Udder cistern size and milkability of ewes of various genotypes

Milerski, M.[1], M. Margetin[2], D. Apolen[2], A. Capistrak[2] & J. Spanik[2]

[1]Research Institute of Animal Production, Pratelstvi 815, P.O. Box 1, CZ-10401 Prague 114 – Uhrineves, Czech Republic
E-mail: milerski.michal@vuzv.cz

[2] Research Institute of Animal Production, workplace Trencianská Teplá, Teplická 103, SK-91401 Trencianska Tepla, Slovak Republic
E-mail: margetin@ttvuzv.sk

Summary

A total of 263 Improved Valachian (IV), Tsigai (T), Lacaune (LC) and crossbred lactating ewes were used to study milk cistern anatomy in dairy sheep bred in Slovakia, to compare two methods of ultrasound udder scanning and to evaluate relations between cistern size and milkability. Milkability traits recording, external measurements, linear assessments and ultrasonic scanning of sheep udders were done. Sums of both cistern cross-section areas were computed on the basis of two methods of udder ultrasonography - from the side of udder (SCA) and from below in a water bath (BCA). Highest LSMs for cistern size (BCA=58.6 cm^2; SCA=61.0 cm^2) and the highest milk yield (MY=545 ml/milking) were detected in purebred LC ewes and also crossbreeds between IV or T and LC had higher cisterns and milk yield than purebred animals of IV (BCA=30.5 cm^2; SCA=38.4 cm^2; MY=412 ml/milking) and T (BCA=25.1 cm^2; SCA=30.1 cm^2; MY=293 ml/milking). On the other hand purebred LC had significantly higher average stripping milk percentage (40.9%) in comparison with other genotypes (22.8% to 28.2%). Between BCA and milk yield was found out slightly lower correlation (r=0.48) than between SCA and milk yield (r=0.53).

Key words: *Sheep, udder, ultrasonography, mammary gland cistern*

Introduction

Sheep milking has long and plentiful tradition in Slovakia. Nevertheless machine milking have been introduced more widely into dairy sheep husbandry here in the last decade. The introduction of machine milking evokes the requirement to pay more attention on morphological and functional characteristics of sheep udders. One of the most interesting udder morphological characteristics from the machine milkability point of view is the size of glandular cistern (*Sinus lactiferus pars glandularis*), as the "cisternal milk" is available for milking before the oxytocine ejection, the large-cisterned animals being in general more efficient producers of milk and more tolerant to long milking intervals (Wilde et al., 1996). There are large differences in the proportion of total milk stored within the cistern among ruminant dairy species. Specialized dairy cows store less than 30% of the total milk yield volume in the mammary gland cisterns (Ayadi et al., 2003). Percentages of cisternal milk in sheep vary from 25% to 75% according to the breed but they are greater than 50% in most dairy sheep breeds (Caja et al., 1999, Rovai et al., 2000). I*n vivo* scanning of the udder internal structures could de done by ultrasonography. Cisterns filled by milk are detectable very well as anechogenic structures in ultrasound scans. Different methods of sheep udder ultrasonography were proposed by Bruckmaier & Blum (1992) and Ruberte et al. (1994). The methods were used for cisternal measurements by Bruckmaier et al. (1997), Caja et al. (1999), Rovai et al. (2000), Nudda et al. (2000), Margetín et al. (2002) and others. This investigation was aimed on the study of milk cistern anatomy in dairy sheep breeds and crossbreeds in Slovakia, the comparison of two methods of ultrasound udder scanning and the evaluation of relations between cistern size and milkability traits in dairy sheep.

Material and methods

Investigations were performed in the experimental flock of Research Institute of Animal Production in Nitra, workplace Trenèianska Teplá. Totally 263 lactating ewes of Tsigai (T), Improved Valachian IV), Lacaune (LC) and crossbreeds between them were used. Six experiment batches were organized during the years 2002-2004 in different stages of lactation. Many animals were investigated repeatedly, so totally 590 individual measurements were done. Ewes were milked without udder prestimulation and milk flow was recorded in 10 s intervals. Then milk emission curves were constructed and total milk yield, machine milk yield, machine stripping milk yield and percentage of stripping yield were computed. 12 hours after milking the external measurements (6 traits), linear assessments (7 traits) and ultrasonic scanning of udders were done. Ultrasonography was carried out from the side of udder (figure 1) according to methodology of Ruberte et al. (1994) and from below in a water bath (figure 2) as described by Bruckmaier & Blum (1992). Scans were made with a digital ultrasound scanner Medison SonoVet2000 using a linear probe L2-5/170 CD. Acoustic coupling agent (Kerolan, Aveflor Kopidlno) was used to attach the probe to the skin in a case of scanning from the udder side. Images were recorded on memory card and later processed by the use of computer program Zodop32. Sums of cross-section areas of both cisterns measured from the side (SCA) and from below (BCA) were measured. The statistical analysis of variance in the dataset was performed using the GLM procedure of SAS. The model equation used for the data adjustment considered the effects of the experiment batch (fixed effect - 6 levels), breed or crossbreed combination (fixed effect - 7 levels), parity (fixed effect - 3 levels), interaction between breed and parity, days in milk (DIM) and square of DIM (both covariables). The CORR procedure SAS was used for the computing of partial correlation coefficients on residuals after the data adjustment by the above mentioned model equation.

