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RESEARCH ARTICLE

Relationship Between Udder Measurements and The Linear Scores for Udder Morphology Traits in Kıvırcık, Tahirova and Karacabey Merino Ewes

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Summary

This study was conducted to define the udder morphology and subjectively assessed by the use of linear scores in 156 ewes of Tahirova, Kıvırcık and Karacabey Merino breeds. Udder morphology was evaluated with respect to data in mid-lactation (90 days). Udder morphology was assessed for: the traits measured were teat length, teat angle, rear udder depth, udder circumference, udder length, udder width and udder volume. Linear scores were assessed for: teat placement, udder depth, degree of separation and degree of suspension of the udder. Analysis of variance was calculated by using of SAS statistical package. Correlations between udder measurements and linear scores were computed for individual examined breeds separately. Subjectively assessed udder measurements for udder circumference, udder length, teat angle and udder volume determined high correlations with actual measurements of the respective traits on udder in all examined breeds (rp=0.477-0.729). Linear scores for udder depth and degree of suspension of the udder were highly correlated (rp= 0.714; 0.357; 0.343 for Tahirova; Kıvırcık and Karacabey Merino ewes). In conclusion, significant different were determined in udder characteristies linear udder traits and phenotypic correlations in Tahirova, Kıvırcık and Karacabey Merino ewes.

Keywords: *Tahirova, Kıvırcık, Karacabey Merino, Udder traits*

Kıvırcık, Tahirova ve Karacabey Merinosu Koyunlarında Meme Morfolojisi Özelliklerinde Linear Puanlama ve Meme Ölçüleri Arasındaki Ilişkiler

Özet

Bu çalışma Tahirova, Kıvırcık ve Karacabey Merinosu ırklarından 156 koyunda çeşitli meme ölçülerinden ve linear puanlamadan yararlanarak meme morfolojisi özelliklerini belirlemek amacıyla yapılmıştır. Meme morfolojisi laktasyonun ortasında (90. gün) alınan verilere göre değerlendirilmiştir. Meme morfolojisi için meme derinliği, meme uzunluğu, meme çevresi, arka meme derinliği, meme başı açısı, meme başı uzunluğu ve meme hacmi gibi özellikler değerlendirilmiştir. Linear puanlamada meme başı yerleşimi, meme derinliği, ayrılma derecesi ve meme bağlantı derecesi gibi özellikler değerlendirilmiştir. Varyans analizi SAS paket program kullanılarak hesaplanmıştır. Meme ölçüleri arasındaki korelasyonlar ve linear puanlar ırklar bazında ayrı ayrı hesaplanmıştır. Subjektif olarak değerlendirilen meme çevresi, meme uzunluğu, meme başı açısı ve meme hacmi gibi özellikler bakımından incelenen bütün ırklarda bu özellikler arasında yüksek düzeyde korelasyon (rp=0.477-0.729) saptanmıştır. Linear meme özellikleri bakımından meme derinliği ve meme bağlantı derecesi arasında yüksek düzeyde korelasyon olduğu bulunmuş ve bu değerler Tahirova, Kıvırcık ve Karacabey Merinosu ırklarında sırasıyla 0.714, 0.357 ve 0.343 olarak belirlenmiştir. Sonuç olarak Tahirova, Kıvırcık ve Karacabey Merinosu koyunlarında meme özellikleri, linear meme özellikleri ve fenotipik korelasyon katsayıları arasında önemli farklılıklar belirlenmiştir.

Anahtar sözcükler: *Tahirova, Kıvırcık, Karacabey Merinosu, Meme özellikleri*

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INTRODUCTION

The anatomy and morphology of the sheep udder has been well known for many years and some examples of curious selection on udder morphology have been assayed (i.e. increasing prolificacy and number of teats). The interest in the dairy sheep udder has increased in the last few years in which anatomy has been explored in depth [1,2], linear evaluation of udder traits has been proposed [3] and the genetic parameters evaluated [4,5]. Moreover, given the negative effects observed in udder morphology as a result of the increase in milk yield, main udder traits of breads of different production level [6] or of genetically isolated lines of the same bred [7] are under comparison.

