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Determination of Linear Udder Traits of Norduz Sheep

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ABSTRACT

Background: A limited number of studies in non-dairy sheep breeds have investigated the assessment of udder morphology on a linear scale. The aim of this study was to use the linear scoring approach to determine the morphological udder traits of non-dairy Norduz ewes.

Methods: Udder traits were measured once in mid-lactation (approximately 90 days) for each ewe before the milking. Udder measurements included the following traits: udder width, udder circumference, udder length, udder depth, teat diameter, teat length, the distance between two teats and teat height from the ground. Linear scoring was done after the udder measurements were taken.

Result: Linear udder scores for teat placement, udder depth, the degree of separation of two halves and the degree of udder suspension were found as 4.10, 6.88, 3.15 and 7.54, respectively. Measurements related to udder size were positively and significantly correlated with each other. As a result, the 9-point linear scale utilized in this study was found to be appropriate for evaluating the udder shape of Norduz ewes. However, it would be beneficial to develop an uncomplicated, easy and practical linear scale that accurately evaluates udder morphology for non-dairy breeds.

Key words: Ewe, Linear scoring, Teat, Udder measurements.

INTRODUCTION

A good and healthy udder structure is critical in terms of quality milk production and offspring suckling. Therefore, research exposing the anatomical and morphological characteristics of the mammary gland in sheep and their association with milk yield, milk quality and adaptability to machine milking has remained important from the past to the present.

Dairy ewes' udder abnormalities are found more frequently than non-dairy ewes' because farmers inspect the udder during daily milking operations. Udder problems in non-dairy ewes are frequently detected either at weaning or just before mating when farmers select ewes for the following breeding season (Zeleke *et al.* 2021). Casu *et al.* (2010) reported phenotypic and genetic relationships between udder morphology and udder health in dairy ewes. The study determined that udder inflammation was more common in ewes with deep udders and teats directed more forward than in sheep with well-attached udders and teats oriented less cranially (Casu *et al.* 2010).

Since udder morphology in sheep is the determinant of udder suitability for machine milking, the first practical classification of sheep udders was based on the suitability of four basic udder types for machine milking (Vrdoljak *et al.* 2020). Many authors have investigated udder morphological traits in various dairy sheep breeds and linear scoring scales have been proposed to evaluate udder morphology in dairy breeds (de la Fuente *et al.* 1996; Casu *et al.* 2006; Ivanova and Raicheva, 2019). However, limited studies have been conducted investigating udder type and morphology and evaluating udder morphology according to a linear scale in non-dairy sheep breeds (Griffiths *et al.* 2019; Murphy and Taylor, 2021; Zeleke *et al.* 2021). No study on the Norduz breed reveals the udder type and morphological traits. This study aimed to evaluate the usability of the linear scale and udder type schema developed for dairy sheep in determining the morphological udder traits of the local non-dairy Norduz ewes.

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MATERIALS AND METHODS

The study was conducted at the Research and Application Farm of Van Yüzüncü Yil University (Van, Turkey) during the 2021 lambing season. The experimental procedures were approved by Van Yüzüncü Yil University Animal Research Local Ethics Committee (reference no 2012/02-16). The animal material of the study consisted of 41 lactating ewes at the age of 3-5 years old, belonging to the Norduz breed of sheep. Norduz is a local fat-tailed sheep breed characterised by high lamb viability and adaptation capacity to the harsh environmental conditions in Eastern Anatolia. This breed is known as a dual-purpose breed utilised for meat and milk.

Udder traits were measured once in mid-lactation (approximately 90 days of lactation) for each ewe before milking (Dzidic *et al.* 2004). Udder types in the ewes were determined according to the scheme in Fig 1 reported by Epstein (1985). The shape and depth of the udder and the

