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Relationships Among Udder Traits and Milk Production in Unimproved Awassi Sheep

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Abstract: Udder characteristics and their relation to milk production were studied in a flock of unimproved Awassi sheep (n = 583) raised in Gözlü State Farm. All udder traits were recorded following the onset of residual suckling regime (34 ± 5 days) concurrently with the first milk recording (41 ± 5 days). Age effects were not significant for all traits. Udder type affected only front udder depth (P< 0.05). Effects of ewes lambing date were not significant for all traits except for the left teat length.Milk production traits were not affected by udder types. Positive and significant phenotypic correlations were observed among commercial milk yield and udder traits (P< 0.01 and P< 0.05). The phenotypic correlation coefficients among udder traits were varied from – 0.08 to 0.95. Four udder types were determined. Cylindirical udder with high and horizontal-set teats was the most common udder type (74.18 %). Udder type had a significant effect on mastitis frequencies (P< 0.01). Udder with oblique and high-set teats was found to be inclined to mastitis.

Key words:ewes,Awassi,udder traits,udder types,milk production

Introduction

Morphological udder traits are very important for dairy animals These traits are of interest to the breeder because of their influence on applicability to mechanical milking, udder health and milk yield (Fernandez *et al.*, 1997). In unimproved Awassi ewes the udder and teats are extremly variable in shape with numerous defects. Low and pendulous udder are of considerable economic importance to the dairyman, since they are more diffucult to milk especially when milking machines are used (Mavrogenis *et al.*, 1988). In dairy ewes, the milk flow is markedly influenced by the shape of udder. From baggy udders with laterally projecting teats, the flow is generally less satisfactory than from those adequate shape with teats pointing downwards. The udder may have the shape of two bottles with a deep identation between the two halves. Frequently the teats are very small with either a downward, lateral or upward direction, or they project, not from the bottom of the udder, but from its outer sides, rendering milking difficult (Epstein, 1985). The location of teats affects the quantity of milk remaining in the udder. There are few studies available about the relationships between economically important udder traits and milk production. Udder characteristics are controlled by both genetic and environmental factors. Udder depth, udder attachment, teat placement, teat size and udder shape are commonly used traits for the selection programmes. Analyses generally indicate that the udder traits are highly variable and heritability estimates have been moderate to high (Gootwine *et al.* and 1980; Charon,1990; Fernandez *et al.*, 1997). Udder length and circumference were positively associated with milk production in sheep (Horak, 1965; Papachristoforou and Mavrogenis 1981; Mavrogenis *et al.* 1988 and Fernandez *et al.* 1997).

There is broad agreement on the optimal udder morphology for a machine milked ewe (Mikus, 1978). Different evaluation systems for udder traits of dairy ewes have been used (Labussiere, 1981; Arranz *et al.* 1989; Kukovics *et al.* 1993; de la Fuenta *et al.* 1996).

The total number of sheep population is 28.492 million in Turkey (Anonymous, 2003). This population is mainly consist of native breeds. Most of these breeds including Awassi which is approximately 4 % of Turkey sheep population are unimproved and their productivity level is low. Few farms practise machine milking for small ruminants in Turkey.

The transition from hand to machine milking requires that the relationships among morphological udder characteristics and milk production, and parameters for adaptability to machine milking to be investigated (Mavrogenis *et al*, 1988). The purposes of this study were to define some morphological traits of the udder of unimproved Awassi sheep and to determine their phenotypic relationships with milk production. Besides, determination of udder types and their mastitis percentages were aimed.

