep breeding farms, both for milk and meat production in many aspects, since teat characteristics are inherited. A poor udder and teat morphology may negatively affect milk production, milking performance, milking-related injuries, infections and lamb production. When the udder and teat morphology of the ewes is better and more suitable for breeding, ewes are less susceptible to infections, stay longer in the sheep herd, the ratio of selection and change decreases and production of milk and meat significantly increases [2].

In milking ewes, assessment of the morphological structure of the udder using a linear scoring scale has emerged as an alternative to the current morphological assessment systems. In the linear assessment, the morphological value of the udder and teat characteristics is determined through a nine-point scale [3, 4]. Linear scoring should characterize the udder morphology as precisely as possible; however, a limited number of scales and criteria should be used for the system in order for it not to be very complex and time-consuming. Obtaining data on the relationship between individual characteristics of the udder morphology is important for including them in the overall selection indices or creating partial selection indices for the udder morphology. This information enables the estimation of future milk selection schemes. The genetic correlations between the related characteristics are also required for the selection index structure; however, large numbers of well-structured data are required for accurate estimation of genetic correlations [5].

Linear morphological assessment of the udder and teat characteristics indirectly reveals the animals' milking characteristics. Thereby, selection applications may be easier and more successful. In the linear morphological assessment process, the subjects that can exceed the optimum level, remain in the herd and can thereby be subjected to a constant selection in terms of udder and teat characteristics. In this way, the population can achieve faster and higher genetic improvement. In the near future, in order to be able to make a more accurate and productive assessment in terms of the udder and teat characteristics in milking ewes, it is expected to define their linear morphological structures and generalize this to the whole registered population [4].

Awassi breed which adapts very well to hot and dry climatic conditions, is among the sheep breeds with high milk yield in the world. It can produce an average of 60–80 liters and up to 504 liters of milk in lactation under modern operating conditions [6]. Hence, breeding of the Awassi breed is of significant importance [7].

On the other hand, Bafra sheep were obtained from Chios breed which stands out with its meat quality besides the high milk and fertility and also Karayaka breed which has adapted to the Black Sea conditions in Türkiye [8]. The lactation milk yield of Bafra ewes has been reported as 111–150 kg and the lactation period as 120 days [9]. In another study by Kahraman and Yüceer Özkul [10], the average daily milk yields of Bafra and Bafra × Akkaraman (F1) ewes were reported to be 849.76 and 753.17 g, the lactation milk yields were 126.40 and 112.52 kg and the lactation periods were 135.84 and 133.80 days, respectively.

Identification of the linear udder characteristics in sheep is an important issue in terms of genetic breeding potential and business economy. There is a great potential in Türkiye, especially in dairy sheep, since selection is not made in this direction [1].

Many studies have been conducted on the Awassi breed examining the udder and teat characteristics and the relationships between them and the milk yield in particular [1, 2, 7, 11, 12, 13, 14, 15]. However, similar studies on Bafra sheep [9, 16] are observed to be insufficient and not widespread. The present study was carried out to evaluate the linear morphological characteristics of the udder and teats and to determine the udder types, lactation milk yields and the lactation durations of Awassi and Bafra (Chios × Karayaka) ewes, both of which are milking breeds.

MATERIAL AND METHODS

This study was carried out in two different private sheep farms in the Malatya province between January and September 2020. The animal material of the study comprised Awassi and Bafra ewe, bred by the public. The first farm had 340 Awassi and the second had 600 Bafra ewes. Care and feeding of the animals were carried out under semi-intensive conditions. Bafra ewes were obtained from a breeding farm two years prior to the study. Awassi sheep, on the other hand, belonged to a business where pure breeding has been carried out in the form of closed herds for a long time. All ewes that were 3–4 years of age, that had given birth on the same dates (on the 2–3-day period when the births were concentrated) and had given birth to a single lamb in these herds, were included in the study as 102 animals for the Awassi breed and 62 for the Bafra breed. These sheep were numbered for follow-up throughout the research.

During the study period, the ewes included in the study were cared for and fed similarly in both farms, with straw and hay as roughage in the last 45 days of pregnancy, as an average of 500 g concentrated feed per animal (HP 16%, 2600 kcal·kg^{-1}). During the lactation period, 250–300 g concentrate feed was given until they went out to the pasture regularly. In this process, the ewes were taken to the pasture during the daytime when the weather conditions were suitable and they were housed in the sheep pen at night. However, from the beginning of April, the sheep were taken to the pasture regularly every day and continued to be grazed in the pasture until the end of October. The sheep were given an additional concentrate feed of approximately 1% of their live weight on return from the pasture.

