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Investigation of Relationship between Udder Morphology, Lactation Traits and Milk Components in Morkaraman and Awassi

Morkaraman ve İvesi Koyunlarında Meme Morfolojisi, Laktasyon Özellikleri ve Süt Bileşenleri Arasındaki İlişkinin Araştırılması

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Abstract

In this study, it was aimed to determine the relationship between lactation traits, milk components and udder morphology in Morkaraman which accounts for approximately 21% of sheep raised in Turkey and was also used by some breeders for milk yield and Awassi sheep. 34 Morkaraman and 32 Awassi sheep were used in this study. Udder measurements were taken once in the middle lactation period (50-65 days of lactation) 2 hours before milking. Electronic caliper was used for measurements. Milk samples were taken every 15 days after birth to determine lactation traits and milk composition. While breed had statistically significant effect on lactation milk yield and lactation length, age had statistically significant effect on all of lactation traits ($p<0.05$). Breed and udder type had no statistical effect on any milk component. 23.5% of Morkaraman and 25% of Awassi have type I udder, while the others have type III udder. In contrast to Morkaraman, positive correlation was found between udder circumference and both lactation milk yield and daily average milk yield and also between udder lenght and both lactation milk yield and daily average milk yield in Awassi. There was more correlation between udder traits and lactation characteristics in Awassi compared to Morkaraman. Although udder type had no significant effect on lactation traits, it was determined that type I udder may be more suitable for machine milking in terms of udder size. New studies on the rate of milking from the alveoli and cistern area in machine milking are recommended.

Keywords: Lactation, Milk components, Udder Traits, Udder Type

Öz

Çalışmada Türkiye koyun varlığının yaklaşık %21'ini oluşturan ve bazı yetiştiricilerin süt verim yönünde de kullandığı Morkaraman ırkı ile ıslah edilmemiş İvesi koyunlarında laktasyon özellikleri ile süt bileşenlerinin meme morfolojisi ile ilişkisini belirlemek amaçlanmıştır. Çalışmada 34 baş Morkaraman ve 32 baş İvesi ırkı koyun kullanılmıştır. Meme ölçüleri laktasyonun ortasında (laktasyonun 50-65. günleri) bir kere olmak üzere sağımdan 2 saat önce alınmıştır. Ölçümlerin alınmasında elektronik kumpas kullanılmıştır. Süt bileşiminin belirlenmesi amacıyla doğumdan sonra her 15 günde bir süt numuneleri alınmıştır. Irk, laktasyon süt verimi ve laktasyon süresi üzerinde, yaş ise tüm laktasyon özellikleri üzerinde istatistiki olarak önemli etkiye sahip olmuştur ($p<0.05$). Meme tipi hem laktasyon özellikleri hem de süt bileşenleri üzerinde önemli bir etkiye sahip olmamıştır. Morkaraman ırkının %23.5'i ve İvesi ırkının ise %25'i tip I memeye sahipken geri kalanları tip III memeye sahiptir. Meme çevresi ve meme uzunluğu İvesi ırkında daha büyük bulunurken, sağ ve sol meme uzunluğu Morkaraman ırkında daha uzun bulunmuştur. Morkaraman ırkının aksine İvesi ırkında meme çevresi ile laktasyon süt verimi ve günlük ortalama süt verimi arasında ayrıca meme uzunluğu ile laktasyon süt verimi ve günlük ortalama süt verimi arasında pozitif korelasyon belirlenmiştir. İvesi ırkında Morkaraman ırkına nazaran meme özellikleri ile laktasyon özellikleri arasında daha fazla pozitif korelasyon tespit edilmiştir. Meme tipi laktasyon özellikleri üzerinde önemli bir etkiye sahip olmamamsına rağmen meme ölçüleri açısından meme I tipinin makine sağıma daha uygun olabileceği belirlenmiştir. Makineli sağımda alveol ve cistern alandan sütün gelme hızı üzerine yeni çalışmaların yapılması tavsiye edilmektedir.