placement of the teats were considered in determining the udder types. Udder measurements included the following traits: udder width (UW, cm), udder circumference (UC, cm), udder length (UL, cm), udder depth (UD, cm), teat diameter in the middle of both right and left teats (TD, mm), teat length from teat base to teat orifice at both teats (TL, mm), the distance between two teats (DBT, cm) and teat height from the ground (THG, cm) (Fig 2). Udder width was measured in the middle of the rear udder. Udder circumference was taken as the circumference of the udder's medium area. Udder length was measured from the rear attachment of the udder to the front of the udder. Udder depth was determined as the rear distance between the abdominal wall and the teat's base. TD and TL measurements were taken using an electronic caliper and the other udder traits were measured using tape (Altýnçekiç and Koyuncu, 2011). After the udder measurements were taken, linear scoring was done by two classifiers according to the method developed by Casu *et al.* (2006). By this method, teat placement (TP), udder depth (UD), degree of separation of two halves (DS) and degree of suspension of the udder (SU) were scored with a 9-point linear scale (Fig 3).

The data were analyzed by the least squares means using the general linear models in SAS (2005). Duncan's multiple-range test was used to compare differences between the means of the sub-groups. Pearson correlation coefficient analysis was used to measure linear association among the traits. The statistical analysis was based on the general linear model:

$$Yijk = \mu + ai + bj + eijk$$

Where:
Yijk= Observation value of the measured or assessed trait.
μ= Overall mean.
ai= Effect of age of ewes (i = 3, 4, 5).
bj= Effect of udder type (j = 2nd type, 3rd type).
eijk= Random error.

RESULTS AND DISCUSSION

Udder type

Udder types were evaluated according to Epstein's schema (Epstein, 1985), but only the second and third udder types were determined in the study. The distribution of sheep by udder type was 37% for the 2nd type and 63% for the 3rd type (Fig 4). Both types of udders had low and oblique teats, while the second type was cylindrical and the third type was pear-shaped. The third udder type (70.3%) was found to be the most common in Morkaraman, Tuj and Awassi sheep breeds and the most optimal and acceptable for machine milking (Türkyýlmaz *et al.* 2018). Similar findings were found in studies reporting the 3rd type as the most common udder type in various sheep breeds (Kukovics *et al.* 2006; Kaygýsýz and Dag, 2017; Prpic *et al.* 2020).

Udder measurements

The least-squares means and standard errors for measured udder traits are presented in Table 1. Lower mean values for UW, UL and UD were reported by Milerski *et al.* (2006) in Tsigai, improved Walachian and Lacaune ewes and by Perez-Cabal *et al.* (2013) in Spanish Assaf ewes. Doðan *et al.* (2013) found a similar mean UC value of 46.04 cm in Anatolian Merino ewes, while Sadeghi *et al.* (2013) obtained a higher value of 49.20 cm in Lori Bakhtiari breed ewes at 3 weeks postpartum.

The udders of 5-year-old ewes were longer than those of 3- and 4-year-old ewes ($P<0.05$). Özyürek (2020) determined that udder circumference and udder length

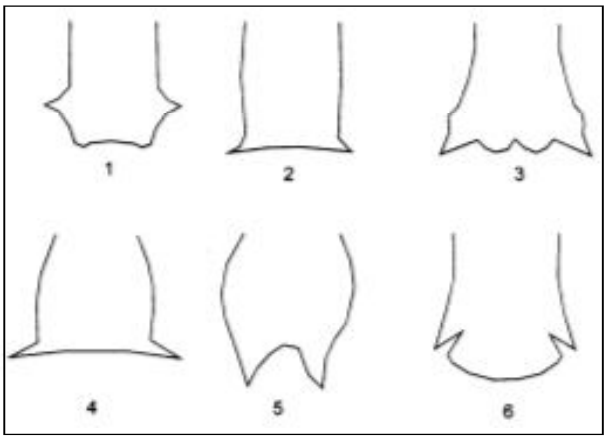

Fig 1: Udder types (Epstein, 1985).

