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Determination of morphological and linear udder traits in Morkaraman, Tuj and Awassi sheep

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ABSTRACT

In this study, it was aimed that determination of udder measurements of Morkaraman, Tuj and Awassi ewes and the correlation between the results. Udder depth and width of the Awassi was higher than other breeds and respectively 13.09±0.32 cm, 14.07±0.43 cm. In Morkaraman, teats length (2.65±0.06 cm) and diameter of the teats (1.83±0.06 cm) were higher from other breeds. The important statistical difference was found between breeds for udder depth ($P<0.05$), very important statistical difference was found between breeds for udder height and teats diameter ($P<0.01$). In this study, teats length and teats diameter were above the limits specified for machine milking for Morkaraman, Tuj and Awassi.

Key words: Awassi, Morkaraman, Tuj, Udder size, Udder linear scores, Udder types.

INTRODUCTION

Although 83% of world milk production is supplied from cows' milk, only 1.3% of it is supplied from sheep's milk. Despite the small share of sheep's milk in total milk production, the fact that there are many types of cheese produced from sheep's milk, and they are more delicious than the cattle milk cheese. Sheep milk cheese is more profitable for the producer cause sheep milk cheese to be more valuable.

Turkey's sheep breeds are combined yield oriented, milk yield is generally low. Types like Tahirova, Sönmez, Acipayam and Türkgeldi created by the recent studies and Awassi in south eastern Anatolia and Sakiz breed in Aegean Region are milk yield oriented sheep. Different kinds of cheese are produced from sheep's milk in Turkey such as Blue Cheese, Berendi, Erzincan, Ikizdere and Aydin tulum cheese, Bingöl brined cheese, Van herby cheese, Edirne white cheese, Kopanisti cheese, Çamur cheese, Ezine cheese and Raw cut cheese.

Many researchers carried out various studies in order to determine the milk yield traits in Morkaraman, Tuj and Awassi sheep breeds. Karaoglu *et al*. (2001) observed in their study that the average lactation milk yield was 33.09 L in Tuj breed and Kirmizibayrak *et al*. (2005) observed that the average lactation milk yield was 51.5 and 88.3 L respectively in Tuj and Morkaraman sheep breeds. Macit and Aksoy (1996) stated that the average lactation milk yield was 138.6 and 81.8 L respectively in Awassi and Morkaraman sheep. Esenbuga (1995) stated that the average lactation milk yield was 108.99 and 70.64 L respectively in Awassi and Morkaraman sheep.

It is seen that the variation between breeds raised in Turkey is extended in terms of milk yield and components. Labussiere *et al*. (1981) calculated positive correlation coefficients between daily and lactation milk yields and udder circumference, udder volume, distance between teats, udder width, length and depth (Dogan *et al*., 2013). There are some studies indicating that udder depth and circumference in sheep have positive relationship with milk yield (Mavrogenis *et al*., 1988 and Fernández *et al*., 1997).

Machine milking in sheep is very limited in Turkey. Also, even 80-85% of the existing milk of highly productive sheep can be milked with machine milking. For machine milking, sheep's teats diameter must be at least 15mm, and the length must be at least 20 mm, teats must be connected to teats vertically, the angle made by the teats and teats axis must be 45°, it must not exceed 75°(Kaymakçi, 2013).

With the studies to reveal the morphological traits of the udder in sheep, milk yield in sheep and the adaptability of the sheep with milking machine are tried to be determined. Also in this study, determination of udder measurements in Morkaraman, Tuj and Awassi sheep breeds and linear udder scores of some udder traits and the identification of correlations between the obtained results are aimed. Especially, the results to be obtained from Morkaraman and Tuj breeds will be compared with the dairy sheep breeds like Awassi breed. This study is expected to be a resource for the milk oriented selection studies to be carried

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out in the future on Morkaraman, Tuj and Awassi sheep breeds.

MATERIALS AND METHODS

Study was carried out at Research and Application Farm of Agriculture Faculty, Atatürk University. In the study, 68 sheep of Morkaraman, 64 sheep of Tuj and 26 sheep of Awassi breeds were used. Sheep were between 2 and 6 ages. When lambs reached at the 60th day, they became weaned. Udder measurements were taken on the 90th day of lactation 2 hours before milking.