In the herd where the study was conducted, deliveries began in mid-January and ended at the beginning of March. The lambs were kept in the same place with their mothers for three days after delivery; afterwards, they were kept in the herd together with their mothers until the pasture period. During the pasture period, ewes and lamb were kept together for 3 hours in the middle of the day and overnight. Weaning was carried out when the lamb were 105 days old. Milking of the ewes was begun one week after birth and the lactation period and lactation milk yield were monitored with regular control milking every month from the first month of lactation. Milking was carried out by hand and control day milk yields were obtained in the form of both morning and evening milking. On the control day, on the day before milking, the lamb were separated from their mothers at 20:00, and the milk obtained at 08:00 in the morning was measured and recorded and then fed to the lamb with bottles. The lamb were kept apart from their mothers all day and after the milking of the control day in the evening, and once the milk had been measured and recorded, the lamb were left with their mothers and the milk was given to the lamb with a

bottle. Milking follow-up was terminated when the ewes began to be milked under 100 mL during the control day milking. The lactation milk yield was calculated according to the Trapeze II Method (Fleischmann Method) using the daily milk yield values of the control days [17]. The following formula was used to calculate the milk yield (MY) according to International Committee For Animal Recording (ICAR)

$$MY = \left[(k_1 A) + \left(\frac{k_1+k_2}{2}\right)a_1 + \ldots + \left(\frac{k_{n-1}+k_n}{2}\right)a_n + k_n C\right]$$

a: Control range; n: number of controls; k: The amount of milk obtained in the controls; A: The day between the milking date and first control date; C: The day between the last control day and drying.

Furthermore, the lactation periods of sheep were calculated according to Berger and Thomas [18]. The udder types of the sheep were observed from the back and the side before morning milking on the 60th day of lactation, photographed and evaluated as Types I, II, III, IV, V, and VI, according to the criteria and typing reported by Epstein [19] (FIG. 1).

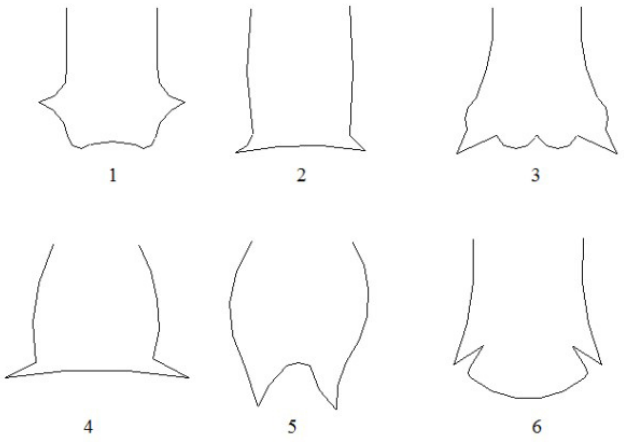

FIGURE 1. Udder types of sheep. 1. Cylindrical udder, teats up and sideways 2. Cylindrical udder, teats down and oblique 3. Pear-shaped udder, teats down and oblique 4. Pear-shaped udder, teats down and horizontal 5. Teats are large, down and vertical udder 6. Udder with teats up and tilted [19]

The morphological linear scoring of udders and teats was made in accordance with the criteria defined by De La Fuente *et al.* [3] and NEIKER [20], before morning milking at the 60th of lactation (FIG 2). In the morphological linear assessments, udder depth (UD), udder furrow (UF), udder attachment (UA), teat shape (TS), teat angle (TA) and teat placement (TP) were also addressed besides the udder type.

UD is defined by the distance between rear attachment and the udder floor, using as a reference the hock. Udders with excessive depth (below the hock) usually reflect deficiencies in the suspensory ligament. UF is the basic ligament that extends to divide the udder from top the bottom and attachments the udder to the body. It is desired that this connection be evident. UA is determined by the perimeter of the insertion to the abdominal wall of the ewe. TS is classified as funnel, cylindrical and bottle, respectively. TA is angle of insertion of the teat with respect to the vertical. TP is defined by teat angle, directed toward the ground, that coincide with minimum cistern height.