1. Cylindrical udder, teats are upward and lateral
2. Cylindrical udder, teats are downwards and inclined
3. Pear-shaped udder, teats are downwards and inclined
4. Pear-shaped udder, teats are downwards and horizontal
5. Teats are big, udder which is downwards and vertical
6. Teats are upward and inclined udder

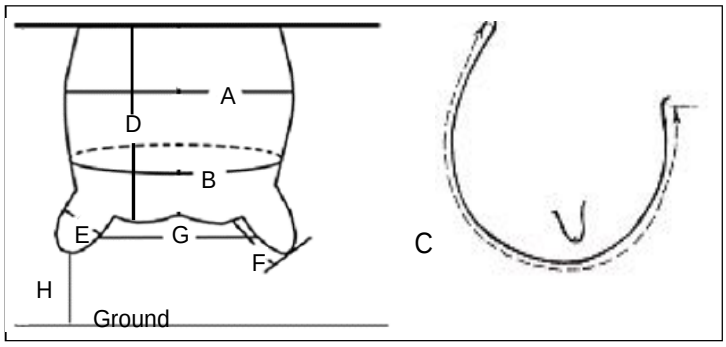

Fig 2: Morphological traits measured on udder and teats (Milerski *et al.* 2006; Türkyýlmaz *et al.* 2018).
A. Udder width (UW), B. Udder circumference (UC), C. Udder length (UL), D. Udder depth (UD), E. Teat diameter (TD), F. Teat length (TL), G. Distance between teats (DBT), H. Teat height from the ground (THG).

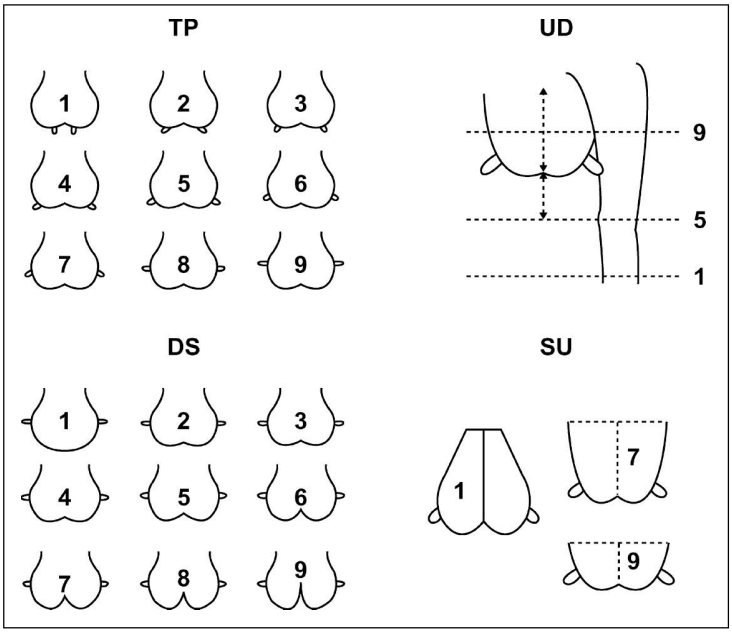

Fig 3: Linear scores for teat placement (TP), udder depth (UD), the degree of separation of two halves (DS) and the degree of udder suspension (SU) (Casu *et al.* 2006).

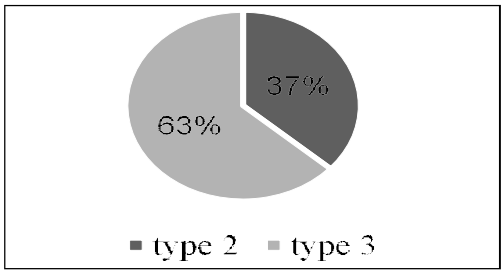

Fig 4: Distribution of the ewes according to udder type.

measurements in Morkaraman and Awassi sheep were higher at 5+ years of age than in the other age groups. The effect of udder types on UC and UL was statistically significant. Significant impacts of udder type on UW (Sarý *et al.* 2015), UL (Özyürek, 2020) and front UD (Dað and Zülkadir, 2004) have been observed in research conducted on several sheep breeds.