***Anahtar kelimeler**: Laktasyon, Süt Bileşeni, Meme Özellikleri, Meme Tipi*

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1. Introduction

As of 2018, Turkey has a total of 35 million 194 thousand sheep. According to TurkStat, while the number of milking sheep was 13 637 thousand heads in 2002 and 657 thousand tons of milk was produced from these sheep, 1 446 412 tons of milk was produced from 18 820 thousand heads of sheep in 2018. While the average lactation milk yield per sheep in 2002 was abouth 48 kg, it increased to abouth 77 kg in 2018. Despite the increase in sheep milk production, the share of sheep in total milk production (22 043 thousand tons in 2018) decreased from 7.8% in 2002 to 6.5% in 2018 (URL-1, 2019).

Although the first studies on the relationship between udder characteristics and milking performance began in the 1970s (Sagi and Morag, 1974), engineering development in milking systems in recent years has increased the interest in the morphology of sheep udder (Makovicky et al. 2014). Many definitions and studies have been conducted in terms of both linear scoring of the udder and udder types (Epstein 1985; de la Fuenta et al. 1996). The anatomical structure of the udder is important for the lamb to be able to suck the milk in lamb breeding (Kaygısız ve Dag, 2017). Udder morphology is also important for milk yield and production, milk composition and machine milking (Kominakis et al. 2009, Makovicky et al. 2017). The distinction between the udder lobes and sinus and vertical teats are important for machine milking in sheep. (Unal et al. 2008a). In addition, positive and significant correlations have been reported between udder type and milk yield (Kaygisiz and Dag, 2017). In Turkey, especially in the last decade, there have been many studies examining udder morphology and the relationship between udder morphology and milk yield and investigating the suitability of sheep for machine milking (Dogan et al., 2013; Altincekic et al., 2011; Akdag et al., 2018; Kaygisiz and Dag, 2017; Unal et al., 2008a; Unal et al. 2008b). The Morkaraman used in the study constitutes approximately 21% of the country sheep. It is also the dominant indigenous breed of the Eastern Anatolia Region. The Awassi are bred South Eastern Anatolia and Çukurova in Turkey. In this study, we aimed to determine the relationship between lactation traits, milk components and udder morphology in Morkaraman and unimproved Awassi sheep.

2. Materials and Methods

The study was carried out in 2018 at Atatürk University, Faculty of Agriculture, Research and Application Farm. 34 Morkaraman and 32 Awassi sheep were used in this study. Birthing started on 02.04.2018 and were completed on 19.04.2018. Lambs were weaned at the end of May. Until the weaning date, the sheep were housed together with the lambs. Then sheep were sent to the pasture between 07:00-17:00 and 0.2kg/concentrate feed was given during the milking in addition to the pasture.

Udder measurements were taken once in the middle lactation period (50-65 days of lactation) 2 hours before milking (Dzidic et al. 2004). Udder circumference, udder length, distance between teat and ground, height at rump, udder width, teat length, teat diameter, distance between teats, udder depth were taken for determining the sheep's udder morphology (Altincekic and Koyuncu 2011). Electronic caliper was used for measurements. The type of udder in sheep was determined as Epstein (1985) and Doğan ve ark. (2013) reported (Figure 1.). However, only the I, III, IV and VI. udder types were found. Ewes that had IV and VI udder types were not used in the study because there were 4 in total.

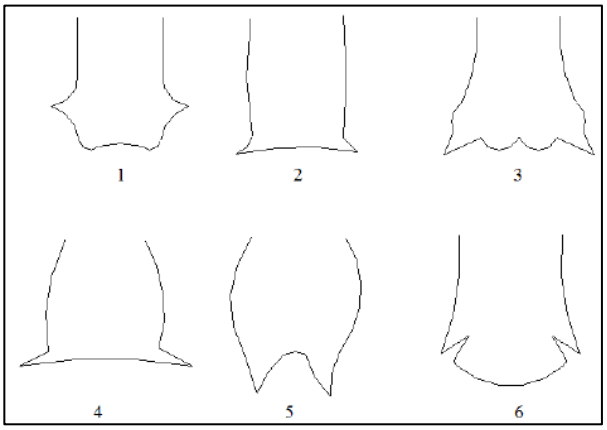

Figure 1. Types of udder in ewe (Epstein 1985)

The sheep were milked once a day with a bucket fixed milking unit at 18:00. Milking controls were repeated every 15 days. Milk weighing was done with a balance sensitive to 1 mg. Milking controls for each sheep were continued until daily milk yield was below 50 g. The time from birth to end of lactation is calculated as lactation length (LL). The lactation milk yield was calculated using daily milk yields determined by milking controls. Trapeze II method was used to determine lactation milk yield (LMY) (Yakan 2012).

