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Correlation between Various Udder Measurements and Milk Components in Morkaraman, Tuj and Awassi Sheep

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ABSTRACT

In this study, it was aimed that to identify components of milk and udder type and to correlations between udder measurements and milk components in Morkaraman, Tuj and Awassi sheep. Milk components are investigated in order to determination of milk quality. The main components of milk are fat, solid non-fat, density, protein, lactose and ash. Density of the milk is expressed in kg/m^3 and the other components are in percent. Fat, solid non-fat, density, protein, lactose and ash percentages of the milk in this study were respectively 7.19%, 9.67%, 1030.78 kg/m^3, 3.18%, 5.55%, 0.93% in Morkaraman; 7.20%, 9.95%, 1031.78 kg/m^3, 3.29%, 5.70%, 0.96% in Tuj; 6.79%, 9.60%, 1030.77 kg/m^3, 3.18%, 5.49% 0.93% in Awassi. There isn't any significant difference between the breed for milk components (p>0.05). Between udder width and non-fat dry matter content, high positive correlation was determined. The ideal and most suitable udder type for machine milking is pear-shaped and oblique teat (Type III). So this result can help us for selection of milking ability in Morkaraman and Tuj breeds.

INTRODUCTION

According to 2015 statistics, the number of sheep in Turkey is 33.8 million head. According to the data of the same year, the number of milking sheep is 19.9 million and the total milk production is 1.6 million liters (Anonymous, 2016). In Turkey, there are more than 260 types of cheese and the most of them are made from sheep milk (Cetinkaya, 2005).

Sheep is a multifaceted livestock species having a large number of breeds over the world. In the past years, sheep production was considered as one of the important animal husbandry activities due to climate, topographic structure and rich flora of Turkey (Karadas *et al*., 2017). Morkaraman breed that constitutes approximately 21.5% of Turkey's sheep population, is predominantly keeping in the Eastern Anatolia Region. Fat tailed Morkaraman breed has different colors from black to brown and has adapted to regional conditions. In terms of farmers, meat yield is in the foreground but it is also used for milk. Awassi breed is predominantly keeping in the Southeastern Anatolia Region, and represent the local breeds with the highest milk production. Fat tailed Awassi sheep has improved herd instinct, great walking ability and adapted high temperature environment of the region. Tuj breed is predominantly keeping in the Northeastern Anatolia Region. In the region, it is used in local cheese production from Tuj ewes' milk.

Literature data reported that the ewes which has bigger udder had higher milk yield and the positive correlation was established between udder circumferences, distance between udder teats, udder width, udder depth and milk yield (Mikus, 1968; Labussiere *et al*., 1981). Also, other researchers reported the positive correlation between milk yield, udder circumference and depth (Mavrogenis *et al*., 1988; Fernández *et al*., 1997). Aimed for better selection of ewes for milk production, the 9 point scale method for measuring of udder height, udder shape, udder teat angle, and udder teat length was developed by De La Fuente *et al*. (1996). Subsequently, this method was used for improvement of suitability for machine milking in Churra, Manchega, Latxa (De La Fuente *et al*., 1999) and Lacaune breeds (Marie *et al*., 1999). Based on the 9 point scale method developed by De La Fuente *et al*. (1996), six different udder types were determined in sheep. It was reported that there was correlation between the udder types and milk yield (Kukovics *et al*., 1993; Dağ and Zülkadir, 2004).

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In Turkey as it is all over the world, approximately 83% of milk production is supplied from cattle. However, sheep milk production is important in terms of components rather than the amount. On this way, sheep milk constitutes the main input of cheese industry with its traits such as the more fat it has than the bovine milk.

According the literature data, the fat content in the sheep milk carried from 3.50% to 7.32%; the solid non-fat content in the sheep milk carried from 10.04% to 18.20%; the protein content in the sheep milk carried from 3.39% to 6.48% (Kurt *et al*., 1975; Kurt and Ergin, 1980; Macit, 1994; Karaoğlu *et al*., 1999; Çelik and Özdemir, 2003; Pulina *et al*., 2005; Kominakis *et al*., 2009; Kondyli *et al*., 2012; Oliveria *et al*., 2012; Bonczar *et al*., 2016; Vianna *et al*., 2017).

This study was aimed at determining the milk components in Morkaraman, Tuj and Awassi sheep breeds, and the correlations between milk components and udder measurements. Also, it was aimed at determining the fact that which of the different udder types defined in the literature appeared in these three breeds.