The improvement of udder conformation might be beneficial to milking ability and animal health, but present selection on dairy production traits does not warrant a favorable trend in udder morphology. Milking characteristics and udder morphology are one of the factors determining milk ability in dairy ewes. Knowledge of milk yield, milking time and udder conformation is necessary for optimal adaptation of the milking environment to the needs of the ewe.

Udders strongly attached to the abdominal wall and with vertical teats placed on the lowest part of the cistern are less subject to teat-cup falls and need fewer manual interventions for stripping [8]. By contrast, when teats are horizontal and implanted far from the udder floor, a certain amount of milk may be retained in the cistern [9]. Horizontal teats are also more susceptible to distortion during machine milking. This inhibits the ejection reflex and thus increases alveolar milk retention [10]. Deep udders also retain part of the milk in the cistern during the machine milking; thus, manual intervention is needed to complete the milk extraction. Several authors have also highlighted the strong relationship between udder depth and milk yield [8,10]. Finally, udder conformation may be linked to functional longevity because grazing ewes with deep udders are more exposed to injury, and consequently may be more liable to be culled.

A linear method for the morphological appraisal of sheep udders has been proposed recently for five traits scored on a nine-point linear scale [11]. Score distributions, objectivity of classifiers, and the effects of environmental factors on linear udder traits have been studied elsewhere [5]. Traits related to udder size (depth, width, and circumference) were significantly influenced by lactation month, flock, and milk yield; traits related to cistern morphology (cistern height, teat position, and teat angle were significantly affected by flock and parity.

The purpose of this work was to determine the relationships between measurements of chosen udder dimensions or angles and subjective assessment of udder characteristics based on linear score in different sheep breeds in Turkey. Linear score should characterize the udder morphology as precisely as possible, but by the use of limited scale and number of criteria in order that the system will not be too complicated and its use in practice too time consuming. The knowledge of the relationships between individual characteristics of udder morphology is important also for their including into total selection indexes or for construction of partial selection indexes for udder morphology and enables to predict future correlated responses in milk-oriented selection schemes. For selection index construction the genetic correlations between traits are needed, but reasonable estimation of genetic correlations demands large and well structured data.

MATERIAL and METHODS

The study was conducted Karacabey state farm in Bursa, Turkey. A total of 156 ewes used in the experiment: 56 Kıvırcık (K); 51 Karacabey Merino (KM) crosses with 90% Germen Mutton Merino and 10% Kıvırcık; 49 Tahirova (T) crosses with 75% East Friesian and 25% Kıvırcık [12]. The ewes were in their second to third lactation. All lambs suckled their dams freely until 45 days of age. They were on a partial suckling regime until 60 days of age when they were weaned completely. Udder measurements were taken by one technician once in mid-lactation (90 days) for each ewe at approximately 2 h before the milking. Teat length (TL) was measured on both sides from teat base until teat orifice. Teat angle (TA) was measured in degrees from vertical line (intramammary ligament) of the udder from a caudal view. Rear udder depth (RUD) was measured by the distance between rear attachment and udder floor. Udder circumference (UC) was measured circumference of the medium area of the udder. Udder length (UL) was measured distance between insertions of teats. Udder width (UW) was measured at middle of the udder. The actual volume of the udder (UV) was estimated by dipping the udder into a water filled bucket and measuring water displacement as previously shown in bucket [13].

Linear assessments were done subjectively by at least 2 classifiers at every round of scoring. The method considers 4 udder traits, each scored with a 9-point linear scale; teat placement (TP), udder depth (UD), degree of separation of the 2 halves (DS), and degree of suspension of the udder (SU). Teat placement is the external highest of the cistern, that is the distance between the teats and the lowest part of the udder,

and the worst is 9, for teats located above the area with the maximum radius of curvature. Udder depth is the distance between the udder cleft and the abdominal wall, taking as a reference point the line joining the hocks; UD is scored 1 (the worst) for deep udders close to the ground, 55 for clefts at the hocks level, and 9 (the best) for shallow udders close to the abdominal wall. The SU is the ratio between the udder attachment width and udder height. The best score of is 9, for udders with an attachment width much larger than the UD, and the worst is 1, for udders with an attachment width much smaller than the UD. The score of 7 is given to apparently square udders, which are the easiest to evaluate. Finally, DS scores the strength of the median ligament. The worst score for DS is 1, with no separation between the left and right glands, whereas 9 < are the best, for udders clearly divided into 2 halves [14].