Milk samples were taken every 15 days after birth to determine the milk composition. The milk samples were placed in 50 ml plastic tubes and stored at +4 degrees and milk composition

analysis (fat, non-fat, protein, lactose and ash) was performed with Boeco Lac milk composition analyzer. The data were first transferred to Microsoft Excel 2010 and then SPSS 17.0 (SPSS, 2005) package program was used with General Linear Model method and Duncan multiple comparison test was used for multiple comparisons.

In the analysis of lactation traits, milk composition and udder characteristics;

$$Y_{ijkl} = \mu + {}_{ai} + b_j + c_k + e_{ijkl}$$

In model;
Y_{ijkl}: Lactation milk yield, lactation length, daily average milk yield and milk composition,
μ: Expected average,
a_i: Effect of genotype (i =2; Morkaraman=1, Awassi=2)
b_j: Effect of age (j =4; 2=1, 3=2, 4=3 and 5=4)
c_k: Effect of udder type (k =2; 1=1 and 3=3)
e_{ijkl}: residual error.

3. Results and Discussion

In this study, the average lactation milk yield, lactation length and average daily milk yield were 32.71 ± 8.4 kg, 88.93 ± 7.1 days and 367.18 ± 46.7 g for Morkaraman, respectively and were 47.99±9.5 kg 130.0±8.02 days and 348.92±52.5 g for Awassi, respectively. The lactation milk yield obtained for Awassi was lower than the values reported by Yıldız and Yıldız, (2002), Gursu and Aygun (2014), Ustuner and Ogan (2013), Alkass and Akreyi (2015). Also, the lactation milk yield found for Morkaraman was lower than the results of Kuçuk et al. (2000), Ozbey and Akcan (2000), Kırmızıbayrak et al. (2005). Talafha and Ababneh (2011) reported that Awassi raised under extensive conditions in the Middle East have a milk yield of 40-60 kg during 150 days lactation period. This result is similar to the result obtained in the study. One reason for the low milk yield of Awassi can be that it was the only a milking per day.

While breed had statistically significant effect on lactation milk yield and lactation length, age had statistically significant effect on all of lactation traits ($p < 0.05$). Breed and udder type had no statistical effect on any milk component. However, age had a significant effect on milk components except ratio of fat ($p<0.05$). In this study, the ratio of fat found in Morkaraman was higher than Macit and Aksoy (1996); Celik and Özdemir (2003); Yılmaz et al. (2011). Also, the ratio of fat found in Awassi was higher than Macit and Aksoy (1996) Sahan et al. (2005) Al-Jundı (2010). The mean value of lactation length was 88.93±7.1 days for Morkaraman and 130.05±8.02 days for Awassi, and this difference was statistically significant ($p<0.05$). Although the lactation length in the Awassi was higher than the Morkaraman, it was found to be lower than the other studies carried out with the Awassi (Ozbey and Akcan, 2000; Seker et al., 2000; Kaygsız and Dag, 2017).

23.5% of Morkaraman and 25% of Awassi have I type udder, while the others have III type udder. Dag and Ugur (2004) reported that the ratio of I type udder was 74.18% in unimproved Awassi. Kaygisiz and Dag (2017) reported that the ratios of I, II, III, IV and VI types udder were 31%, 1%, 42%, 3% and 23% respectively, also V type udder was not found. For Bafra breed, Unal et al. (2008a) reported that the most common udder type (43%) was type III udder that has lobes with separate and vertical extending teats. Dogan et al. (2013) in Anatolian Merino sheep, I, II, III, IV, and VI udder types were found to be 22.0%, 20.3%, 22.0%, 16.9% and 18.6% respectively, also V udder type was never encountered. Similar to the results of this study, Kukovics et al. (2006) reported that the most common udder type was III udder type in the Awassi. Udder type had no significant effect on both lactation traits and milk components. The reason that milk components were not affected by udder type may be due to the major effect of nutrition on milk components. Kocak et al. (2018) for both lactation properties and milk composition in Pirlak; Akdag et al. (2018) only for milk composition (except lactose) in Karayaka reported similar results with this study, while Dogan et al. (2013) and Kaygisiz and Dag (2017) reported different results.