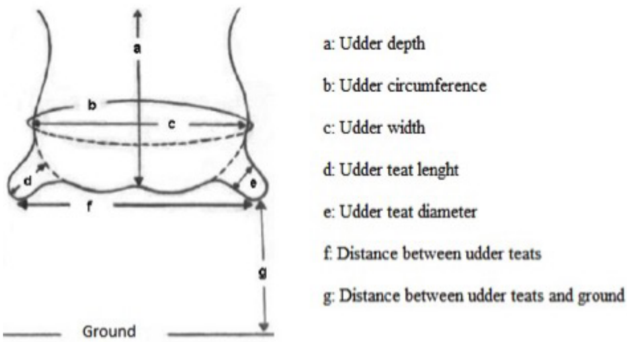

Fig. 1. Udder measurements scheme (Akcapinar *et al.* 2008).

MATERIALS AND METHODS

The study was performed at the Research and Application Farm of Agriculture Faculty, Atatürk University in Turkey, on 158 dairy sheep belonging to 3 breeds: Morkaraman (n = 68), Tuj (n = 64), and Awassi (n = 26). Sheep were between 2nd – 6th lactation. When lambs reached at the 60th day, they became weaned. Udder measurements were taken on the average 90th ± 5 day of lactation as shown in Figure 1 before milking (Yardımcı, 2001). Udder width, udder depth and distance udder teats places were measured by measuring cane. Udder circumference was measured at the widest part of udder and just over the udder teats by using tape measure. Udder teats length was measured from linking udder to tip of teats. Udder teats diameter was measured at the thickest portion of teats by using caliper.

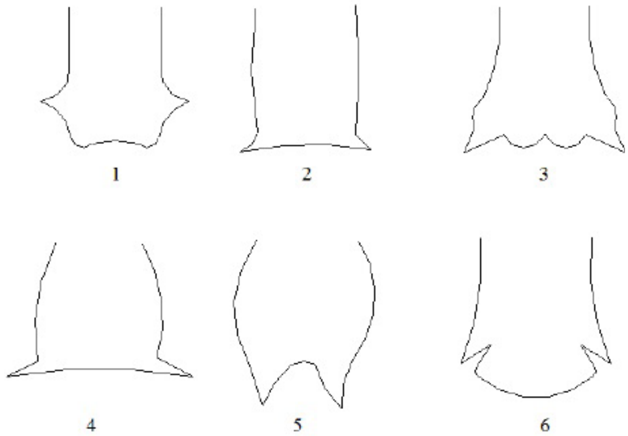

Fig. 2. Udder types in sheep (Epstein 1985; Dogan *et al.* 2013). 1, Cylindrical udder, udder teats are upward and lateral; 2, Cylindrical udder, udder teats are downwards and inclined; 3, Pear-shaped udder, udder teats are downwards and inclined; 4, Pear-shaped udder, udder teats are downwards and horizontal; 5, Udder teats are big, udder which is downwards and vertical; 6, Udder teats are upward and inclined udder.

The udder type in sheep was determined as reported by Epstein (1985) and Doğan *et al*. (2013) (Fig. 2). Linear udder scores was determined according to the method (Fig. 3) reported by De La Fuente *et al*. (1996).

50 mL samples were taken from the milk of the sheep and kept in the cold chain, then on the same day, they were taken into Milk Analysis Laboratory of the Department of Animal Science in Atatürk University Faculty of Agriculture, and the milk component analysis was performed with BOECO Milk Analyzer.

Analysis of variance was applied in determining the differences in milk components of breeds, correlation between udder measurements and milk components were analyzed using SPSS Pearson Correlation, and $\chi 2$ analysis was applied in determining the differences between breeds in terms of udder type. For this analysis, SPSS 17.0 package program was used and the Duncan test for the differences between averages.

RESULTS AND DISCUSSION

In the study, the results related to the percentages of fat, solids non-fat, density, protein, lactose and ash which are the components of milk samples of Morkaraman, Tuj and Awassi sheep are given in Table I.

