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EFFECTS OF WEANING SYSTEM ON MILK AND EXTERNAL MAMMARY CONFORMATION TRAITS OF SICILO-SARDE TUNISIAN DAIRY EWE

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ABSTRACT

A better development of the Sicilo-Sarde dairy sheep in Tunisia needs a review of its behavior by adopting early weaning and generalizing mechanical milking that involves an adaptation of the external mammary morphology (MM). Thirty ewes were divided into two groups (early and late weaning; EW and LW respectively) to study the effects of weaning system (WS) and milking time (MT) on milk and external MM traits in early milking period. MM was evaluated by six measurements and three scores of udder and teat. EW group had higher milk production (MP) and lower fat and protein amounts that increased with MT advancement ($P<0.001$). WS did not affect MM traits ($P>0.05$), only teat length was higher for LW ewes ($P<0.05$). Udder depth, teat diameter, distance between teats and teat angle score decreased with MT ($P<0.01$). Significant interactions were noted between WS and MT for most traits studied. MP was negatively correlated with fat and protein amounts (-0.38 and -0.50 respectively) and moderately correlated with udder depth, cistern height, teat diameter (from 0.31 to 0.42). Fat and protein had negative correlation with udder depth, teat diameter and distance between teats. Higher correlation was determined between udder depth and distance between teats ($r=0.60$; $P<0.001$). In conclusion, EW system allows a better start of the milk production in early milking period. Cistern height, teat length and teat angle score are the prominent traits which affect milk ability and adaptation of ewe to machine milking and consequently they must be included in selection program.

Keywords: Dairy sheep, milk composition, mammary conformation, Correlation, milkability.

INTRODUCTION

The level of milk production (MP) in early lactation and especially during the first two months is crucial for both total milk production ewes and lamb growth. Thus, MP increases rapidly until the peak of lactation reached at 3-4 weeks after lambing (Cappio-Borlino et *al*., 1997). In addition, about 25% of total MP is obtained during the first month of lactation (McKusick et *al*., 2001). In Tunisia, in Sicilo-Sarde farms, the only dairy sheep in northern Africa, ewes are milked after a long suckling period that exceeds two and a half months and sometimes 100 days (Meraï et *al*., 2014; Aloulou et *al*. 2018) and can probably explains, among others, the low level of MP of this breed. Thus, this farming mode is not economic for dairy ewes. Efforts should be conducted to increasing both the commercial milk yield and growth performance of lambs. More appropriate behavior by an earlier start of the milking period is required.

In other hand, mechanical milking of Sicilo-Sarde ewes is a recent technological advance that is developing in dairy sheep farms. Furthermore, the mechanical milking ability of the ewe is under control of several effects including mammary conformation (Rovai et *al*., 1999; Marnet and Negrão, 2000; Milerski et *al*., 2006; Gelasakis et *al*., 2012). In fact, under perfect conditions of milking, characteristics of mammary morphology are very important for the milkability of dairy ewes and also for their udder health, the quantity and the quality of milk (Dzidic et *al*., 2004). The udder of Sicilo-Sarde ewe is quite well developed, with a strong attachment with straight teats (Khaldi and Farid, 1981). The external mammary morphology of the Sicilo-Sarde in Tunisia has been studied only once in the region of Bizerte (Ayadi et *al*., 2011). Thus, the present work aims to evaluate the effects of weaning system (early *vs.* late) and milking time on milk and external mammary morphology traits in early milking period.

MATERIALS AND METHODS

Thirty multiparous Sicilo-Sarde ewes were used at the farm of the Cooperative Unit of Agricultural Production of Methline (Bizerte, Tunisia) to study the effects of weaning system (WS) and milking time (MT) on milk and external mammary morphology traits in early milking period. Ewes were divided into two groups according to WS (early and late weaning; EW and LW respectively). During the experimental trial, ewes were reared indoor and received daily 1.8 and 0.7 kg/head of oat hay and commercial concentrate respectively.