Materials and Methods

Data were obtained from 583 unimproved Awassi ewes (a flock) raised in Gözlü State Farm. First lambing age was approximately 24 months. Ewes were divided into three different groups in respect of lambing dates (1-14 February =Early, 15-28 February =Middle, 1-14 March =Late). All lambs sucked their dams freely until 34 ± 5 days of age. They were on a residual suckling regime until 75 ± 5 days of age, when they were weaned completely from milk. During the residual suckling period, lambs joined their dams after morning and afternoon milkings for residue sucklings by a period of 30 minutes each. All ewes were hand milked twice daily and the first milk test was performed 7 days after the onset of residual suckling regime. Milk tests were repeated fortnightly until the all ewes were dried off. Commercial milk yield (milking period yield) was calculated from fortnightly test day records. All

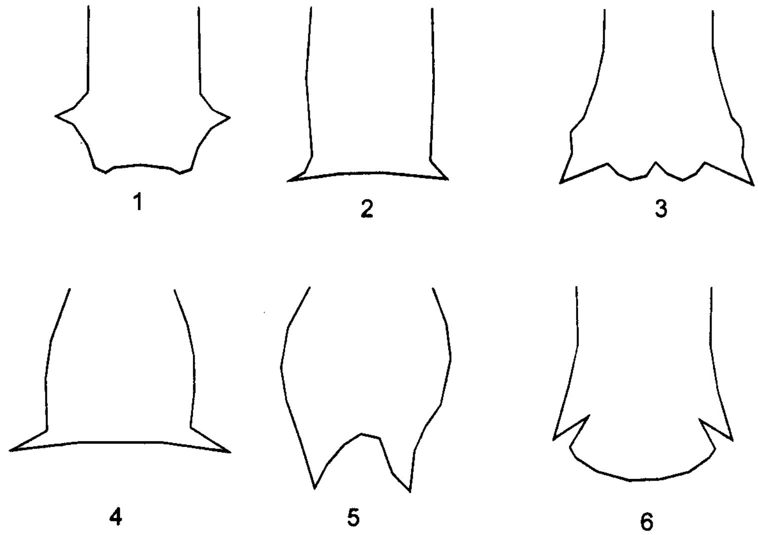

Fig. 1: Sketch of different Awassi udders and teats

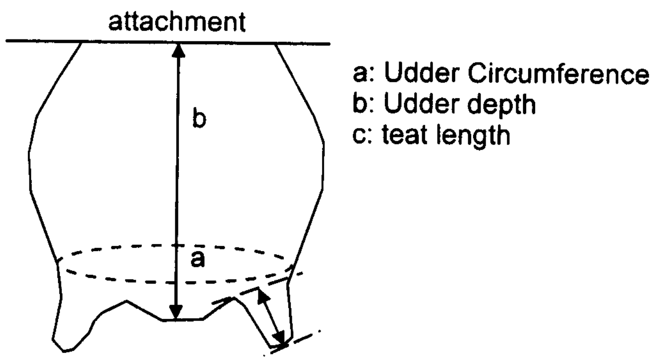

Fig. 2: Udder measurements

udder traits were recorded once concurrently with first milk recording, a stage in lactation used by other investigators (Gootwine *et al.*, 1980 and Mavrogenis *et al.* 1988). Udder types were determined according to Fig. 1 as in Epstein (1985). Ewes were classified according to their udder types. Each types were counted and their percentages were determined. Type 2 and 5 were not seen in the flock. Teat numbers were determined in each udder types. Two types of teat number (2 and 4) were defined. Udder measurements were udder circumference, udder depth (front and rear) and teat length (left and right). The measurements were recorded after milking. The method of measurement is shown in Fig. 2. Udder measurements were determined on a total of 367 ewes. There were 216, 41, 33, and 77 animals in udder types 1, 3, 4, and 6, respectively.

Udder circumference was measured above teat placement. Front and rear udder depths are defined by the distances between udder attachment and the udder floor. Teat lenghts are measured from tip to base.

Date of lambing, age at lambing, lambing type and number of teats were recorded. All animals were identified at birth by eartags. Lactations initiated with abortion, affected by mastitis or terminated abnormally (illness other than mastitis or death) were excluded from analyses.