In the study, for the udder morphology of the sheep, udder depth, udder circumference, udder width, teats length, teats diameter, distance between teats and distance between teats and the ground were included (Fig.1). Measurements were taken as specified by Altinçekiç and Koyuncu (2011). Electronic compass, tape measure and measure cane were used in taking measurements. As indicated by Fuenta *et al*. (1996), udder height, teats angle, teats length and udder type were taken for linear udder traits. Score of 1-9 were used in linear scoring (Table 1.).

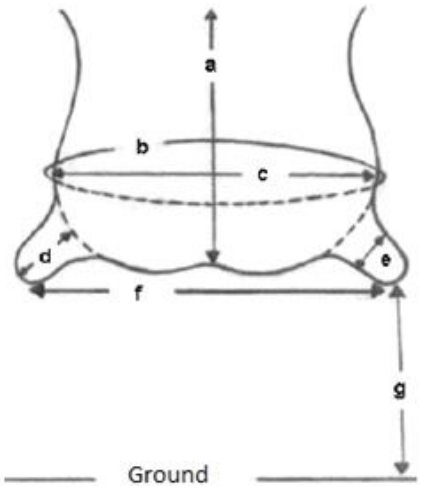
The GLM procedure of SPSS 19.0 (2010) packaged software was used in the variance analysis of the data obtained in the study. Least-square method was used in determining the differences between the breeds of Udder traits, and the correlation coefficients between the udder traits were calculated.

RESULTS AND DISCUSSION

In the study carried out, variance analysis of udder traits in Morkaraman, Tuj and Awassi sheep breeds is given in Table 2. Udder depth and udder width in Awassi sheep breeds were observed to be high as 13.61±0.43 cm and 12.78±0.97 cm, respectively compared to other breeds. In Morkaraman sheep, teats length (2.63±0.07 cm), teats diameter (1.71±0.04 cm) and the distance between teats and the ground (29.32±0.37 cm) were observed to be higher than the other breeds. Except for distance between teats and the ground (P<0.01), all other traits were observed to be statistically non-significant difference between breeds. Udder depth, udder circumference, udder width, distance between teats and distance between teats and the ground was found highly significant (P<0.01) for ages. Highest distance between teats and the ground was determined in two age sheep and highest value of other traits were in five age and older sheep. When age was bigger, udder circumference, udder width, teats diameter and distance between teats were higher vice-versa.

In the study carried out, variance analysis of linear udder scores in Morkaraman, Tuj and Awassi sheep breeds is given in Table 3. Udder height in Tuj and Awassi sheep breeds were observed to be high as 5.21±0.16 cm and 5.03±0.25 cm respectively compared to Morkaraman breeds. In Morkaraman breeds, teats length (5.23±0.15) was observed to be higher than the other breeds. Udder height (P<0.01) and teats angle (P<0.05) caused significantly difference between breeds. In variance analysis of linear udder scores, age didn't affect teats angle, teats length and udder shape. Five age and older sheep was significantly higher (P<0.01) than other ages in udder height score.

It was observed that the udder depths in Morkaraman and Tuj sheep breeds were parallel to the values reported for the same breeds by Kirmizibayrak *et al*. (2005), and the udder circumference was lower than the said researcher. In the study, it was observed that the teats length, teats angle and udder height for all breeds were lower than the values found for Tahirova, Kivircik and Karacabey Merinos by Altinçekiç and Koyuncu (2011); and similar results were obtained in teats length. In the study carried out on Akkaraman and AkkaramanxSakiz F1 cross-breed sheep by Yardimci and Özbeyaz (2001), udder width was observed to be similar with Awassi breed, and to be higher than Morkaraman and Tuj breeds. Udder circumference and distance between teats were observed to be higher than all three breeds. In a study carried out on Mehraban and Ghezel



a: Udder depth

b: Udder circumference

c: Udder width

d: Udder teat lenght

e: Udder teat diameter

f: Distance between udder teats

g: Distance between udder teats and ground

Fig 1: Udder measurements scheme

Table 1: Linear score table of udder traits

Trait	Scores		
Udder height			
	1(short)	5 (medium)	9 (deep)
Udder angle			
	1 (horizontal)	5 (45 degree angle)	9 (vertical)
Teats length			
	1(short)	5 (medium)	9 (long)
Udder shape			
	1(imperfect)	5 (medium)	9 (ideal)