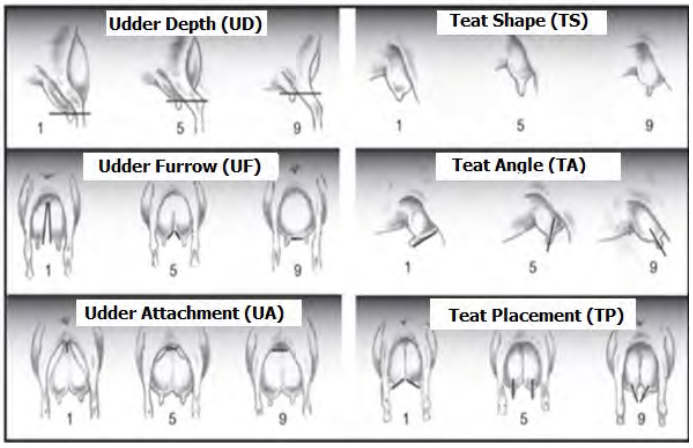

FIGURE 2. The scoring scale that was used for the udder and teat linear morphology [3, 20]

First, the descriptive statistics were estimated. The normality distribution of each property was analyzed. They were evaluated for meeting the parametric test assumptions. The Independent student's t-test was used for comparisons between breeds with regard to lactation milk yield, average daily milk yield, milk yield at the 60th day of lactation, lactating periods and the udder and teat linear morphological characteristics. The breeds were compared for udder types using the Fisher's exact test. Furthermore, the correlation coefficients between the udder type and the linear morphological characteristics of the udder and teat were estimated using the Pearson correlation analysis [21]. The SPSS version 22.0 statistical package program was used for these analyses [22].

RESULTS AND DISCUSSION

The lactating periods and the milk yield of Awasi and Bafra ewes

In the present study, the lactation milk yield (P>0.05), the 60th-day milk yield, the average daily milk yield and the lactation period were found to be higher in Bafra ewes (P<0.01; TABLE I).

This result is quite striking out of the countenance of the Awassi, which is a milking breed. This situation, which is in favor of the Bafra breed, is understood to have resulted from the effect of the Chios breed in its genotype.

The lactation milk yield and the lactation period calculated for Awassi and Bafra ewes were higher than the values reported by Kahraman and Yüceer Özkul [10], while the daily milk yield calculated for Bafra ewe was lower.

TABLE I
Lactating periods and milk yield of Awasi and Bafra ewes (x̄ ± SEM)

Characteristics	Awassi (n=102)	Bafra (n=61)	*P*
Lactation milk yield (L)	139.85±5.31	145.91±9.97	0.56
60th day average milk yield (mL)	752.60±23.22[b]	1460.45±101.50[a]	0.01
Daily average milk yield (mL)	665.50±19.94[b]	816.67±35.76[a]	0.01
Lactation period (day)	208.53±4.471[a]	175.23±4.635[b]	0.01

The lactation period was 173.81 days and the lactation milk yield was 244.39 L in the Elit Awassi sheep herd raised in the Ceylanpınar Agricultural Enterprise by Kaygısız and Dağ [2]. In a study conducted on Awassi ewes by Seker *et al.* [11], the lactation period was determined as 158.20 days and the lactation milk yield as 115.01 kg. In another study by Seker *et al.* [11], the average daily milk yield, the lactation milk yield and the lactation period in Awassi ewes were found to be 677.00 g, 102.90 kg and 150.00 days, respectively. The lactation period calculated in the present study was found to be higher than the values reported in the studies above. The lactation milk yield was lower than that reported by Şeker *et al.* [1] and Kaygısız and Dağ [2]; however, the lactation milk yield and the average daily milk yield were found to be lower than those reported by Seker *et al.* [11]. The differences between the findings in the present study and some literature reports have been suggested to have resulted from the differences in genotype, age, and birth type, as well as the changes in climate, care and feeding conditions.

The udder types determined in Awassi and Bafra ewes

In this study, while type 1 (32.4%), type 3 (35.3%), type 4 (14.7%), type 5 (2.0%) and type 6 (15.7%) udders were detected in Awassi ewes, type 2 udder was not detected. Type 1 (18.0%), type 2 (11.5%), type 3 (34.4%), type 4 (19.7%), type 5 (3.3%) and type 6 (13.1%) udder types were found in Bafra ewes. Significant differences were found between these breeds with regard to breast types ($P<0.01$), and type 3 was found to be the closest to each other in proportion, and the farthest udder type was found to be type 1. The absence of type 2 udders in Awassi ewes was determined to be the main difference between the two breeds (TABLE II).