Results and discussion

In table 1 the F-values of systematic effects obtained by analysis of variance of cistern areas are presented. Both measurements, from side (SCA) and from below (BCA), were significantly affected by all effects considered in model equation, anyway the effect of breed or crossbred combination was the strongest in both cases. Determination coefficients of used model equations of variance analysis were R^2=0.531 for BCA and R^2=0.512 for SCA. The least squares means and standard errors for the effect of breed or crossbred combination are listed in table 2. There were statistically significant differences in cistern size and milk yield between purebred Improved Valachians (IV), Tsigai (T) and Lacaune (LC). LC imported to Slovakia in order to improve milk production had the highest cistern size and the highest milk yield and also hybrids between IV or T and LC had higher cisterns and milk yield than purebred animals of native breeds. On the other hand purebred LC had significantly the highest stripping milk yield. Average percentage of stripping milk from total milk yield was 40.9% in LC while in other genotypes varied from 22.8% to 28.2%. The sums of both cistern cross-section areas were higher for measurements from side (30.08 cm^2- 60.98 cm^2) than from below (25.13 cm^2- 58.55 cm^2) in all genotypes. Higher relative differences in cistern areas between scanning from below and from side was detected in native breeds (IV–26.6%; T-19.7%) while in LC the difference was only 4.2%. Bruckmaier et al. (1997) refer about total cisternal cross sections obtained by udder ultrasonography from below 33±7cm^2 for LC . However in response to oxytocin injection alveolar milk was ejected causing enlargement of the cisternal area by 45±8%. Caja et al. (1999) detected in Ripollesa ewes 4 hours after milking average cistern area 5.6±0.5 cm^2 measured by ultrasonography from side of udder. Partial phenotypic correlations between BCA or SCA and other morphological and functional udder characteristics in purebred IV, T, LC and in all genotypes together are presented in table 3. Correlations between cistern areas and external udder size represented by udder height, udder width and udder length were moderate (r=0.38-0.61). Correlations between cistern areas and total milk yield were slightly higher in a case of measurements from side (r=0.52-0.58) than from below (r=0.45-0.53). Caja et al. (1999) found out similar correlation between SCA and milk yield r=0.46. For purebred LC was characteristic low correlation between machine milk yield and cistern size and on the contrary higher correlation between stripping yield and cistern size. These facts resulted in slightly positive correlations between cistern size and percentage of stripped milk in LC, while in IV and T these correlations were rather negative. Also correlations between cistern size and linear score for the udder shape from the point of view of machine milking were in LC much lower (r=0.16-0.26) than in IV (r=0.46-0.47) or T (r=0.42-0.43). Many LC ewes had baggy udders with big cisterns and horizontally placed teats. Big part of cistern volume was located below the orifice into the teat canal and therefore part of cisternal milk could be reached rather by stripping than by machine milking. Fernández et al. (1997) found out high positive genetic correlation between milk yield and udder depth (r_g=0.82) and negative genetic correlation between milk yield and linear assessment of udder shape (r_g=-0.26). These correlations showed that selection for milk yield could produce worse udder morphology.

Conclusions

The results show that the use of Lacaune sheep breed in Slovakia for genetic improvement of native dairy sheep breeds or for creation of synthetic line will lead to improving of milk production, but on the other hand could turn to the worse udder morphology with negative impact on some aspects of milkability. Taking this fact into account the use of udder morphology traits in breeding programs for dairy sheep would be reasonable. Ultrarsonography of udders, both from below and from side, could be used for cistern size evaluation. Correlations between cistern size and milkability traits could be utilized in breeding. Nevertheless some breed specificities have to be considered.

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Table 1. Analysis of variance of sums of cistern cross-section areas measured from side (SCA) and from below (BCA).

	BCA		SCA	
Effects	F-value	P>F	F-value	P>F
Batch of experiment	5.02	0.0019	4.98	0.0020
Breed or crossbred combination	67.25	<0.0001	53.49	<0.0001
Parity	7.08	0.0009	3.91	0.0205
Breed-parity interaction	2.15	0.0086	2.10	0.0104
Days in milk (DIM)	5.71	0.0172	19.81	<0.0001
DIM ^{2}	5.90	0.0154	15.85	<0.0001
	R^2=0.531		R^2=0.512	

Table 2. Effect of breed or crossbred combination on cistern size and milkability traits in sheep (LS-means±SE).