While breed has statistically significant effect on teat length (right) ($p<0.01$), teat length (left), udder circumference, udder length ($p<0.05$); udder type only has significant effect on udder circumference, udder length and height at rump ($p<0.05$). When it can be looked age, it has significant effect only on udder length and height at rump ($p<0.05$). The mean udder circumference was 34.47±0.8 and 37.61±0.9 cm for Morkaraman and Awassi, respectively. In a different study conducted by Ozyurek et al. (2018), the udder circumference was 36.08±0.58 for Morkaraman and 35.32±0.97 for Awassi. Udder circumference and udder length were found to be higher in the Awassi while right and left udder lengths were found to be longer in Morkaraman.

Table 1. The least square means and standard errors for some lactation traits and milk componenets

Factors		LMY (kg)	LL	DMY (g)	Fat (%)	SNF (%)	Protein (%)	Lactose (%)	Ash (%)
	μ	40.94±6.4	111.07±5.4	357.3±35.5	7.20±0.2	9.21±0.1	3.01±0.1	5.30±0.1	0.88±0.0
Breed	**n**	*	*	ns	ns	ns	ns	ns	ns
M	34	32.71±8.4	88.93±7.1	367.18±46.7	7.12±0.3	9.18±0.2	3.01±0.1	5.28±0.1	0.88±0.0
A	32	47.99±9.5	130.05±8.02	348.92±52.5	7.26±0.4	9.23±0.2	3.01±0.1	5.31±0.1	0.89±0.0
Age		*	*	*	ns	*	*	*	*
2	18	$34.93±12.4^{a}$	$103.03±10.5^{b}$	$328.6±68.9^{a}$	7.57±0.5	$9.62±0.3^{b}$	$3.15±0.1^{b}$	$5.54±0.1^{b}$	$0.92±0.0^{b}$
3	16	$32.59±12.4^{a}$	$106.57±10.4^{b}$	$302.0±68.4^{a}$	7.54±0.5	$8.75±0.2^{a}$	$2.83±0.1^{a}$	$5.07±0.1^{a}$	$0.84±0.0^{a}$
4	20	$47.68±11.1^{b}$	$96.43±9.3^{a}$	$452.5±61.2^{ab}$	7.45±0.4	$8.83±0.2^{ab}$	$2.86±0.2^{ab}$	$5.11±0.1^{ab}$	$0.85±0.0^{ab}$
5+	12	$50.55±15.0^{b}$	$140.94±12.6^{c}$	$355.6±82.9^{b}$	6.09±0.6	$9.47±0.3^{ab}$	$3.17±0.1^{ab}$	$5.39±0.2^{ab}$	$0.91±0.0^{ab}$
Udder type		ns	ns	ns	ns	ns	ns	ns	ns
1	16	42.64±12.45	115.82±10.4	365.79±68.7	6.75±0.45	9.03±0.25	2.97±0.09	5.18±0.1	0.87±0.0
3	50	39.87±70.01	108.11±5.9	352.07±38.7	7.66±0.27	9.31±0.14	3.04±0.05	5.37±0.2	0.89±0.0

M: Morkaraman, A: Awassi, LMY: Lactation Milk Yield, LL: Lactation length, DMY: Daily milk yield, SNF: Solid non fat; Means with different superscript in each column (a, b, c) differ significantly; ns=not significant. *: P<0.05

Table 2. The least square means and standard errors for udder measurements (cm)