Table 2: Variance analysis of udder traits (cm) in Morkaraman, Tuj and Awassi sheep

Breed Morkaraman	N	Udder depth	Udder circumference	Udder width	Teats length	Teats diameter	Distance between teats	Distance between teats and the ground
		$\bar{X} \pm S_{\bar{X}}$	$\bar{X} \pm S_{\bar{X}}$	$\bar{X} \pm S_{\bar{X}}$	$\bar{X} \pm S_{\bar{X}}$	$\bar{X} \pm S_{\bar{X}}$	$\bar{X} \pm S_{\bar{X}}$	$\bar{X} \pm S_{\bar{X}}$
		ns	ns	ns	ns	ns	ns	**
	68	12.62±0.26	36.08±0.58	12.27±0.20	2.63±0.07	1.71±0.04	14.21±0.22	29.32±0.37[a]
Tuj	64	12.73±0.27	36.45±0.60	12.30±0.21	2.59±0.07	1.76±0.05	14.25±0.23	27.40±0.38[b]
Awassi	26	13.61±0.43	35.32±0.97	12.78±0.33	2.43±0.12	1.75±0.07	14.12±0.37	27.90±0.61[b]
Age		**	**	**	ns	ns	**	**
2	26	12.00±0.43 [c]	33.47±0.97[d]	11.54±0.33[b]	2.31±0.12	1.59±0.07	12.96±0.37[c]	30.03±0.61[a]
3	49	13.26±0.31[ab]	35.92±0.70[c]	12.65±0.24[a]	2.61±0.08	1.71±0.05[ab]	14.27±0.27[b]	27.75±0.44[b]
4	29	12.78±0.41[bc]	36.09±0.92[b]	12.56±0.32[a]	2.65±0.11	1.80±0.07 [a]	14.34±0.35[b]	27.54±0.58[b]
5≤	54	13.91±0.29 [a]	38.32±0.65[a]	13.05±0.22[a]	2.63±0.08	1.85±0.05 [a]	15.20±0.25[a]	27.51±0.41[b]

*: Significant (P< 0.05); **: Highly Significant (P< 0.01); ns: Non-significant
[a, b, c]: The difference between the averages shown by the same letter is non-significant.

sheep breeds, udder circumference was observed to be lower than Morkaraman and Tuj breeds, and to be similar with Awassi breed; udder depth was observed to be lower than all three breeds. In the same study, teats length was observed to be higher than all three breeds (Izadifard and Zamiri, 1997).

On the contrary, in Awassi breed (Iniguez *et al*., 2009), udder circumference, udder depth, udder height and teats length were observed to be higher than the results of this study. Also, in another study carried out on different blood-grade crossbreeds of Istrian and Awassi breeds, teats length was observed to be higher (Dzidic *et al*., 2004).

Likewise, Such *et al*. (1999), Milerski *et al*. (2006), Kominakis *et al*. (2009), Gelasakis *et al*. (2012) , Prpic *et al*. (2013) also noticed udder width, udder depth, teats length, udder height and teats angle in diary Lacaune sheep breed as higher than the values we found for Morkaraman, Tuj and Awassi sheep.