Data were analysed by least squares techniques using the general linear models procedure of Harvey (1987). The statistical analyses was based on the following model:

$Y_{ijklm} = \mu + a_i + u_j + d_k + t_l + b_m + e_{ijklm}$

Y_{ijklm} = observation for each trait

μ = mean

a_i = Effect of ewes age

u_j = Effect of udder type

d_k = Effect of ewes lambing date

t_l = Effect of teat number

b_m = Effect of ewes lambing type

e_{ijklm} = Random residual effect

Affected ewes by mastitis were classified according to udder types. Thus mastitis ratios were determined in each udder types. Mastitis frequencies in each udder types was statistically tested by using khi-square test.

Results

Least square means for udder measurements in relation to age, udder type, ewes lambing date, number of teat and lambing type are shown in Table 1. Age effects were not significant for all traits. Udder type affected only front udder depth ($P < 0.05$). Effects of ewes lambing date were not significent for all traits except for the left teat length. Number of teats and ewes lambing type did not affect all measurements ($P > 0.05$).

Least square means of milk production traits according to some environmental factors are presented in Table 2. Effect of age and udder types on milk production traits were not significant. Ewes lambing date affected only lactation length ($P < 0.05$). Milk production traits were not affected by number of teats and ewes lambing type. Phenotypic correlations among udder measurements and milk production traits are shown in Table 3. Positive correlations were observed between commercial milk yield and udder circumference ($P < 0.01$), between commercial milk yield and udder depth ($P < 0.01$) and between commercial milk yield and teat lengths ($P < 0.05$). Similarly, Positive correlations were also observed among daily milk yields (avarage and maximum) and udder measurements ($P < 0.01$ and $P < 0.05$). The correlations among udder measurements are varied from – 0.08 to 0.95. There were some negative correlations as well. But they were not statistically significant. Most of the correlations among milk production traits are positive and significant. Frequency distributions of udder types and their mastitis percentages are presented in Table 4. CUTHH type was the most common udder type (74.18 %). PUTLO, PUTLH and UWTHO types were 7.04 %, 5.63 % and 13.15 % respectively. Observed and expected frequencies for mastitis were tested by khi square analyses (Table 4).Differences between observed and expected mastitis frequencies in relation to udder types were significant ($P < 0.01$). It is seen from Table 4 that UWTHO type inclined to mastitis. Also distribution of teat numbers to the udder types were significant ($P < 0.01$). However mastitis frequencies in relation to teat numbers were not significant (Table 5).

Discussion

Age did not affect udder measurements and milk production traits. It may be attributed to the first lambing age (24 month). Body tissues nearly completes their growth soon after these ages. However, Papachristoforou and Mavrogenis (1981), Mavrogenis *et al.* (1988) and de la Fuente *et al.* (1996) found

Table 1: Least square means and standart errors of udder measurements according to some environmental factors in unimproved Awassi ewes.

