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MEASUREMENT OF THE MAMMARY GLAND CISTERN OF DAIRY EWES

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Abstract

At the 3rd and 5th month of lactation, using the ALOKA-250 ultrasonograph with a 3.5 MHz probe, the udder cistern size of the breed Improved Valachian (IV) and the crossbreed IV x Lacaune (IV x LC) was surveyed. Using the method from side 72 ewes were measured, in which the probe was placed in the inguinal-abdominal fold. Variance analysis was used to evaluate the obtained data (length, width and udder cistern area), taking into account the effect of the genotype, stage of lactation and lactation order. The average length, width and area of the left udder cistern (LUC) was 80.72 mm; 33.53 mm and 1907 mm^2; for the right udder cistern (RUC) 79.44 mm; 33.01 mm and 1851 mm^2. The genotype had a statistically significant effect on the LUC as well as the RUC size ($P < 0.05$ to 0.001). The LUC area of the IV x LC ewes was 32.7% bigger than at IV (2175 mm^2 and 1639 mm^2, respectively), and the difference of the RUC was up to 51% in favour of the crossbreed (2227 mm^2 and 1475 mm^2, respectively). This may be due to laterality, the natural asymmetry found in many mammals. The variability in the observed variables of the left and right udder cisterns was greater in crossbreeds than in the purebred IV ewes.

Keywords: ewes, lactation, udder cistern, ultrasonographic technique, from side method, genotype effect

INTRODUCTION

The anatomical and morphological characteristics of the udder are important factors for optimal machine milking in any dairy species. Ultrasonography is a simple, reliable, non-invasive imaging technique without side effects (Abshenas *et al.,* 2014; Gonzalez-Bulnes *et al.,* 2010). Nowadays, ultrasonography can be seen as an extension of the clinical evaluation of different structures or masses, providing information on their anatomical or morphological features. This rapid and simple technique, also used in other animals, provides useful information on the characteristics of a tissue, using a grey scale and twodimensional image (Payan-Carreira and Martins-Bessa, 2008). The use of ultrasonography in the study of the mammary gland has been also developed for farm animals (Payan-Carreira and Martins-Bessa, 2008; Nudda *et al.,* 2000; Franz *et al.,* 2004).

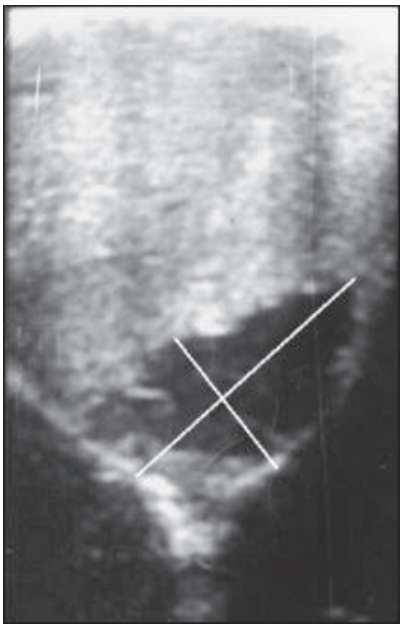
The aim of the work was to diagnose the udder cistern size using ultrasonographic technique with the method from side during the milking period, for the breed Improved Valachian (IV) and the F1 generation of the crossbreed IV x Lacaune.

MATERIALS AND METHODS

Ultrasound images of the right and left udder cistern were obtained using a 3.5 MHz ALOKA-250 probe according to the method published by Nudda *et al.* (2000). The probe was applied in the inguinal-abdominal fold between the two halves of the udder. The operator performed an equal axis scan of the opposite side of the udder in order to obtain a sonographic image with the largest possible cistern size (method from side – Fig. 1).

The ewes included in the research were at first to fourth lactation (lactation order: previously has 1 to 4 times lambs), and were at the 3rd month (during the 1st measurement) and at the 5th month of recent lactation (during the 2nd measurement) – listed as "lactation stage" in the Tabs. I to IV.

The cisterns were scanned for about 12 hours after the last milking repeatedly for the same ewes in the 3rd and 5th month of lactation. The total milk production of ewes obtained at evening milking after the end of scanning was 416.3 ml at the 1st measurement and 328.5 ml at the 2nd measurement. For each scan a sonographic image was made, where the length and width of the cistern were measured on the computer (in mm) in places designed by Nudda *et al.* (2000). Each sonographic image was the basis for planimetric detection of the udder cistern area (in mm^2). The sonographic examination of the left and right cisterns with the method from side was carried out successfully in total at 72 ewes of the Improved Valachian (IV, n = 38) and the crossbreeds IV x Lacaune (IV x LC, n = 34). The diagnosed ewes were at first to fourth lactation.