Teat measurements

The study found that overall means for TD, TL, DBT and THG were 17.58 mm, 35.95 mm, 18.02 cm and 26.83 cm, respectively (Table 2). It was determined that the teats of Norduz ewes were shorter and thinner than those of Chios ewes (Gelasakis *et al.* 2012) but longer and wider than those of Pelibuey ewes (Arcos-Alvarez *et al.* 2020). Similar values for DBT and THG were obtained in Karakul sheep on the 45th day of lactation by Erol *et al.* (2020). Teat measurements were not significantly affected by the age of the ewe, while the udder type had a significant effect only on TD. Merkhan (2014) determined the significant effect of ewe age on left teat diameter and right teat length, while Özyurek (2020) reported that distance between teats (P<0.05) as well as left teat diameter (P<0.05) increased with ewe age. In contrast to this study, Akdag *et al.* (2018) determined that udder type significantly affected TD, TL and DBT in Karayaka sheep.

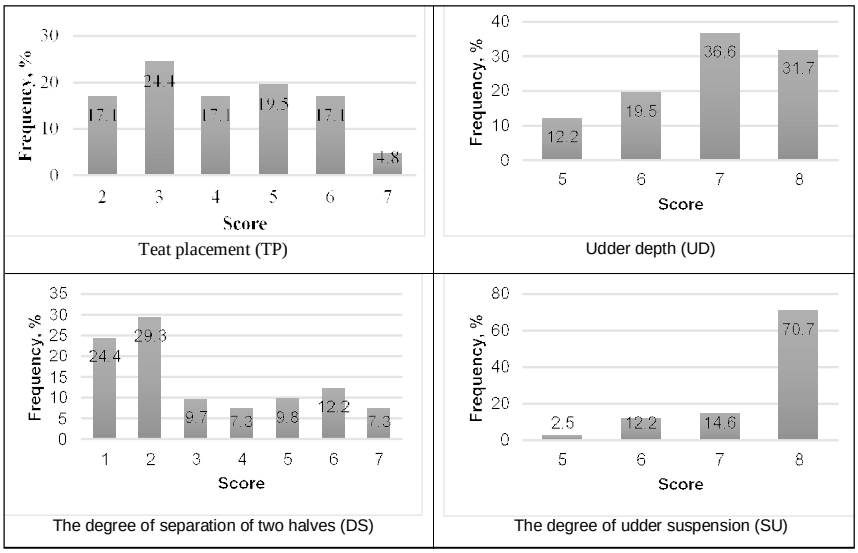

Fig 5: Frequency distributions of linear udder scores.

Table 1: The least-squares means (±SE) for udder measurements (cm).

Factors		n	UW	UC	UL	UD
Age					*	
	3	9	22.22±1.02	45.11±1.39	37.33±2.04[b]	21.89±0.81
	4	19	21.74±0.66	46.95±1.41	37.53±2.06[b]	22.47±0.89
	5	13	22.92±1.40	45.54±1.97	39.54±1.97[a]	22.62±1.05
Udder type				*	*	
	2	15	22.93±1.31	43.73±1.75	39.00±2.12	23.40±1.03
	3	26	21.80±0.51	47.46±1.02	37.62±1.49	21.81±0.61
Overall		41	22.22±0.57	46.10±0.94	38.12±1.21	22.39±0.55

UW: Udder width; UC: Udder circumference; UL: Udder length; UD: Udder depth; *: P<0.05.

Table 2: The least-squares means (±SE) for teat measurements.

Factors		n	TD (mm)	TL (mm)	DBT (cm)	THG (cm)
Age						
	3	9	20.82±2.14	37.02±3.77	18.22±1.45	27.56±1.09
	4	19	16.68±1.45	35.49±2.61	18.05±0.88	26.58±0.96
	5	13	16.67±1.72	35.88±1.72	17.85±0.84	26.69±1.28
Udder type			*			
	2	15	15.35±1.41	35.05±2.33	18.27±1.03	26.80±1.15
	3	26	18.87± 1.26	36.46±2.00	17.88±0.66	26.85±0.73
Overall	41	17.58±0.98	35.95±1.51	18.02±0.56	26.83±0.62	

TD: Teat diameter; TL: Teat length; DBT: Distance between teats; THG: Teat height from the ground; *: P<0.05.

Table 3: Means (±SE) for linear udder scores.