Breed	BCA cm ^{2}	SCA cm ^{2}	Milk yield ml/milking	Stripping yield ml/milking
Improved Valachian (IV)	30.52±1.27[b]	38.35±1.29[b]	412.3±13.8[b]	105.5±8.4[a]
Tsigai (T)	25.13±1.07[c]	30.08±1.09[c]	293.1±11.5[d]	79.3±6.8[b]
Lacaune (LC)	58.55±1.19[d]	60.98±1.21[d]	544.9±12.8[a]	222.9±7.5[d]
IV x LC	43.04±2.42[a]	46.80±2.46[a]	510.2±26.1[a]	134.3±15.3[a]
(IV x LC) x LC	38.22±1.61[a]	44.43±1.63[a]	502.8±17.3[a]	130.4±10.1[a]
T x LC	37.81±1.72[a]	41.91±1.74[ab]	424.1±18.4[bc]	119.7±10.8[a]
(T x LC) x LC	42.67±4.81[a]	45.37±4.88[ab]	468.8±51.8[ac]	107.1±30.2[ab]

[a,b,c] : values with the same letters in the same column do not differ significantly (P<0.05)

Table 3. Correlations between cistern areas and other udder traits in sheep.

Breed	Improved Valachian		Tsigai		Lacaune		All genotypes	
	BCA	SCA	BCA	SCA	BCA	SCA	BCA	SCA
Ultrasound measurements								
SCA	0.71	-	0.76	-	0.84	-	0.79	-
Linear scoring of udders								
Udder depth	0.53	0.49	0.48	0.41	0.55	0.59	0.61	0.48
Cistern height	0.31	0.14	0.38	0.23	0.25	0.09	0.27	0.11
Teat placement	0.23	0.04	0.32	0.15	0.21	0.02	0.22	0.06
Teat length	-0.08	-0.06	0.21	0.12	0.26	0.17	0.13	0.09
Udder attachment	0.24	0.35	-0.06	0.11	0.12	0.16	0.11	0.18
Udder cleft	0.23	0.36	0.26	0.31	-0.04	0.06	0.10	0.18
Udder shape	0.47	0.46	0.42	0.43	0.16	0.26	0.27	0.32
External udder measurements								
Udder length	0.57	0.44	0.53	0.46	0.60	0.55	0.55	0.50
Udder width	0.43	0.50	0.40	0.38	0.40	0.47	0.41	0.45
Udder height	0.60	0.44	0.45	0.38	0.58	0.54	0.55	0.49
Cistern height	0.33	0.17	0.45	0.31	0.29	0.20	0.32	0.19
Teat length	-0.10	-0.09	0.04	0.03	0.21	0.06	0.03	0.00
Teat angle	0.14	0.01	0.24	0.05	0.15	0.06	0.17	0.03
Milkability traits								
Milk yield for 30 s	0.48	0.48	0.55	0.50	0.04	0.21	0.23	0.29
Machine milk yield	0.47	0.50	0.49	0.50	0.09	0.21	0.28	0.37
Total milk yield	0.53	0.58	0.49	0.52	0.45	0.53	0.48	0.53
Stripping yield	0.25	0.31	0.19	0.24	0.48	0.44	0.38	0.35
% of stripp. Yield	-0.07	-0.06	-0.15	-0.11	0.23	0.11	0.06	-0.02