1: *Ultrasonographic image of the left udder half milk cistern, indicating the length and width of the cistern (method from side).*

The primary udder cistern measurements (length, width, and the area of the left and right cisterns) obtained with the method from side were analyzed using the three-factor analysis of variance with interaction, where the genotype (IV and IV x LC), lactation stage (1st and 2nd measurements) and the lactation orderof the evaluated ewes (first and second lactation as well as third and fourth lactation) were taken into account as fixed effects. Tab. II and Tab. IV show estimates of averages calculated with the method of least squares (LSM ± SE). Data were processed by restricted maximum likelihood (REML) methodology using a MIXED procedure from the SAS statistical package v.9.2, 2002–2008.

I: *Variance analysis of the length, width and area of the left udder cistern of ewes surveyed according to the method from side*

Source of variability	df	Left udder cistern length		Left udder cistern width		Left udder cistern area	
		MS	F	MS	F	MS	F
Genotype (A)	1	2143.1	9.02 ++	391.0	7.69 ++	288.0	5.39 +
Lactation stage (B)	1	330.0	1.39 ns	124.4	2.45 ns	60.7	1.14 ns
Lactation order (C)	1	68.7	0.29 ns	89.3	1.76 ns	114.0	2.14 ns
Interaction							
AB	1	207.1	0.87 ns	54.8	1.08 ns	97.2	1.82 ns
AC	1	96.5	0.41 ns	48.5	0.95 ns	4.6	0.09 ns
BC	1	214.1	0.90 ns	42.9	0.84 ns	77.4	1.45 ns
Rest	65	237.6	-	50.8	-	53.4	-

II: *Estimated averages (LSM ± SE) of the length, width and area of the left udder cistern of ewes surveyed according to the method from side*

Source of variability	Group	Left udder cistern length (mm)			Left udder cistern width (mm)			Left udder cistern area (mm2)		
		n	LSM	SE	n	LSM	SE	n	LSM	SE
Genotype	IV	38	73.43	2.592	38	30.42	1.199	38	1639	123.9
	IV x LC	34	88.01	4.103	34	36.64	1.897	34	2175	194.5
Lactation stage	1st	36	78.48	3.082	36	34.90	1.425	36	2004	147.6
	2nd	36	82.96	3.082	36	32.15	1.425	36	1810	146.2
Lactation order	1st and 2nd	28	79.42	4.163	28	32.04	1.925	28	1738	198.0
	3rd and 4th	44	82.03	2.495	44	35.02	1.154	44	2075	118.3
Sum	-	72	**80.72**	2.427	72	**33.53**	1.122	72	**1907**	115.0

III: *Variance analysis of the length, width and area of the right udder cistern of ewes surveyed according to the method from side*

Source of variability	df	Right udder cistern length		Right udder cistern width		Right udder cistern area	
		MS	F	MS	F	MS	F
Genotype (A)	1	2774.6	17.13 +++	722.9	25.69 +++	566.7	16.0 +++
Lactation stage (B)	1	308.5	1.91 ns	84.5	3.00 ns	45.2	1.28 ns
Lactation order (C)	1	0.1	0.00 ns	0.2	0.01 ns	1.2	0.03 ns
Interaction							
AB	1	24.8	0.15 ns	0.0	0.00 ns	8.1	0.23 ns
AC	1	116.6	0.72 ns	189.3	6.73 +	45.2	1.28 ns
BC	1	4.7	0.03 ns	18.6	0.66 ns	4.6	0.13 ns
Rest	64	162.0	-	28.14	-	35.42	-

IV: *Estimated averages (LSM ± SE) of the length, width and area of the right udder cistern of ewes surveyed according to the method from side*

Source of variability	Group	Right udder cistern length (mm)			Right udder cistern width (mm)			Right udder cistern area (mm^2)		
		n	LSM	SE	n	LSM	SE	n	LSM	SE
Genotype	IV	37	71.13	2.158	37	28.77	0.899	37	1475	100.9
	IV x LC	34	87.75	3.387	34	37.25	1.412	34	2227	158.4
Lactation stage	1st	35	77.25	2.570	35	34.15	1.071	35	1935	120.2
	2nd	36	81.86	2.546	36	31.86	1.061	36	1767	119.1
Lactation order	1st and 2nd	27	79.49	3.448	27	33.09	1.437	27	1868	161.2
	3rd and 4th	44	79.39	2.060	44	32.93	0.858	44	1834	096.3
Sum	-	71	**79.44**	2.008	71	**33.01**	0.837	71	**1851**	093.9