Parameters	n	Mean±SE	Min	Max
TP	41	4.10±0.24	2	7
UD	41	6.88±0.16	5	8
DS	41	3.15±0.31	1	7
SU	41	7.54±0.13	5	8

TP: Teat placement; UD: Udder depth; DS: The degree of separation of two halves, SU: The degree of udder suspension.

Linear udder scores

The scoring for TP, UD, DS and SU in Norduz ewes was higher than the values reported by Devi *et al.* (2022) for Patanwadi ewes (Table 3). Akgün and Koyuncu (2021) reported similar mean TP, DS and SU scores, but a higher UD score in Kıvırcık ewes.

In Fig 5, according to TP, udders with three scores had the highest percentage (24.4%), while those with seven (4.8%) had the lowest percentage. Contrary to the

Table 4: Correlation coefficients among udder morphological traits.

	UC	UL	UD	TD	TL	DBT	THG
UW	0.536***	0.496***	0.611***	-0.381**	-0.247	0.593***	-0.111
UC		0.607***	0.388**	0.024	-0.089	0.324*	-0.415***
UL			0.411**	0.068	0.076	0.152	-0.530***
UD				-0.179	-0.153	0.417**	-0.136
TD					0.628***	-0.426**	-0.174
TL						-0.588***	-0.274
DBT							0.122

UW: Udder width; UC: Udder circumference; UL: Udder length; UD: Udder depth; TD: Teat diameter; TL: Teat length; DBT: Distance between teats; THG: Teat height from the ground; *: P <0.05; **: P <0.01; ***: P <0.0001.

study findings, a higher frequency of ewes with highly implanted teats was identified in dairy ewes (Casu *et al.* 2006; 2010). As for UD, udders with 7 (36.6%) and 8 (31.7%) scores were observed with the highest percentage in Norduz sheep breed. Similarly, a balanced trend was observed in UD in Bulgarian sheep with a score of 7 or 8 (Ivanova and Raicheva, 2019). However, Griffiths *et al.* (2019) did not identify Romney ewes with a UD score greater than 5.

The degree of separation of two halves (DS) showed maximum variation in Norduz ewes, where 53.7% of the ewes received 1 and 2 worst scores. The ewes with scores ranging from 5 to 8 were identified for SU in the study. Similarly, Ivanova and Raicheva (2019) did not identify high scores (8 and 9) for DS. Unlike the findings of this study, higher variations (from 1 to 7) were observed for SU in Bulgarian ewes.

Correlations among udder traits

Table 4 shows correlation coefficients among udder morphological traits. Measurements related to udder size (UW, UC, UL and UD) were positively and significantly correlated. Similar to the findings of this study, positive and significant correlations were reported between udder measurements in different breeds of sheep (Özyurek *et al.* 2018; Shettima *et al.* 2022). From the teat measurements, TD showed negative correlations with UW (-0.381, P <0.01) and DBT (-0.426, P<0.01) and positive (0.628, P<0.0001) correlations with TL. However, Sarý *et al.* (2015) determined positive correlations between TD and UC (0.40, P<0.01), UD (0.41, P<0.01), UW (0.42, P<0.01) in Tuj sheep. Also, a weaker correlation (0.274) was found between the two measurements of teats (length and width) in Lacaune ewes (Panayotov *et al.* 2018). Positive and significant correlations of DBT with UW, UC and UD were determined, while the correlation with TL were negative and significant. Also, THG had negative correlations with UC (-0.415, P<0.0001) and UL (-0.530, P<0.0001). On the other hand, Shettima *et al.* (2022) determined that the correlations of left and right TL with UL, UW and UC ranged from 0.368 to 0.785 (P<0.05; P<0.01) in Nigerian sheep breeds.

CONCLUSION

This study evaluated the usability of linear scale and udder type schemas developed for dairy sheep in a dual-purpose and local sheep breed. According to the evaluations, the udders of Norduz ewes were medium in size, with a low lateral teat positioning and a balanced width and depth structure. As a result, the 9-point linear scale (Casu *et al.* 2006) utilised in this study was appropriate for evaluating the udder shape of Norduz ewes. However, developing an uncomplicated, easy and practical linear scale that accurately evaluates udder morphology for non-dairy breeds would be beneficial.

Conflict of interest: None.

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