Factors		UC	UL	DTG	HR	UW	TL (right)	TL (left)	TD (right)	TD (left)	DT	UD
	μ	36.16±0.6	22.65±0.4	28.29±0.6	70.90±0.6	10.73±0.3	1.65±0.04	1.66±0.08	1.43±0.04	1.42±0.03	12.22±0.4	11.89±0.4
Breed	**n**	*	*	ns	ns	ns	**	*	ns	ns	ns	ns
M	34	34.47±0.8	20.96±0.5	29.67±0.7	71.46±0.8	10.04±0.4	1.87±0.05	1.91±0.11	1.49±0.06	1.49±0.04	12.08±0.5	11.61±0.5
A	32	37.61±0.9	24.10±0.6	27.11±0.8	70.42±1.0	11.33±0.4	1.47±0.06	1.46±0.12	1.38±0.07	1.36±0.05	12.33±0.5	12.13±0.5
Age		*	*	ns	ns	ns	ns	ns	ns	*	*	ns
2	18	$35.7±1.2^{a}$	$21.57±0.8^{a}$	28.87±1.1	69.65±1.3	11.78±0.6	1.91±0.08	1.31±0.17	1.34±0.08	$1.27±0.06^{a}$	$10.86±0.7^{b}$	10.89±0.7
3	16	$33.98±1.2^{a}$	$23.75±0.8^{b}$	26.97±1.2	71.56±1.3	8.87±0.6	1.39±0.08	1.33±0.16	1.33±0.08	$1.24±0.06^{a}$	$10.23±0.7^{a}$	10.43±0.7
4	20	$35.50±1.1^{a}$	$21.76±0.7^{a}$	29.65±1.0	71.43±1.2	10.13±0.5	1.71±0.07	1.68±0.15	1.36±0.07	$1.36±0.05^{b}$	$12.12±0.6^{a}$	11.68±0.6
5+	12	$39.62±1.5^{b}$	$23.86±1.0^{b}$	27.47±1.4	71.38±1.6	11.81±0.7	1.52±0.10	1.52±0.20	1.33±0.10	$1.34±0.08^{b}$	$12.11±0.9^{a}$	12.23±0.9
Udder type		ns	*	ns	*	ns	ns	ns	ns	ns	ns	ns
1	16	36.55±1.2	24.25±0.8	28.65±1.1	72.75±1.3	10.82±0.6	1.75±0.08	1.71±0.16	1.55±0.08	1.52±0.06	13.36±0.7	12.37±0.7
3	50	35.92±0.71	21.65±0.4	28.06±0.6	69.75±0.7	10.680±0.3	1.59±0.04	1.64±0.09	1.36±0.05	1.36±0.03	11.50±0.4	11.59±0.4

M: Morkaraman, A: Awassi, UC: Udder Circumference , UL: Udder length, DTG: Distance between teat and ground, HR: Height at rump, UW: Udder width, TL (right): Teat length, TL(left): Teat length, TD(right): Teat diameter, TD(left): Teat diameter, DT: Distance between teats, UD: Udder depth; Means with different superscript in each column (a, b, c) differ significantly; ns=not significant. *: P<0.05

Udder circumference was found for the Awassi breed is 2.05 cm lower than the Israeli sheep (Prpic et al. 2013) and 3.39 cm lower than the Suffolk (Martinez et al. 2011). The udder circumference found lower for the Morkaraman than the result of Kirmizibayrak et al. (2005). Also the teat length was determined lower than the value reported by Milerski et al. (2006) in dairy breeds and by Izadifard and Zamiri (1997) in Iranian fat tail breeds. According to the age groups, the udder circumference, teat length and distance between teats were found to be the highest in 5+ years age when compared to the other age groups. These findings obtained in our study were similar with Unal et al. (2008a) and Prpic et al. (2013).