Ewes were weaned from their lambs at 30-35 and 60-70 days *postpartum* respectively for EW and LW groups. Ewes were machine milked twice daily at 09:00 and 21:00 h. The amount and chemical composition of milk were recorded weekly for the two first measuring thereafter the dairy control was done every two weeks during the 45 days of starting exclusive milking. Chemical composition of milk was determined from samples of the morning milking using a MilkoScan FT 4000 (Foss Electric, integrated Milk Testing).

External mammary morphology (MM) was evaluated by six measurements and three linear scores of udder and teat according to Milerski et *al*. (2006) and the

modified method described by Marie-Etancelin et *al*. (2005), respectively. Udder and teat morphology included: udder depth (UD), udder height (UH), cistern height (CH), teat length (TL), teat diameter at the base (TD) and distance between teats (DBT). Subjective linear scores evaluation of udder cleft (UCS), udder-hock distance (UHDS) and teat angle (TAS) were carried out using a scale from 1 to 9 : UCS (1= udder cleft absent, 9= glands were clearly divided), UHDS (1=udder-floor well below hocks; 9= udder-floor above hocks) and TAS with regard to the vertical position (1= horizontal; 9= vertical). The measurements of udder and teat morphology traits were measured one to three hours after the morning milking.

The data of milk traits and mammary morphology were analyzed using the GLM procedure (SAS, version 9.1), with weaning system (WS) and milking time (MT) as variation factors. Differences between Least Square Means were considered significant when $P \leq 0.05$.

RESULTS AND DISCUSSION

Weaning system (WS) had significant effects on all milk traits ($P \leq 0.05$) in early milking period (Table 1). Ewes of EW group produced significantly higher daily milk production (DMP) by +123 ml than those of LW group. These findings agree with previous studies (McKusick et *al*., 2001; Dikmen et *al*., 2007; Mohamed et *al*., 2008) that have found an increase in the production of milk marketed for early weaning system. It could be associated with the fact that dairy ewes produced about 38 and 30% of total milk in the first and second months of lactation (McDonald et *al*. 1995). McKusick et *al*. (2001) also reported that about 25% of total milk production is obtained in the first four weeks of lactation.

As for milk chemical composition, milk of LW group contain higher amount of milk fat (+13.3 g/kg), protein (+3.4 g/kg) and total solids (+15.6 g/kg). Also, its parts had increased with the advancement of milking period by +9.7, 6.5 and 11.4 g/kg respectively for milk fat, protein and total solids as reported by Bencini and Pulina (1997) and Komprej et *al*. (2012). Thus, these authors found that production and composition of milk vary with lactation stage and mainly milk fat content and milk production change inversely.

Significant interactions also were noted between WS and MT for production and composition of milk. For EW ewes, the DMP had decreased by 41% during the first month of milking. However, MT did not affect ($P>0.05$) the DMP for LW ewes which were more persistent in their milk production in early lactation period. Also, Marnet and Negrão (2000) reported that the transition from suckling to exclusive milking is usually accompanied by a drop in milk production of about 30-40%. The rate of milk drop was higher in early lactation than after (Bencini and Pulina, 1997; Marnet and Negrão, 2000) may be related to the important maternal effect during this period. For this reason, the DMP of EW ewes had declined more rapidly. In this context, previous work recommended in the pre-weaning period to combined suckling and milking whose purpose is to reduce the negative effects of weaning shock for both ewe and lamb (McKusick et *al*., 2001; Dikmen et *al*., 2007).