Factors	No. of Obs.	Udder circumference (cm)	Udder depth		Teath length	
			Front (cm)	Rear (cm)	Left (cm)	Right (cm)
Age						
2.5	44	32.88 ± 1.01	8.58 ± 0.49	15.02 ± 0.53	3.77 ± 0.04	3.85 ± 0.06
3.5	53	34.35 ± 1.16	7.88 ± 0.58	15.02 ± 0.63	3.79 ± 0.05	3.82 ± 0.07
4.5	90	33.25 ± 0.77	8.07 ± 0.38	15.73 ± 0.42	3.78. ± 0.06	3.83 ± 0.05
5.5	95	32.77 ± 0.84	8.29 ± 0.41	16.26 ± 0.45	3.76 ± 0.04	3.86 ± 0.05
6.5	52	32.68 ± 1.28	8.55 ± 0.62	15.97 ± 0.68	3.76 ± 0.07	3.85 ± 0.08
7.5	24	31.78 ± 1.54	9.28 ± 0.74	15.06 ± 0.82	3.64 ± 0.08	3.98 ± 0.09
8.5	9	34.73 ± 1.81	7.31 ± 0.89	16.07 ± 0.98	3.80 ± 0.10	3.79 ± 0.11
Udder type						
CUTHH	216	32.11 ± 0.53	7.60 ± 0.26 [a]	15.83 ± 0.28	3.80 ± 0.03	3.78 ± 0.03
PUTLO	41	32.65 ± 1.28	8.96 ± 0.62 [b]	14.56 ± 0.67	3.73 ± 0.08	3.94 ± 0.08
PUTLH	33	35.88 ± 1.37	7.65 ± 0.69 [a]	15.23 ± 0.75	3.79 ± 0.08	3.87 ± 0.09
UWTHO	77	32.18 ± 1.34	8.93 ± 0.65 [b]	16.74 ± 0.71	3.70 ± 0.07	3.84 ± 0.08
Ewes lambing date						
Early	162	33.07 ± 0.81	8.37 ± 0.40	15.30 ± 0.44	3.69 ± 0.04 a	3.92 ± 0.05
Middle	144	32.66 ± 0.77	8.24 ± 0.38	15.82 ± 0.42	3.78 ± 0.04 b	3.83 ± 0.05
Late	61	33.88 ± 0.93	8.23 ± 0.46	15.65 ± 0.51	3.79 ± 0.05 b	3.82 ± 0.06
Number of teats						
2	231	33.32 ± 0.70	8.27 ± 0.35	15.56 ± 0.38	3.76 ± 0.04	3.86 ± 0.04
4	136	33.08 ± 0.77	8.29 ± 0.38	15.62 ± 0.41	3.76 ± 0.04	3.85 ± 0.05
Lambing type						
Single	283	32.87 ± 0.63	8.30 ± 0.31	15.71 ± 0.34	3.76 ± 0.03	3.86 ± 0.04
Twin	84	33.54 ± 0.86	8.26 ± 0.43	15.47 ± 0.47	3.76 ± 0.05	3.85 ± 0.05
Overall	367	33.20 ± 0.64	8.28 ± 0.32	15.59 ± 0.35	3.76 ± 0.04	3.85 ± 0.04

[a,b] : P< 0.05

Table 2: Least square means and standart errors of milk production traits according to some environmental factors in unimproved Awassi ewes

Factors	No. of obs.	Commercial milk yield (l)	Lactation length (day)	Milking period (day)	Average daily milk (ml)	Maximum daily milk yield (ml)
Age						
2.5	44	107.99 ± 0.38	179.51 ± 1.73	149.50 ± 0.52	714.62 ± 2.51	1184.54 ± 56.48
3.5	53	108.06 ± 0.44	181.29 ± 2.04	149.20 ± 0.60	714.03 ± 2.91	1268.53 ± 64.91
4.5	90	107.28 ± 0.29	182.27 ± 1.35	150.03 ± 0.40	719.25 ± 1.93	1193.98 ± 43.10
5.5	95	107.49 ± 0.31	184.70 ± 1.41	149.19 ± 0.42	718.05 ± 2.03	1229.31 ± 44.98
6.5	52	107.74 ± 0.48	184.56 ± 2.22	149.41 ± 0.66	716.54 ± 3.18	1219.32 ± 70.81
7.5	24	107.76 ± 0.56	184.81 ± 2.61	149.15 ± 0.77	716.68 ± 3.75	1101.57 ± 83.25
8.5	9	108.09 ± 0.68	187.39 ± 3.15	148.25 ± 0.93	714.06 ± 4.52	1143.84 ± 101.15
Udder type						
CUTHH	216	107.62 ± 0.19	184.18 ± 0.91	149.14 ± 0.27	717.25 ± 1.30	1174.73 ± 29.05
PUTLO	41	107.63 ± 0.46	185.03 ± 2.12	149.40 ± 0.63	717.09 ± 3.04	1174.97 ± 67.72
PUTLH	33	107.95 ± 0.51	185.74 ± 2.37	148.79 ± 0.70	715.27 ± 3.40	1231.14 ± 75.91
UWTHO	77	107.88 ± 0.48	179.06 ± 2.20	149.66 ± 0.66	715.09 ± 3.18	1185.49 ± 71.30
Ewes lambing date						
Early	162	107.84 ± 0.31	179.03 ± 1.38 [a]	149.52 ± 0.42	715.68 ± 2.04	1182.29 ± 45.88
Middle	144	107.60 ± 0.30	188.23 ± 1.34 [b]	149.05 ± 0.41	717.49 ± 2.01	1174.28 ± 44.89
Late	61	107.88 ± 0.35	183.26 ± 1.62 [c]	149.18 ± 0.48	715.36 ± 2.30	1218.18 ± 51.49
Number of teats						
2	231	107.58 ± 0.26	183.82 ± 1.20	149.50 ± 0.36	717.39 ± 1.72	1193.62 ± 38.37
4	136	107.96 ± 0.28	183.19 ± 1.34	148.99 ± 0.39	714.96 ± 1.88	1189.55 ± 42.62
Lambing type						
Single	283	107.71 ± 0.23	183.79 ± 1.07	149.28 ± 0.32	716.57 ± 1.53	1178.01 ± 34.26
Twin	84	107.83 ± 0.32	183.22 ± 1.50	149.22 ± 0.44	715.78 ± 2.14	1205.16 ± 47.94
Overall	367	107.77 ± 0.24	183.50 ± 1.11	149.25 ± 0.33	716.18 ± 1.57	1191.58 ± 35.33