Table 3: Variance analysis of udder linear score in Morkaraman, Tuj and Awassi sheep

Breed Morkaraman	N	Udder height	Teats angle	Teats length	Udder shape
		$\bar{X} \pm S_{\bar{X}}$	$\bar{X} \pm S_{\bar{X}}$	$\bar{X} \pm S_{\bar{X}}$	$\bar{X} \pm S_{\bar{X}}$
		**	*	ns	ns
	68	4.36±0.15 [b]	4.23±0.18 [a]	5.23±0.15	4.71±0.16
Tuj	64	5.21±0.16 [a]	4.39±0.18 [a]	5.09±0.16	4.57±0.16
Awassi	26	5.03±0.25 [a]	3.52±0.29 [b]	4.75±0.26	5.13±0.26
Age		**	ns	ns	ns
2	26	4.22±0.25 [c]	4.34±0.29 [a]	4.55±0.26 [b]	4.82±0.26
3	49	4.74±0.18 [bc]	3.93±0.21 [ab]	5.15±0.18 [ab]	4.66±0.19
4	29	4.91±0.24 [b]	4.31±0.28 [a]	5.30±0.24 [a]	5.16±0.25
5≤	54	5.59±0.17 [a]	3.61±0.20 [b]	5.08±0.17 [ab]	4.59±0.17

*: Significant (P< 0.05); **: Highly Significant (P< 0.01); ns: Non-significant
[a, b, c]: The difference between the averages shown by the same letter is non-significant.

It was observed that relationship of udder circumference with age was similar, although relationship of teat diameter and udder width with age was different than Gelasakis *et al*. (2012).In a study carried out on Istrian breed (Prpic *et al*., 2013), relationship of udder circumference, udder depth, udder width with age was observed to be different than the results of this study, but relationship of teat length with age was similar with the results of this study.

Correlations between udder measurements of Morkaraman sheep breed are shown in Table 4. A high positive correlation was observed between udder circumference and udder depth and udder width, teats diameter and distance between teats, and a high negative correlation was observed with distance between teats and the ground. It was observed that teats length had high positive correlation only with teats diameter.

The correlation results found for udder circumference and udder width and teats length and teats diameter showed similarity with the results found by Iniguez*et al*. (2009), Kominakis *et al*. (2009) and Prpic *et al*. (2013).

The correlations between linear udder scores in Morkaraman sheep breed are given in Table 5. Positive correlation was observed between teats angle and udder shape and udder height. The results related to teats angle and udder height were observed to be parallel to Fuente *et al*. (1996) and Margetin *et al*. (2013), and they were observed to be different by Milerski *et al*. (2006), Altinçekiç and Koyuncu (2011) and Gelasakis *et al*. (2012).

When the correlations between the linear udder scores and udder measurements presented in Table 4 were examined, it was seen that there was high positive correlation

Table 4: Correlations between udder measurements in Morkaraman Tuj and Awassi sheep breed

Udder measurements	Breed	Udder depth	Udder circumference	Udder width	Teats length	Teats diameter	Distance between teats
Udder circumference	M	0.630**					
	T	0.680**					
	A	0.857**					
Udder width	M	0.637**	0.725**				
	T	0.578**	0.858**				
	A	0.781**	0.922**				
Teats length	M	0.059	0.040	0.213			
	T	0.300**	0.406**	0.429**			
	A	-0.133	-0.053	-0.031			
Teats diameter	M	0.341**	0.514*	0.449**	0.430**		
	T	0.561**	0.510**	0.468**	0.762**		
	A	0.347	0.32	0.26	0.114		
Distance between teats	M	0.437**	0.663**	0.531**	0.125	0.524**	
	T	0.515**	0.737**	0.725**	0.582**	0.603**	
	A	0.781**	0.852**	0.822**	-0.255	0.285	
Distance between teats and the ground	M	-0.428	-0.546**	-0.457**	-0.153	-0.459**	-0.321**
	T	-0.534**	-0.453**	-0.420**	-0.221	-0.211	-0.450**
	A	-0.464*	-0.428	-0.373	0.013	-0.032	-0.227

*: Significant (P< 0.05); **: Highly Significant (P< 0.01); ns: Non-significant
M: Morkaraman, T: Tuj, A: Awassi

Table 5: The correlations between linear udder scores in Morkaraman, Tuj and Awassi sheep breed

Linear udder scores	Breed	Udder height	Teats angle	Teats length
Teats angle	M	0.257*		
	T	0.142		
	A	0.038		
Teats length	M	0.078	0.225	
	T	0.422**	0.270*	
	A	0.071	0.428*	
Udder shape	M	0.154	0.715**	0.17
	T	0.121	0.647**	0.244
	A	0.481*	0.523**	0.539**