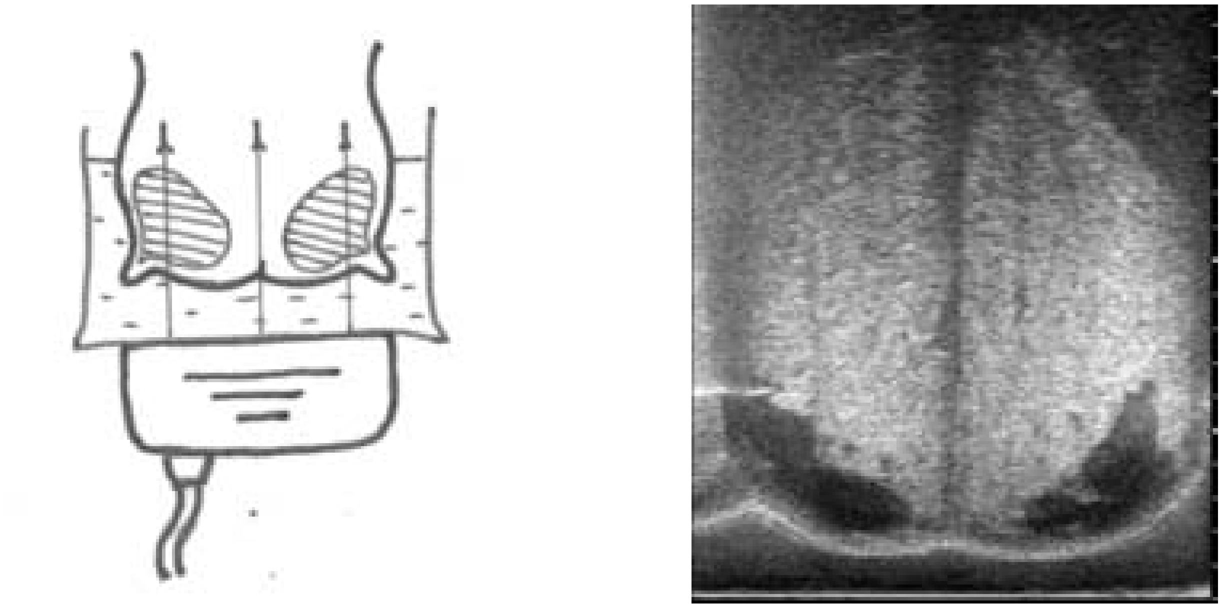

Figure 1. Ultrasonic scan of sheep udder from below (sum of cistern areas – BCA).

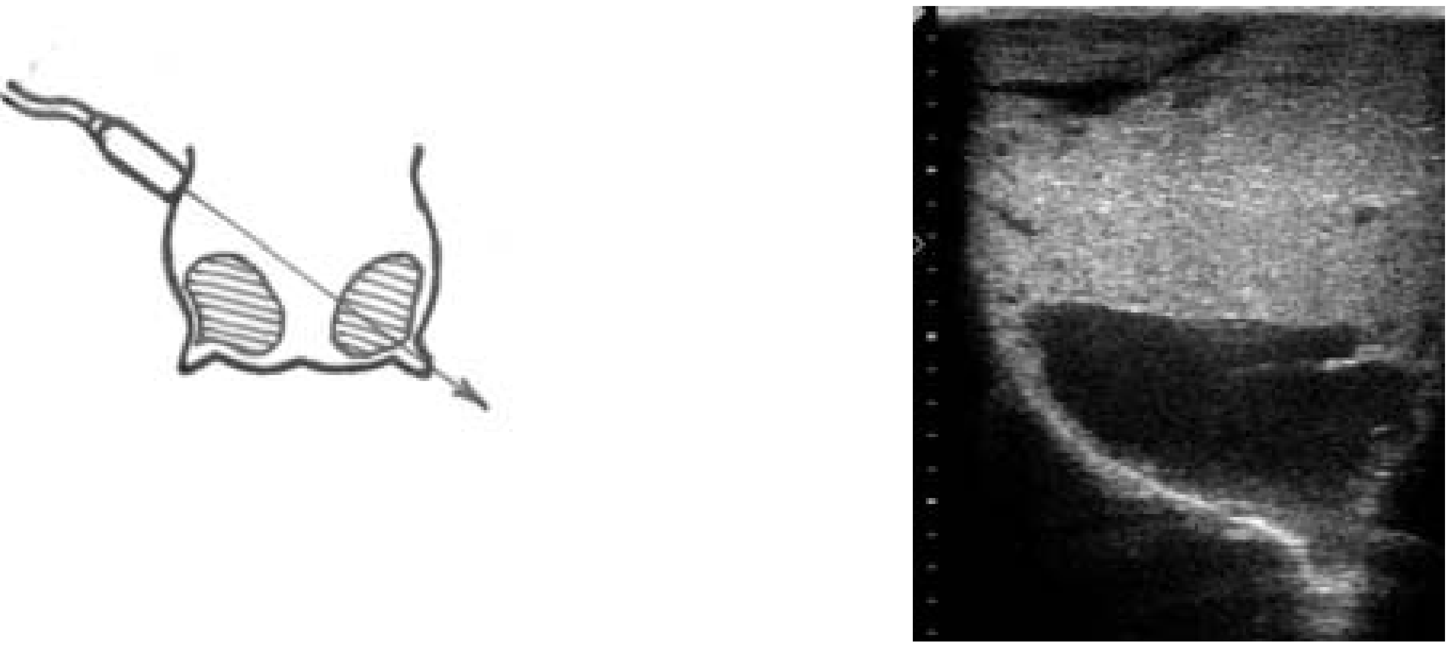

Figure 2. Ultrasonic scan of sheep udder from side (sum of both cistern areas –SCA).