A negative correlation was found between the lactation length and milk fat content in Morkaraman ($p<0.05$, $r=-0.447$). In addition, positive correlation was found between the lactation length and protein content in milk

(p<0.05; r=0.519). When the relationship between udder characteristics and milk yield in Morkaraman was examined, a positive correlation was found between udder depth and lactation milk yield (p<0.05, r=0.425). There were a high positive correlation between udder depth and lactation milk yield (p<0.01; r=0.631), lactation length (p<0.05, r=0.606) and daily average milk yield (p<0.05, r=0.562) in Awassi. Similar to this study, Snowder and Glimp (1991) in Rambouillet X Finn-Dorset sheep, Perez Linarez et al. (1984) in Mancha, Izadifard and Zamiri (1997) in Mehraban and Ghezel, Emediato et al. (2008) in Bergamasca reported similar correlations. In contrast to Morkaraman, positive correlation was found between udder circumference and lactation milk yield and daily average milk yield and also between udder length and lactation milk yield and daily average milk yield in Awassi. Furthermore, in contrast to the Awassi, there was a positive correlation between udder depth and SNF (p<0.05; r=0.536), protein (p<0.05; r=0.570) and lactoz (p<0.05; r=0.497) in the Morkaraman.

Table 3. Coefficients of phenotypic correlation among some milk contenents and udder traits in Morkaraman

	Fat	SNF	Protein	Lactose	LMY	LL	DMY	UC	UL	HR	UW
SNF	-0.082										
Protein	-0.281	0.979***									
Lactoz	0.069	0.988***	0.938***								
LMY	-0.145	0.071	0.097	0.050							
LL	-0.447*	0.107	0.193	0.038	0.731**						
DMY	0.186	-0.145	-0.179	-0.114	0.679**	0.030					
UC	-0.049	0.445	0.438	0.440	0.201	-0.039	0.313				
UL	-0.191	0.253	0.282	0.225	0.265	0.134	0.115	0.052			
HR	-0.049	-0.311	-0.286	-0.319	-0.093	0.118	-0.332	-0.073	0.148		
UW	-0.167	0.447	0.460	0.422	0.316	0.091	0.334	0.481**	0.540*	-0.417	
UD	-0.271	0.536*	0.570*	0.497*	0.425*	0.270	0.296	0.701**	0.279	-0.205	0.671**

SNF: Solid non fat, LMY: Lactation Milk Yield, LL: Lactation length, UC: Udder circumference, UL: Udder length, HR: Height at rump, UW: Udder width, UD: Udder depth, *: P<0.05, **:P<0.01, ***:P<0.001,

Table 4. Coefficients of phenotypic correlation among some milk contenenets and udder traits in Awassia

	Fat	SNF	Protein	Lactose	LMY	LL	DMY	UC	UL	HR	UW
SNF	-0.049										
Protein	-0.347	0.954***									
Lactoz	0.176	0.975***	0.862**								
LMY	0.094	0.199	0.162	0.219							
LL	-0.275	0.462	0.519*	0.397	0.593*						
DMY	0.189	0.073	0.015	0.115	0.976**	0.413					
UC	0.103	0.241	0.199	0.262	0.670**	0.517*	0.629**				
UL	-0.377	-0.391	-0.250	-0.468	0.566*	0.290	0.581*	0.357*			
HR	-0.316	-0.298	-0.186	-0.365	-0.355	-0.113	-0.348	-0.143	0.236		
UW	0.097	0.429	0.375	0.445	0.454	0.464	0.396	0.833**	0.051	-0.119	
UD	-0.147	0.198	0.235	0.162	0.631**	0.606*	0.562*	0.767**	0.336	-0.237	0.697**

SNF: Solid non fat, LMY: Lactation Milk Yield, LL: Duration of lactation, UC: Udder circumference, UL: Udder length, HR: Height at rump, UW: Udder width, UD: Udder depth, *: P<0.05, **:P<0.01, ***:P<0.001,

There was more correlation between udder characteristics and lactation traits in Awassi compared to Morkaraman. The reason for this situation can be explained as the milking character of the Awassi. Similar to the studies conducted in different breeds (Kominakis et al., 2009; Prpic et al. 2013), there was a positive correlation between udder traits (udder depth, udder circumference and udder width) in both breeds (p<0.05; r=0.357-0.833).

4. Conclusion

There was more positive correlation between udder characteristics and lactation traits in Awassi compared to Morkaraman. Although udder type had no effect on lactation characteristics and udder measurement, lactation characteristics and udder measurement were higher in I udder type. So, I udder type may be more suitable for machine milking in terms of udder size. New studies on the rate of milking from the alveoli and cistern area in machine milking are recommended.

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