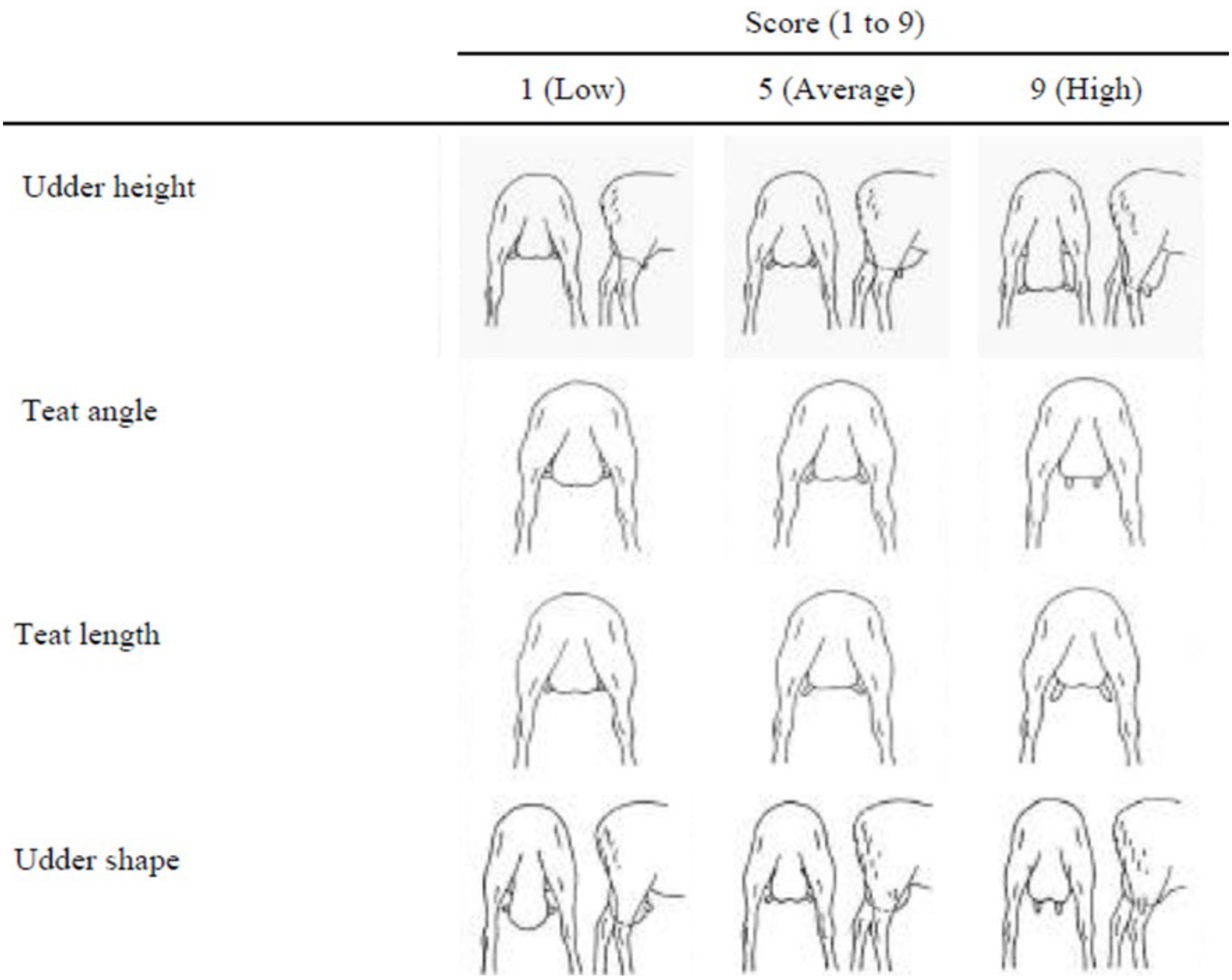

Fig. 3. Linear scores of udder traits (Caja *et al*. 1981).

Table I.- Least-squares averages and standard deviation values of milk components of sheep.

Traits	Morkaraman	Tuj	Awassi	P
Fat (%)	7.19±0.35	7.20±0.31	6.79±0.35	ns
Solid non-fat (%)	9.67±0.26	9.95±0.23	9.60±0.26	ns
Density (kg/ m^3)	1030.78± 0.82	1031.78± 0.75	1030.77±0.84	ns
Protein (%)	3.18±0.09	3.29±0.08	3.18±0.09	ns
Lactose (%)	5.55±0.15	5.70±0.14	5.49±0.15	ns
Ash (%)	0.93±0.03	0.96±0.02	0.93±0.03	ns

ns, non-significant.

Although statistics were insignificant, the fat in Awassi sheep was observed to be relatively lower than other breeds. This situation is considered to be caused by the increase in milk percentage whereas the decrease in fat percentage.