*: Significant (P< 0.05); **: Highly Significant (P< 0.01); ns: Non-significant
M: Morkaraman, T: Tuj, A: Awassi

between udder height and udder depth and udder circumference, udder width and teats diameter, there was high negative correlation with distance between teats and the ground, and there was high positive correlation between teats angle and udder width. Milerski *et al*. (2006) observed positive correlation between udder height and udder width (0.721) and udder depth (0.802), and observed similar results between udder height and teats length with this study. In another study, positive correlation was observed between udder height and udder depth (0.855), and similar results between udder height and teats length were observed with this study (Margetin *et al*., 2013).

While the relationships of udder depth, udder circumference, udder width, teats length, teats diameter and distance between teats measurements of Tuj sheep breed were significantly positive (P<0.01) between each other, the biggest positive relationship was observed between udder width and udder circumference (0.858 and P<0.01-Table 4). The biggest negative relationship was observed between distance between teats and the ground and udder depth (-0.534 and P<0.01). Distance between teats and the ground showed negative relationship also with other udder measurements. This negative relationship was observed to be statistically insignificant with teats diameter, and observed to be significant with the others (P<0.01).

It was observed that the relationship of udder circumference with udder depth was higher than the values reported by Altinçekiç and Koyuncu (2011), Kominakis *et al*. (2009) and Kirmizibayrak *et al*. (2005), and similar with the values of Prpic *et al*. (2013),while its relationship with udder width was lower than the values reported by Altinçekiç and Koyuncu (2011), Prpic *et al*. (2013) and Kominakis *et al*. (2009). According to the values reported by Margetin *et al*. (2013), the relationship of udder width between udder depth and teats length, and the relationship between udder depth and teats length were observed to be higher.

A positive relationship was observed among linear udder scores of Tuj sheep breed. Accordingly, while the highest positive relationship was observed between udder shape and teats angle (0.647 and P<0.01), its relationship with udder height occurred at the lowest level (0.121), and it was observed to be statistically insignificant. A very significantly positive relationship (0.422 and P<0.01) was observed between udder height and teats length.

According to the obtained values; the relationship of teats angle with udder height was observed to be higher (0.40) than the values reported by Fuente *et al*. (1996), and its relationship with udder shape was observed to be low (0.69).

The results between udder measurements and udder linear scores in Tuj sheep breeds were examined in Table 6. Accordingly, the biggest positive relationship was observed between teats length score and teats circumference (0.743 and P<0.01), and the biggest negative relationship was observed between udder height score and distance between teats and the ground (-0.501 and P<0.01). Also, it was observed that the udder height score had significantly positive relationship (P<0.01) with other udder measurements. The teats length score showed a positive relationship with all udder measurements other than distance between teats and the ground. While teats angle score showed significantly positive relationship with teats length (0.266 and P<0.05) and teats diameter (0.337 and P<0.01), its relationship with other udder measurements was observed to be insignificant. The relationship of udder shape score with all udder measurements other than teats diameter (0.264 and P<0.05) was insignificant, and it showed a very low relationship with udder depth (0.007) and distance between teats and the ground (-0.014).

It was observed that the relationship of udder height with udder depth and udder width was lower than the values reported by Milerski *et al*. (2006), and its relationship with teats length was significantly high. According to values reported by Margetin *et al*. (2013), the relationship of udder height with udder depth was lower, and its relationship with teats length was higher.

The biggest positive relationship between udder measurements of Awassi sheep breeds was observed between the udder width and udder circumference (0.922 and P<0.01), and the biggest negative relationship was observed between distance between teats and the ground and udder depth (-0.464 and P<0.05) (Table 4). While udder width measurement showed significantly positive relationship (P<0.01) with udder depth (0.781), udder circumference (0.922) and distance between teats (0.822) measurements, its relationship with other measurements were observed to be insignificant. It was determined that teats length and teats diameter measurements had no statistically significant effect on other measurements.