[a, b, c]: P< 0.05

Table 3: Phenotypic correlations among udder measurements and milk production traits in unimproved Awassi ewes

Item	UC	FUD	RUD	LTL	RTL	CMY	LL	MP	ADMY
FUD	0.30**								
RUD	0.54***	0.62***							
LTL	0.15	-0.08	0.03						
RTL	0.12	-0.09	-0.09	0.95***					
CMY	0.40**	0.24**	0.30**	0.17*	0.17*				
LL	0.13	0.09	0.13	0.08	0.08	0.05			
MP	0.25**	0.16	0.09	0.02	0.03	0.22*	0.41**		
ADMY	0.38**	0.23**	0.30**	0.17*	0.17*	0.99***	0.00	0.13	
MDMY	0.25**	0.30**	0.30**	0.17*	0.16	0.73**	0.08	0.15	0.72**

UC= Udder Circumference, FUD = Front Udder Depth, RUD = Rear Udder Depth, LTL = Left Teath Length, RTL = Right Teat Length, CMY = Commercial Milk Yield, LL = Lactation Length, MP = Milking Period, ADMY = Average Daily Milk Yield, MDMY = Maximum Daily Milk Yield.
*: P< 0.05; **: P< 0.01; ***: P< 0.001

Table 4: Frequency distributions of udder types and their mastitits percentages (%)

Item[a]	Udder Typoes Frequencies				
	CUTHH	PUTLO	PUTLH	UWTHO	Total
n	432	41	33	77	583
%	74.18	7.04	5.63	13.15	100
NEIM	9	1	2	16	28
Mastitis Percentages (%)	2.08	2.44	6.06	20.78	4.80
NEEIM	20.75	1.97	1.58	3.70	28
$(f - f')^2/f'$	6.65	0.48	0.11	40.89	X^2 =48.13**[a]

NEIM: Number of ewes infected by mastitis (f), NEEIM: Number of expected ewes infected by mastitis (f')
** : P< 0.01

Table 5: Frequency distributions of teat numbers to the udder types and their mastitis percentages (%)