The obtained values in this study in terms of fat percentages were lower than reported values by Demirci and Gündüz (2000), Özder *et al*. (2004) and Doğan *et al*. (2013); higher than reported values by Yıldız and Denk (2006), Zamiri *et al*. (2001) and Sallam *et al*. (2005). In terms of solid non-fat percentages in the study, the values were lower than reported by Demirci and Gündüz (2000), Özder *et al*. (2004), Doğan *et al*. (2013) and Sallam *et al*. (2005). While the obtained protein percentages were found to be lower than the most of studies, the lactose percentages were found to be higher (Demirci and Gündüz, 2000; Zamiri *et al*., 2001; Özder *et al*., 2004; Sallam *et al*., 2005; Yıldız and Denk, 2006; Doğan *et al*., 2013). According to values reported by Karaca *et al*. (2003), while fat percentage was high in Morkaraman and Tuj sheep, it was low in Awassi sheep, solids non-fat was observed to be low, and ash percentage was observed to be similar.

Showing the relationship between the milk component and udder measurements in Morkaraman sheep breeds and linear udder scores is given in Table II. The positively correlation was observed between the milk components and udder width and circumference in Morkaraman sheep breeds; and negative relationship was observed with udder teat length and udder shape from udder teat length and linear scores although it was not significant. Negative correlation was observed between milk components and udder teat length; and positive correlation was observed between milk components and udder diameter. The highest positive correlation in fat yield was found by udder teat width (P<0.01).

Table II.- Milk component, udder measurements and scores correlation for sheep.

Breed	Fat	Solids non-fat	Density	Protein	Lactose	Ash
Morkaraman						
Udder traits (cm)						
Udder depth	0.302	0.545**	0.551**	0.550**	0.537**	0.539**
Udder circumference	0.508**	0.36	0.303	0.314	0.384*	0.37
Udder width	0.536**	0.476*	0.428*	0.438*	0.495**	0.485**
Udder teat length	-0.201	-0.171	-0.152	-0.153	-0.18	-0.174
Udder teat diameter	0.087	0.21	0.218	0.219	0.204	0.206
DUT	0.206	0.209	0.193	0.197	0.215	0.21
DUTF	-0.166	-0.057	-0.030	-0.036	-0.067	-0.061
Linear Udder Scores (1-9)						
Udder height	0.366	0.038	-0.3	-0.016	0.07	0.058
Udder teat angle	-0.062	-0.21	-0.222	-0.22	-0.202	-0.199
Udder teat length	-0.254	-0.193	-0.166	-0.168	-0.205	-0.197
Udder shape	-0.038	-0.237	-0.258	-0.255	-0.225	-0.227
Tuj						
Udder traits (cm)						
Udder depth	0.133	-0.096	-0.151	-0.142	-0.07	-0.077
Udder circumference	0.362*	0.264	0.202	0.214	0.287	0.282
Udder width	0.392*	0.426*	0.383*	0.392*	0.439**	0.440**
Udder teat length	-0.027	0.165	0.199	0.191	0.146	0.16
Udder teat diameter	0.212	0.086	0.039	0.046	0.106	0.106
DUT	0.136	-0.07	-0.121	-0.114	-0.046	-0.048
DUTF	0.05	0.147	0.157	0.158	0.142	0.136
Linear Udder Scores (1-9)						
Udder height	0.248	-0.098	-0.19	-0.177	-0.052	-0.069
Udder teat angle	0.209	0.353*	0.330*	0.337*	0.355*	0.355*
Udder teat length	-0.051	0.151	0.186	0.179	0.13	0.145
Udder shape	0.488**	0.623**	0.545**	0.563**	0.644**	0.637**
Awassi						
Udder traits (cm)						
Udder depth	0.046	0.664**	0.730**	0.724**	0.617**	0.648**
Udder circumference	0.033	0.549**	0.605**	0.600**	0.510**	0.538**
Udder width	-0.056	0.449*	0.519**	0.512**	0.406*	0.433*
Udder teat length	0.01	-0.187	-0.212	-0.207	-0.169	-0.177
Udder teat diameter	0.016	-0.038	-0.036	-0.034	-0.036	-0.033
DUT	-0.124	0.38	0.458*	0.447*	0.334	0.363
DUTF	-0.348	-0.419*	-0.369	-0.378	-0.435*	-0.437*
Linear Udder Scores (1-9)						
Udder height	0.169	0.375	0.372	0.376	0.369	0.384*
Udder teat angle	0.226	-0.173	-0.258	-0.244	-0.127	-0.145
Udder teat length	0.078	-0.154	-0.195	-0.188	-0.13	-0.14
Udder shape	0.083	0.052	0.035	0.04	0.061	0.065

*, significant (p<0.05); **, very significant (p<0.01); DUT, distance between udder teats; DUTF, distance between udder teats and floor.