Table 1. Least squares mean for the effects of weaning mode and milking time on milk yield and chemical composition (g/kg) in early milking period of Sicilo-Sarde ewes

	Mean	**Weaning system**		**Milking time**		**Weaning system * milking time**			
		EW	**LW**	**T1**	**T2**	**EW-1**	**EW-2**	**LW-1**	**LW-2**
DMP(ml)	589	658[a]	525[b]	706[a]	477[b]	829[a]	486[b]	583[b]	468[b]
Fat	69.2	62.3[b]	75.6[a]	64.1[b]	73.8[a]	47.97[c]	76.71[ab]	80.25[a]	70.88[b]
Protein	52.0	50.2[b]	53.6[a]	48.7[b]	55.2[a]	44.55[b]	55.87[a]	52.76[a]	54.47[a]
Total Solids	172.3	164.2[b]	179.8[a]	166.3[b]	177.7[a]	147.59[c]	180.74[ab]	185.06[a]	174.58[b]

[a,b,c,] means, in the same line and for the same effect, with different superscript are significantly different (P< 0.05); DMP: Daily Milk Production; EW, Early Weaning; LW, Late Weaning; ml, millilitre;

Results of external mammary morphology (MM) are shown in Table 2. No significant differences between the two WS were observed for all udder and teat traits except teat length (TL). LW ewes had longer teat than these of EW groups (28.4 *vs.* 25.0 mm). Also, Rovai et *al*. (1999) found an increase in the TL when lactation progress. However, udder depth (UD), teat diameter at the base (TD) and distance between teats (DBT) had decreased and udder-hock distance score (UHDS) increased with the advancement of MT. These results agree with those of Rovai et *al*. (1999). The other measurements of MM were not affected (P > 0.05) by the MT. Significant interactions were noted between WS and MT for most MM traits. The values of UD, TD, and DBT were higher and udder-hock distance score (UHDS) was lower for EW ewes at the beginning of milking as DMP was higher. However, TL was higher for LW group at the beginning of MT. For both groups, the means of teat angle score (TAS) indicated that teats became positioned more horizontally with the advancement of lactation as reported by de la Fuente et *al*. (1996).

Overall, the mean obtained for UH (202.6 mm) was in the range given by Gelasakis et *al*. (2012) for Chios ewes. The average of CH (37.9 mm) was lower than 46-54 mm reported by Gelasakis et *al*., (2012). The average of TL (26.7 mm) for the Sicilo-Sarde ewe were shorter than 33.6-36.5 and 43-47 mm reported respectively by Milerski et *al*. (2006) and Gelasakis et *al*. (2012). The difference between studies may be related to breed, parity and stage of lactation (Milerski et *al*., 2006; Gelasakis et *al*., 2012). As for the subjective linear scores, UCS, UHDS and TAS averaged 6.52, 6.00 and 3.30 respectively. These means indicated that ewes had glands visibly divided, their udder-floor was slightly above the hock and the teat had an angle of about 64° to the vertical.

Table 2. Least squares mean for the effects of weaning system and milking time on mammary morphology characteristics in early milking period of Sicilo-Sarde ewes

		Weaning system		Milking time		Weaning system * Milking stage			
	Mean	EW	LW	T1	T2	EW-T1	EW-T2	LW-T1	LW-T2
Udder and teat measurements (mm)									
UD	80.0	81.9	78.2	88.3^{a}	71.8^{b}	93.5^{a}	70.36^{c}	83.00^{b}	73.33^{c}
UH	202.6	203.4	202.0	202.6	202.7	202.14	204.64	203.17	200.83
CH	37.9	39.3	36.6	38.0	37.9	40.32	38.23	35.62	37.52
TL	26.7	25.0^{b}	28.4^{a}	27.1	26.2	23.75^{b}	26.20^{b}	30.47^{a}	26.28^{b}
TD	15.2	15.8	14.7	17.0^{a}	13.5^{b}	18.42^{a}	13.18^{c}	15.59^{b}	13.88^{bc}
DBT	106.9	108.2	105.7	112.2^{a}	101.7^{b}	114.64^{a}	101.79^{b}	109.67^{ab}	101.67^{b}
Subjective linear scores									
UCS	6.52	6.54	6.50	6.20	6.83	6.14	6.93	6.27	6.73
UHDS	6.00	5.75	6.23	5.60^{b}	6.38^{a}	5.00^{b}	6.50^{a}	6.20^{a}	6.27^{a}
TAS	3.30	3.14	3.45	3.89^{a}	2.70^{b}	3.75^{a}	2.54^{b}	4.03^{a}	2.87^{ab}