RESULTS AND DISCUSSION

The experience gained from using the ultrasonograph method to determine the udder cistern size during lactation is positive. The application of the probe in the inguinal-abdominal fold of one udder half (method from side) allowed a relatively rapid examination of the inner morphology of the udder cistern. The total operation time for the examination of both left and right udder halves plus taking their photographs did not last longer than three minutes per ewes.

Tab. I and Tab. III provide an analysis of the variance of length, width and the area of the left and right udder cisterns surveyed with the method from side. The genotype had a statistically significant effect on the length, width and the area in both the left and right udder half ($P < 0.05$ to 0.001). The F values for genotype were larger for the right cistern. Neither the "stage of lactation" nor the "lactation order" factor had a statistically significant effect on the analyzed values.

The average values of length and width (show in the Tab. II and Tab. IV) of the left udder cistern (80.72 mm and 33.53 mm, respectively) were larger than for the right cistern (79.44 mm and 33.01 mm, respectively). At Sarda ewes after 24 hours without milking, Nudda *et al.* (2000) determined the length of 73.88 mm at the left cistern, 61.59 mm at the right cistern; width 42.71 mm and 39.13 mm, respectively, and the of area 2110 mm^2 and 1692 mm^2, respectively. Our results largely correspond to the above mentioned results of Nudda *et al.* (2000), especially in the fact that the left cistern is bigger (12.29 cm longer and 3.58 cm wider) than the right one, although in our case the differences are not so distinct (1.28 cm longer and 0.52 cm wider). This asymmetry is explained by Nudda *et al.* (2000) as the different effects of the milker on the individual halves of the udder during manual milking, where the milk production in the left udder is usually larger at older hand-milked sheep than in the right half of the udder. This may be due to laterality, the natural asymmetry found in many mammals, but the repeatedly observed difference still does not explain well enough the cause of the phenomenon, it will need further research to clarify.

Our average values of left and right udder cistern area (1907 mm^2 and 1851 mm^2, respectively) show the Tab. II and Tab. IV. Detailed study of cisternal area measured from the bottom of udder of main breeds raised in Slovakia revealed that Tsigai and Improved Valachian (2600–2800 mm^2) had only half cisternal area of Lacaune (5800 mm^2; Milerski *et al.*, 2006). In available scientific literature, cisternal area are detected in Ripollesa sheep (Caja *et al.*, 1999; 5.6 cm^2), East Friesian (Bruckmaier and Blum, 1992; Bruckmaier *et al.*, 1997; from 19 to 40 cm^2), Lacaune (Bruckmaier *et al.*, 1997; 33 cm^2; Rovai *et al.*, 2008, 24 cm^2; Castillo *et al.*, 2008, 31.36 ± 1.00 cm^2), Manchega (Castillo *et al.*, 2008, 15.01 ± 1.00 cm^2), Sarda (Nudda *et al.*, 2000, 19 cm^2).

From the breeding point of view, it is noteworthy that at all monitored variables, the crossbreed IV x LC has achieved significantly higher values at both the right and left udders (Tab. II, Tab. IV). The area of the left cistern was 32.7% bigger in the crossbreed IV x LC than in the purebred IV ewes (2175 mm^2 and 1639 mm^2 , respectively), and the difference at the right cistern was up to 51.0% in favour of the crossbreed (2227 mm^2 and 1475 mm^2, respectively). The variability in the observed variables of the left and right udder cisterns was greater in crossbreeds than in the purebred IV ewes (Tab. II and Tab. IV).

CONCLUSION

Our results indicate that the IV x LC crossbreed could be more suitable for machine milking than the purebreed IV ewes, but this will have to be confirmed by monitoring the milk yield and the udder size values by involving a larger number of ewes. Although the influence of the "stage of lactation" factor was statistically insignificant, a decrease in the average area of the udder cistern is evident from both Tab. II and Tab. IV, which is associated with a gradual reduction in milk production during lactation. In older ewes (on the third and fourth lactation), the udder cistern length, width and area were observed only for the left cistern, but the differences were also non-significant in this case.

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