The data were analyzed by completely randomized design considering the effect of the moment when measurements were done utilizing analysis of variance (ANOVA) and the Tukey test for the differences between averages. The correlation estimates between all traits were calculated based on single intrinsic values of each ewe estimated from the corresponding models. The Pearson's correlation analyses were performed by using the CORR procedure from the SAS statistical package [15].

RESULTS

The mean of traits measured for udder and teats are shown in *Table 1*. Average rear udder depth of individual breeds was 7.67 cm (T), 7.36 cm (K) and 7.34 cm (KM). The phenotypic correlations between udder characteristics are shown in *Table 2, 3* and *4* for Tahirova, Kıvırcık and Karacabey Merino respectively. Means and standard errors for linear udder traits are shown *Table 5*. Phenotypic correlations among linear udder traits are given *Table 6*.

DISCUSSION

Mc Kusick et al.[16] measured higher average udder depth for multiparous East-Friesian ewes (19.7 cm). The larger udder volume is associated with unfavorable position of the teats for milking which could cause falling off the teat cups [10]. The teat angle was lower to Lacaune and Churra ewe breeds [5,10]. Significant differences were found among the breeds related to udder length, udder volume and udder width (P<0.05). The stage of lactation produced significant effects on all udder traits in accordance with Fernandez et al.[5].

In regard to the correlation coefficients between

Table 1. *Means (±S.E.) for characteristics of udder morphology in Tahirova, Kıvırcık and Karacabey Merino ewes*
Tablo 1. *Tahirova, Kıvırcık ve Merinos koyun ırklarında morfolojik meme özelliklerine ait ortalama değerler*

Traits	Tahirova	Kıvırcık	Karacabey Merino
Rear udder depth (cm)	7.67±1.41	7.36±0.99	7.34±0.93
Udder circumference (cm)	35.81±2.92	35.09±3.24	34.35±3.55
Udder length (cm)	23.01±2.69 ^{a}	22.11±2.62 ^{ab}	21.32±2.64 ^{b}
Udder volume (l)	1.65±0.24 ^{b}	1.77±0.46 ^{a}	1.60±0.13 ^{b}
Udder width (cm)	13.17±1.24 ^{a}	12.41±0.91 ^{b}	12.28±0.93 ^{b}
Teat length (cm)	2.88±0.38	2.68±0.47	2.72±0.42
Teat angle (°)	31.98±2.14	31.44±1.46	30.72±1.71

Values in line not followed by the same letter differ significantly (P<0.05)

Table 2. *Correlation coefficients among udder measurements in Tahirova dairy crossbreed ewes*
Tablo 2. *Tahirova koyun ırkında meme ölçüleri arasındaki korelasyon katsayıları*

Traits	UW	RUD	UC	UL	TL	TA
RUD	0.233					
UC	0.614 **	0.205				
UL	0.210	0.086	0.725 **			
TL	0.336 *	0.241	0.252	0.327		
TA	0.391 *	-0.004	0.477 *	0.289	0.279	
UV	0.185	-0.170	0.337 *	0.201	-0.096	0.421 *

** P<0.05, **P<0.01*

Table 3. *Correlation coefficients among udder measurements in Kıvırcık ewes*
Tablo 3. *Kıvırcık koyun ırkında meme ölçüleri arasındaki korelasyon katsayıları*

Traits	UW	RUD	UC	UL	TL	TA
RUD	0.145					
UC	0.398 *	0.398 *				
UL	0.161	0.328	0.579 **			
TL	0.271	-0.218	-0.048	0.151		
TA	0.401 *	0.219	0.530 **	0.303	0.206	
UV	0.284	0.330	0.607 **	0.535 **	0.114	0.582 **

** P<0.05, **P<0.01*

Table 4. *Correlation coefficients among udder measurements in Karacabey Merino ewes*
Tablo 4. *Karacabey Merinosu koyun ırkında meme ölçüleri arasındaki korelasyon katsayıları*

Traits	UW	RUD	UC	UL	TL	TA
RUD	0.188					
UC	0.499 *	0.608 *				
UL	0.325 *	0.610 **	0.520 **			
TL	0.256	0.091	0.122	0.090		
TA	0.274	0.162	0.470 *	0.160	0.157	
UV	0.182	0.554**	0.729 **	0.398 *	-0.062	0.401 *