Item[a]	Udder types frequencies in relation to teat numbers								
	CUTHH		PUTLO		PUTLH		UWTHO		Total
	2	4	2	4	2	4	2	4	
Observed (f)	281	151	14	27 26	7	51	26	583	
Expected (f′)	271.91	160.09	25.81	15.19	20.77	12.23	48.47	28.53	583
$(f - f')^2/f'$	0.304	0.516	5.404	9.182	1.317	2.236	0.132	0.224	$X^2 = 19.315^{**}$
NEIM	7	2 0	1	2 0	6	10	28		
NEEIM	5.85	3.15	0.34	0.66	1.58	0.42	10.60	5.40	28
$(f - f')^2/f'$	0.226	0.420	0.340	0.175	0.112	0.420	1.996	3.920	$X^2 = 7.609$

[a]NEIM: Number of ewes infected by mastitis (f), NEEIM: Number of expected ewes infected by mastitis (f′)

** : $P < 0.01$

that udder circumference and udder depth increased with lactation number in Chios sheep. Also some researchers emphasized that the increase being more pronounced from first to second than between second and subsequent lactation. Besides first lambing age of their material was 14 - 17 months. Age effect on milk production have been reported as significant (Carter *et al.* 1971, Mavrogenis and Louca, 1980 and Mavrogenis *et al.* 1988). Gootwine *et al.* (1980) reported significant differences between hoggets and ewes, while the differences among older ewes (2 to 5 years old) were much smaller.

Udder type did not affect udder measurements except for front udder depth. Nevertheless, Fernandez *et al.* (1997) and de la Fuente *et al.* (1996) reported that udder shape affected udder traits. Ewes lambing date affected only left teat length ($P < 0.05$). All udder measurements were not affected by number of teat and ewes lambing type. Papachristoforou and Mavrogenis (1981) reported that udder length and udder circumference decreased from 3rd to 92 days of lactation. Similar findings reported by de la Fuente *et al.* (1996). Udder type did not have a significant effect on milk production. There were also considerable differences between udder types in milk production (Kukovics *et al.* (1993).

Determination of the correlations among udder traits is important for defining morphological aptitute to milking. Udder circumference was positively correlated with udder depth and milk production. Similar findings were reported by Papachristoforou and Mavrogenis (1981), Mavrogenis *et al.* (1988). In agreement with this study Fernandez *et al.* (1997) reported positive phenotypic correlation between udder depth and milk production in Churra ewes.

Occurence percentages of the udder types in this study were different from the percentages in improved Awassi sheep reported by Epstein (1985). This difference was probably because of selection for milk yield and udder morphologies in improved Awassi sheep. On the other hand Fernandez *et al.* (1997) reported that selection for increased milk yield might worsen udder morphology for machine milkability, as a result of increased udder depth and reduced teat vertically.

Udder hygien is markedly influenced by udder morphology. Teat placement and their direction affects milk flow and the quantity of milk remaining in the udder after milking. Especially UWTHO type inclined to mastitis. Fernandez *et al.* (1997) reported that, deeper udders may be susceptible to more frequent trauma. They also reported that larger teats are also closer to the ground and probably have larger orifices which positively correlated with log SCC. Mastitis occurence percentages in relation to teat number were not significant. However, selection against for additional teats needs to be carried out, since they are an obstacle to milking and may contribute to the uncleanliness of the milk.

Conclusion

The results from this study indicate that milk production was not influenced by udder types. A selection program may be carried out against faulty udders such as CUTHH, PUTLH and UWTHO udder types without decreasing milk production.

There were positive phenotypic correlations between commercial milk production and some udder measurements. If udder measurements are going to be used as an aid to selection it would then seem more appropriate to select animals for udder circumference which positively correlated with milk production. For definite expression genetic correlations between udder traits and milk production must be studied on pedigree registered flocks. Mastitis percentages were different in udder types. Distribution of supernumerary teats to the udder types were different. However there were no difference between teat number groups in respect of mastitis percentages. In addition, an index can be used for evaluation of the udder morphology instead of individual udder traits. Also, canonic correlations between udder traits and milk production traits can be calculated.

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