Table III.- Udder types and chi-square analysis according to breeds.

Breed	Udder type										Total	
	1		2		3		4		6			
	n	%	n	%	n	%	n	%	n	%	n	%
Morkaraman	16	22.8	1	1.4	49	70	2	2.8	2	2.8	70	100
Tuj	8	12.3	4	6.1	47	72.3	6	9.2	0	0	65	100
Awassi	9	33.3	0	0	18	66.6	0	0	0	0	27	100
Total	33	20.3	5	3	114	70.3	8	4.9	2	1.2	162	100

Chi-square value, 15.042; P, 0.058.

In the study carried out by Iniguez *et al*. (2009), the results they reported between milk components and udder circumference and udder depth showed similarity with this study. Also, with the same researchers, Mavrogenis *et al*. (1988) and Emediato *et al*. (2008) observed a negative correlation between milk components and udder teat length in parallel with this study. With Iniguez *et al*. (2009), similar results were observed between milk components and udder teat diameter.

A positive correlation was observed between fat yield and udder shape, udder circumference and udder width in Tuj sheep breeds, and the highest positive correlation with fat yield was observed with udder shape (P<0.01). An insignificant relationship was observed between fat yield and udder teat length and teat length. Also, it was observed that udder width and udder shape had positive effect on milk components.

They observed similar positive correlation with this study between udder circumference and udder width and fat yield and solids non-fat in the study they carried out on Awassi sheep breeds. The negative relationship between udder teat length and fat yield was observed to be similar with Mavrogenis *et al*. (1988), Emediato *et al*. (2008) and Iniguez *et al*. (2009); and the relationship between udder teat length and other milk components were observed to be different.

A trait of significant positive or negative relationship was not observed between fat yield and udder measurements in Awassi sheep. It was observed that fat yield had positive relationship with udder teat angle, and negative relationship with distance between udder teats and distance between udder teats places. A negative relationship was observed between distance between udder teat places and milk components. The positive relationship between udder circumference and milk components stated by Iniguez *et al*. (2009), and the negative relationship between udder teat length and milk components stated by Mavrogenis *et al*. (1988), Emediato *et al*. (2008) and Iniguez *et al*. (2009) showed similarities with this study, except for fat. There was a significant correlation between milk fat percentages and udder width and udder circumference for Morkaraman and Tuj breeds, and not for Awassi sheep. This is because the fat percentages increases with udder width and udder circumference increases, milk yield due to decrease.

A statistical difference was not observed between breeds according to udder type in study carried out (Table III). In all three breeds, 3rd udder type was mostly observed (70.3%), and 6th udder type was observed at the least (1.2%). 5th udder type was not observed in all three breeds. Doğan *et al*. (2013), in the study they carried out on Anatolian merino sheep, stated that 3rd udder type was mostly observed, and then secondly, 1st udder type was observed, and 5th udder type was never observed. In the study carried out by Dağ and Zülkadir (2004), they stated that udder teats were located high, and the cylindrical udder facing the ground was the most common type (74.18%).

According to the results, the most ideal and most suitable for machine milking type was the 3rd udder type, pear-shaped, udder teats are downwards and inclined. This trait is considered to help the selection to be made in terms of milk in Morkaraman and Tuj sheep breeds.

CONCLUSIONS

In the study carried out, a statistical difference was not observed between breeds in terms of milk components. Although statistics were insignificant, it was observed that the fat yield in Awassi sheep breeds was relatively low compared to other breeds. This situation is considered to be caused by the dairy characteristic of Awassi. In all three breeds, high positive correlation was observed between udder length and solids non-fat. The most ideal and most suitable for machine milking type was the 3rd udder type, pear-shaped, udder teats are downwards and inclined. Because of the fact that the 3rd udder type was mostly observed (70.3%) in all three breeds, this trait is considered to help the selection to be made in terms of milk in Morkaraman and Tuj sheep breeds.

Statement of conflict of interest

Authors have declared no conflict of interest.

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