^{a,b,c,} means, in the same line and for the same effect, with different superscript are significantly different (P< 0.05); EW, Early Weaning; LW, Late Weaning; T, Time; mm, millimetre, MT, milking Time ; UD, Udder Depth ; UH, Udder Height; CH, Cistern Height; TL, Teat Length; TD, Teat Diameter; DBT, Distance Between Teats; UCS, Udder Cleft Score; UHDS, Udder-Hock Distance Score; TAS, Teat Angle Score

Relationships between traits of milk and MM measurements were studied by determine the Pearson correlation coefficients (Tableau 3). Fat and protein amounts were negatively correlated with DMP (r= -0.38 and -0.50, respectively) as reported by Bencini and Pulina (1997). DMP was moderately correlated with UD, CH, TD (r=0.31-0.42). Also, suggesting the use of these traits in selection program to improve the productivity of this ewe. Fat and protein amounts were correlated negatively with UD, TD and DBT and had positive correlation with UHDS. MM traits were little correlated between them. The highest correlation coefficient was determined between UD and DBT (r=0.60; P<0.001). CH, TL and TAS are the prominent traits which affect milkability and adaptation of ewe to machine milking and consequently they must be included in selection program.

Table 3. Pearson correlation coefficients between milk yield traits and mammary morphology characteristics in early milking period of Sicilo-Sarde ewes

	DMP	Fat	Protein	UD	UH	CH	TL	TD	DBT	UCS	UHDS
Fat	-0.38 **	-									
Protein	-0.50 ***	0.54 ***	-								
UD	0.31 *	-0.41 **	-0.31 *	-							
UH	0.25 NS	-0.03 NS	0.04 NS	0.32 *	-						
CH	0.42 **	-0.09 NS	-0.14 NS	0.08 NS	0.45 ***	-					
TL	-0.01 NS	0.23 NS	0.04 NS	-0.18 NS	-0.02 NS	-0.08 NS	-				
TD	0.38 **	-0.49 ***	-0.47 ***	0.33 *	-0.01 NS	0.03 NS	0.24 NS	-			
DBT	0.31 *	-0.29 *	-0.33 *	0.60 ***	0.26 *	0.14 NS	0.02 NS	0.39 **	-		
UCS	0.06 NS	0.21 NS	0.05 NS	-0.36 *	-0.12 NS	0.09 NS	-0.03 NS	-0.10 NS	0.00 NS	-	
UHDS	-0.20 NS	0.34 **	0.29 *	-0.27 *	-0.23 NS	-0.22 NS	0.09 NS	-0.34 **	-0.57 ***	-0.07 NS	-
TAS	0.00 NS	-0.19 NS	-0.17 NS	0.23 NS	-0.18 NS	-0.53 ***	0.35 **	0.45 ***	0.26 *	-0.22 NS	-0.21 NS

UD, Udder Depth; UH, Udder Height; CH, Cistern Height; TL, Teat Length; TD, Teat Diameter; DBT, Distance Between Teats; UCS, Udder Cleft Score; UHDS, Udder-Hock Distance; TAS, Teat Angle Score; NS, Not Significant; *, P≤0.05; **, P≤0.01; ***, P≤0.001

CONCLUSION

During the early milking period, early weaning system allows a better start of the milk production. However, mammary morphology traits did not change with weaning system. Cistern height, teat length and teat angle score are the prominent traits which affect milkability and adaptation of ewe to machine milking and consequently they must be included in selection program of this breed. More detailed study with a high number of animals should be carried out to better characterize of the mammary morphology of Sicilo-Sarde ewe.

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