The relationship of udder width with udder circumference was observed to be higher than the values

Table 6: The correlation results between udder measurements and udder linear scores in Morkaraman Tuj and Awassi sheep breed

		Udder measurements						
Linear udder scores	**Breed**	**Udder depth**	**Udder circumference**	**Udder width**	**Teats length**	**Teats diameter**	**Distance between teats**	**Distance between teats and the ground**
Udder height	M	0.350**	0.486**	0.424**	0.086	0.429**	0.299*	-0.573**
	T	0.675**	0.635**	0.572**	0.446**	0.564**	0.643**	-0.501**
	A	0.700**	0.768**	0.634**	-0.038	0.512**	0.659**	-0.527**
Teats angle	M	-0.049	0.06	0.329**	0.211	0.118	-0.197	-0.149
	T	0.044	-0.038	0.072	0.266*	0.337**	-0.126	0.231
	A	-0.263	-0.21	-0.116	0.355	0.05	-0.452*	-0.142
Teats length	M	0.079	0.033	0.200	0.963	0.407**	0.117	-0.172
	T	0.293*	0.386**	0.394**	0.976**	0.743**	0.552**	-0.181
	A	-0.097	-0.01	-0.011	0.969**	0.199	-0.258	-0.142
Udder shape	M	-0.043	0.112	0.275*	0.154	0.196	-0.077	-0.198
	T	0.007	0.043	0.166	0.236	0.264*	-0.014	0.174
	A	0.232	0.365	0.376	0.497**	0.253	0.158	-0.296

*: Significant (P< 0.05); **: Highly Significant (P< 0.01); ns: Non-significant
M: Morkaraman, T: Tuj, A: Awassi

reported by Altinçekiç and Koyuncu (2011), Prpic *et al*. (2013) and Kominakis *et al*. (2009).

It was observed that linear udder scores of Awassi sheep breed showed positive relationship between each other (Table 5). Accordingly, while teats angle and teats length measurements showed significantly (P<0.01) positive relationship (0.523 and 0.539) with udder shape; their positive relationship between udder height was observed to be at the least level (0.038 and 0.071), and it was observed to be statistically insignificant.

According to the obtained values; it was observed that the relationship of udder shape with udder height and teats length was higher (-0.10 and 0.22) than the values reported by Fuente *et al*. (1996), and its relationship with teats angle was low (0.69).

The relationships between udder measurements and udder linear scores in Awassi sheep breeds were examined in Table 6. Accordingly, it was observed that udder height score showed a very significant positive relationship (0.768 and P<0.01) with udder circumference, and it showed a very significant negative relationship (-0.527 and P<0.01) with distance between teats and the ground. Also, it was observed that udder height score was significantly related with all other udder measurements (P<0.01) other than teats length (-0.038). While teats angle score showed significantly negative relationship (-0.452 and P<0.05) with the measurement of distance between teats, its relationship with other udder measurements was observed to be insignificant. It was observed that teats length had no significant relationship with none of the udder measurements. Udder shape score showed a significant relationship (0.497 and P<0.01) only with teats length.

It was observed that the relationship of udder height with udder depth and udder width was lower than the values reported by Milerski *et al*. (2006), and its relationship with teats length was observed to be similar. According to values reported by Margetin *et al*. (2013), the relationship of udder height with udder depth and teats length was observed to be lower.

CONCLUSION

For machine milking, the teats diameter of the sheep must be at least 15 mm, and the teats length must be at least 20 mm. (2013). In the study carried out, the teats length and teats diameter for Morkaraman, Tuj and Awassi sheep breeds were observed to be above the specified limits for machine milking. Kirmizibayrak *et al*. (2005), Ünal *et al*. (2008) and Iniguez *et al*. (2009) stated in their studies that there was positive correlation between udder circumference and udder width and milk yield. The fact that statistically significant difference was not observed between Morkaraman and Tuj sheep breeds and Awassi sheep breed in terms of udder circumference and udder width increases the possibility of these two breeds' responding to the improvement in terms of milk yield. Due to the operating conditions, the correlation between milk yield and udder measurements could not be examined. New studies examining the correlation between milk yield and udder measurements should be carried out especially for Morkaraman sheep breed that constitute about 20% of sheep of the country.

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