** P<0.05, **P<0.01*

Table 5. *Means (±S.E.) for linear udder traits in Tahirova, Kıvırcık and Karacabey Merino ewes*
Tablo 5. *Tahirova, Kıvırcık ve Karacabey Merinosu koyun ırklarında linear meme özellikleri için ortalama değerler*

Traits	Tahirova	Kıvırcık	Karacabey Merino
Teat placement	4.36±0.21 [b]	5.06±0.21 [ab]	5.19±0.21 [a]
Udder depth	6.77±0.33	6.60±0.34	6.49±0.33
Degree of separation	3.42±0.32	3.74±0.33	3.43±0.32
Degree of suspension of the udder	8.22±0.18 [a]	7.23±0.19 [b]	7.65±0.18 [ab]

Values in line not followed by the same letter differ significantly (P<0.05)

Table 6. *Phenotypic correlations among linear udder traits*
Tablo 6. *Linear meme özellikleri arasındaki fenotipik korelasyonlar*

Breeds	Traits	UD	DS	SU
	TP	0.096	0.006	0.046
Tahirova	UD		-0.045	0.714 **
	DS			-0.114
	TP	0.291	-0.007	-0.020
Kıvırcık	UD		-0.013	0.357 *
	DS			0.099
	TP	0.153	-0.000	-0.090
Karacabey Merino	UD		-0.280	0.343 *
	DS			-0.210

** P<0.05, **P<0.01*

udder traits, three natural groups can be distinguished as indicated by Fernández et al.[5]: 1) traits related udder size (depth, width and circumference), 2) traits related to cistern morphology and teat placement (teat angle) and 3) traits that define teat size (teat length). Udder floor, udder circumference and udder depth are characters that can be looked upon as best describing the type and volume of the udder. Furthermore, Yardımcı and Özbeyaz [17] reported that udder characteristics except the height of udder from the floor and length of teat were decreased from the peak yield to the end of lactation in Akkaraman and Sakız x Akkaraman F_1 crossbreds.

The correlations between the three traits that determine udder size (depth, width and circumference) were high and positive except for rear udder depth between udder weight correlations in three ewe breeds. In other breeds, three traits were also highly correlated because of their relationship to milk yield [5,18-20].

Highest correlations were observed between udder length and udder circumference (0.725), udder circumference and udder weight (0.614) in Tahirova breeds; udder circumference and udder length (0.579), udder circumference and teat angle (0.530), udder circumference and udder volume (0.607), udder length and udder volume (0.535) in Kıvırcık breeds; udder circumference and rear udder depth (0.608), udder length and rear udder depth (0.610), udder length and udder circumference (0.520), rear udder dept and udder volume (0.554), udder circumference and udder volume (0.729) in Karacabey Merino breeds. When morphological traits are related to milk yield the greatest effects are observed for udder width and height and commonly tendencies are only observed for the remaining traits [16,21,22]. Teat length was found to be lower and negatively correlated with the other measurements except for Tahirova dairy crossbred ewes.

Means ranged from 3.42 for degree of separation to 8.22 for degree of suspension of the udder. Analogous data for dairy ewes [14,23]. These patterns correspond to a worsening of milkability and to a relaxation of the suspensory system of the udder. This finding agrees with previous results [7,11,14,24]. Significant differences were found between breeds and crossbred sheep breeds concerning teat placement and degree of suspensions of the udder ($P<0.05$).

A negative and insignificant correlation among linear udder traits was found except for udder depth and degree of suspension of the udder. Legarre and Ugerte [25] found a genetic correlation between teat placement and udder depth (-0.42) in Manchega ewes, Casu et al.[26] found a genetic correlation (-0.42) in Sarda dairy sheep. On the other hand, Mc Kusick et al.[16] did not find a significant phenotypic correlation between udder height score and teat placement score in East Friesian crossbred dairy ewes.

This study confirms that the udder measurements and scores of Tahirova, Kıvırcık and Karacabey Merino sheep. These traits may be suitable selection markers to improve these breeds milking ability. Udder circumference had strong, positive estimates of phenotypic correlation with udder width, udder length, and teat angle and udder volume in ewes. In the near future, udder scoring will be extended to the entire registered population to conduct a more accurate and efficient genetic evaluation.

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