TABLE II
The udder types determined in Awassi and Bafra ewes

Breeds	Udder Types												Total
	1		2		3		4		5		6		
	n	%	n	%	n	%	n	%	n	%	n	%	n
Awassi	33	32.4	–	–	36	35.3	15	14.7	2	2.0	16	15.7	102
Bafra	11	18.0	7	11.5	21	34.4	12	19.7	2	3.3	8	13.1	61
P	0.01												

In a study conducted by Kaygısız and Dağ [2] on Awassi ewes, type 1 (31%), type 2 (1%), type 3 (42%), type 4 (3%) and type 6 (23%) udders were identified. In a study conducted by Özyürek [14], 25% of the Awassi breed were found to have type 1 udder and the remaining had type 3 breasts. Similarly, type 1 and type 3 breasts were also found to be at a higher rate in this study (Table 2). In the other study conducted by Kaygısız and Dağ [2], type 5 breasts were not detected, and type 2 breasts were found at the lowest rate. In many studies on the same breed, the difference regarding the udder types is striking. These differences are considered to have been caused by the udder type preferences during the breeding selection process, age, number of lactations, birth type, lactation period, time of data collection and care and feeding conditions. In addition to the afore-mentioned factors, in the present study, the genotype was also found to have a significant effect on the differences between the two breeds in terms of udder types.

The scores of udder and teat linear morphological characteristics in Awassi and Bafra ewes

According to the results of the study, the UD, UF and the UA were found to be higher in the Awassi breed ($P<0.01$), and the linear morphological scores of teat shape (TS) ($P<0.01$), TA ($P<0.01$) and the TP were found to be higher in the Bafra breed (TABLE III).

TABLE III
The scores of udder and teat linear morphological characteristics in Awassi and Bafra ewes ($\bar{x}$ ± SEM)

Breeds	Udder depth (UD)	Udder furrow (UF)	Udder attachment (UA)	Teat shape (TS)	Teat angle (TA)	Teat placement (TP)
Awassi (n=102)	6.10±0.27	6.33±0.27	4.49±0.27[a]	6.49±0.33[a]	3.98±0.29[a]	1.47±0.14
Bafra (n=61)	6.31±0.28	6.77±0.32	5.72±0.24[b]	1.20±0.11[b]	1.72±0.26[b]	1.20±0.11
P	0.58	0.30	0.01	0.01	0.01	0.13

Şeker *et al.* [1] found the mean values of the linear morphological characteristics of the udder and teats as 6.10 for teat placement and 4.40 for udder attachment and udder depth in the Awassi breed. In a study conducted on Kıvırcık ewes in breeder conditions, Akgün and Koyuncu [5] determined the mean scores of udder depth, udder separation degree (udder furrow), udder attachment degree and teat placement as 8.0, 3.4, 6.9, and 4.6, respectively.

In the present study, the scores of teat placement detected in Awassi and Bafra ewes were determined to be lower than those found by Şeker *et al.* [1] and higher than those reported for udder attachment and udder depth. Moreover, the scores found for udder depth, udder furrow and teat placement in Awassi and Bafra ewes were lower than the scores reported by Akgün and Koyuncu [5], and the score for udder attachment was found to be higher.

When the linear morphological characteristics of the udder and teat in Awassi and Bafra sheep in this study were examined, and furthermore, when the milk yield, udder health and milking requirements were considered, the udder depth, udder furrow and the teat placement were evaluated as adequate–appropriate in both breeds. However, it was observed that the Bafra breed had better structural characteristics for udder attachment and the Awassi breed had better structural characteristics for teat shape and teat angle. The animals in this study were aged 3–4 years, had singleton pregnancies and the linear morphology scoring was made on the 60th day of lactation. It is suggested that the differences between the findings of this study and the findings of other studies may be due to the differences in genotype, age, the number of lactations, udder type, birth type, lactation period, the time of evaluation of the udder and teat characteristics and the differences in care and feeding conditions.

The correlation coefficients between linear morphological scores of udder and teats in Awassi and Bafra ewes

In the present study, the correlation coefficients between udder furrow and udder depth, teat angle and teat groove in Awassi ewes, and the correlation coefficients between udder furrow and udder depth, teat angle and teat shape, teat placement and teat angle,

udder type and udder furrow in Bafra ewes were found to be positive and significant ($P<0.05$, $P<0.01$; TABLE IV).

TABLE IV
Correlation coefficients between linear morphological scores of udder and teat in Awassi and Bafra ewes

Breeds	Traits	Udder depth (UD)	Teat shape (TS)	Udder furrow (UF)	Teat angle (TA)	Udder attachment (UA)	Teat placement (TP)
Awassi (n=102)	Udder depth						
	Teat shape	-0.06					
	Udder furrow	0.49**	0.16				
	Teat angle	0.22*	0.19	0.13			
	Udder attachment	-0.24*	-0.23*	-0.33**	-0.27**		
	Teat placement	-0.05	-0.05	-0.17	0.04	0.06	
	Udder type	0.09	0.03	0.36**	0.04	0.10	0.11
Bafra (n=61)	Udder depth						
	Teat shape	-0.28*					
	Udder furrow	0.36**	-0.29*				
	Teat angle	0.15	0.86**	-0.05			
	Udder attachment	0.23	0.08	-0.05	0.22		
	Teat placement	-0.28*	0.99**	-0.29*	0.38**	0.08	
	Udder type	0.05	0.07	0.28*	0.131	0.07	0.07

*: The correlation coefficient is significant at the 0.05 level ($P<0.05$). ** : The correlation coefficient is significant at the 0.01 level ($P<0.01$)

The correlation coefficients between the udder attachment and udder depth, udder furrow, teat shape, teat angle in Awassi ewes, and the correlation coefficients between teat shape and udder depth the udder furrow with teat shape, teat angle and udder furrow, udder attachment and udder furrow, teat placement and udder depth and udder furrow in Bafra ewes, were found to be negative and significant ($P<0.05$, $P<0.01$). Apart from the correlation coefficients between udder furrow and udder depth, udder type and udder depth, no significant similarity was found in terms of correlation coefficients between other characteristics in both breeds.

In a study conducted by Şeker *et al.* [1] on Awassi ewes, the phenotypic correlation between the udder type and udder attachment (0.65) was found to be statistically significant. In this study, low and negative correlation coefficients were found for udder type and teat placement (-0.23), and for udder depth and teat placement (-0.19). In a study conducted by Altınçekiç and Koyuncu [23] on Tahirova, Kıvırcık, and Karacabey Merino sheep, positive and high correlation coefficients were determined between the udder depth and udder attachment (0.714, 0.357 and 0.343, respectively, according to breeds). In addition, in another study conducted by Milerski *et al.* [24] on Tsigai, Enhanced Walachian, and Lacaune sheep, the subjectively evaluated linear scores for udder depth, cistern depth, teat placement and teat size demonstrated high correlations with actual measurements of udder and teat characteristics in all breeds (0.65–0.80).

There are some differences between the findings of the correlation coefficients of linear morphological scores of the udder and teat in this study and the results of other studies. Since the morphology of the udder and teat characteristics is affected by various factors including breed, age, lactation period, birth type and milking system, it was suggested that the differences could have resulted from these factors. It has also been suggested that the differences between this study and other literature reports may have resulted from variables such as the number of animals and the time of linear morphological scoring in the studies.

CONCLUSIONS

Lactation milk yield, average milk yield, 60th–day milk yield, daily average milk yield and lactation period were found to be higher in Bafra ewes than in Awassi ewes. Among the linear udder characteristics between Awassi and Bafra ewes, the differences in udder attachment, teat shape, and teat angle, 60th–day milk yield, daily average milk yield and lactation period were found to be significant. Type 3 udder, which is suitable for milking, was found at the highest rate in both breeds; type 2 udder was not detected in Awassi ewes and type 2 udder was observed at the lowest rate in Bafra ewes.

In dairy farms in particular, the selection of ewes with a smoother udder structure and more suitable udder and teat characteristics for machine milking is important for improvement of the herd. In this way, the profitability of sheep breeding farms may be increased.

Morphological evaluation of udder and teat should be considered in breeding selection.

The linear morphological evaluation of udder characteristics contributes to this process. In order for this evaluation to be more effective and functional, it should be carried out on more animals for a longer period of time, it should be performed nationwide and the repeatability and heritability of the relevant characteristics should also be estimated. In this way, it will be possible to contribute further to the breeding of sheep, mainly Awassi and Bafra ewes, which are two important breeds in Türkiye.

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 and 2020/73919507-280.01.01-E.909546).

Conflict of interest statement

The authors declare there is no conflict of interest.

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