THE USE OF ULTRASONOGRAPHY IN THE STUDY OF MAMMARY GLAND CISTERNS DURING LACTATION IN SHEEP

POUŽITIE ULTRASONOGRAFIE PRI ŠTÚDIU CISTERIEN MLIEČNYCH ŽLIAZ POČAS LAKTÁCIE U OVIEC

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Abstract
Building on previous measurements of the same sample by the method *from side* (Makovicky et al. 2019), this time the method *from bottom* was used to survey the udder cistern size of both udder halves (in total 27 sonographic measurements) of the breed Improved Valachian (IV) and the crossbreed IV x Lacaune (IV x LC), at the 3rd and 5th months of lactation, using the ALOKA 250 ultrasonograph with a 3.5 MHz probe. Variance analysis was applied to evaluate the obtained data (length, width and udder cistern area), taking into account the effect of the genotype factor, control measurement and lactation. The average area of the left udder cistern (LUC) and right udder cistern (RUC) detected with the method *from bottom* was 924 mm^2 and 993 mm^2, respectively. The genotype factor had a statistically non-significant effect on both the LUC and RUC size. However, larger areas of LUC and RUC were also found in the case of the crossbreed IV x LC. The average area of the LUC and RUC measured with the method *from side* (previous measurements) and the method *from bottom* at control measurements was 1751 mm^2 and 959 mm^2, respectively. The correlation between the averages of the LUC and RUC areas determined with the method *from side* and *from bottom* was strong ($r = 0.764$).
Keywords: ewes, lactation, udder cistern, ultrasonographic technique, method *from bottom*, genotype effect

INTRODUCTION

Ultrasonography is a valuable non invasive technique for visualizing changes of the cisternal area in dairy cows, in dairy goats, in dairy ewes, in camels and in buffaloes.

The main goal was to find out the udder cistern size using ultrasonographic technique with the method *from bottom* during the milking period of the breed Improved Valachian (IV) and the F1 generation of the crossbreed IV x Lacaune.

MATERIAL AND METHODS

Ultrasound images of the right and left udder cistern were obtained using a 3.5 MHz ALOKA-250 probe. 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. For each scan a sonographic image was made. Each sonographic image was the basis for planimetric detection of the udder cistern area (in mm^2).

In the control measurement, the size of both the left and right udder halves was measured simultaneously by scanning the whole udder using the method *from bottom* (Fig. 1). The udder in this case was immersed in water as described in Bruckmaier and Blum (1992) and Bruckmaier et al. (1997). Altogether, with the method *from bottom*, we evaluated 27 cisterns of the udder (14 IV; 13 IV x LC).

From the sonographic images obtained with the method *from bottom*, the area of the left and right cisterns was found using the planimetric method, and the primary data were evaluated by two-way analysis of variance with interaction. The same method was also used to assess the average area of the left and right cistern.

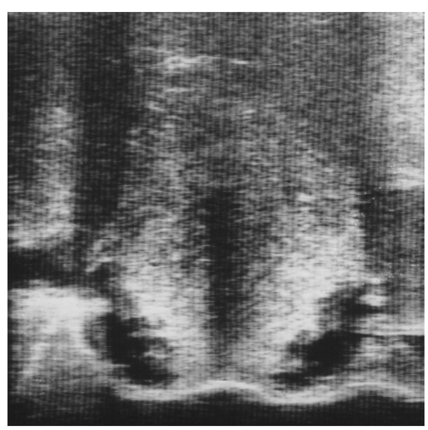

Fig. 1: Ultrasonographic image of the uddern cistern detected with the method from bottom

RESULT AND DISCUSSION

The experience gained from using an ultrasonographic method to determine the udder cistern size during lactation is positive. The application of the probe to the inguinal-abdominal fold of one udder halves (*from side* method) – where the udder was not immersed in the fluid – allows relatively rapid examination of the inner morphology of the udder cistern. The total operating time for the examination of both left and right udder halves plus taking photographs is no longer than 3 minutes. However, more demanding is the simultaneous detection of the left and right udder cistern sizes with the method *from bottom*, where the udder is immersed in fluid. The biggest advantage of this method compared to the method *from side* is that it can detect the size of that part of the udder cistern (in both halves) which is located below the teat duct outlet, which according to Bruckmaier et al. (1997) affects the milking ability of ewes and, in particular, the proportion of excess milk during machine milking.

The results of the variance analysis of the left and right udder cistern areas are shown in Table I, and the averages of the two indicators measured with the method *from below* are in Table II.

Table I .Variance analysis of the left and right udder cistern areas of the ewes surveyed with the method from bottom

Source of variability	df	Left udder cistern area		Right udder cistern area	
		MS	F	MS	F
Genotype (A)	1	37.8	2.68 ns	29.4	1.90 ns
Control measurement (B)	1	71.4	5.07 +	12.2	0.79 ns
Lactation (C)					
AB	1	24.4	1.74	11.5	0.74
Rest	23	14.09	-	15.50	-

Table II. Estimated averages (LSM ± SE) of the left and right udder cistern areas of the ewes surveyed with the method from bottom

Genotype	Group	Left udder cistern area (mm^2)			Right udder cistern area (mm^2)		
		n	LSM	SE	n	LSM	SE
Control measurement	IV	14	742	104.7	14	833	109.8
	IV x LC	13	1105	195.3	13	1153	204.9
Lactation	1^{st} a 2^{nd}	10	674	197.8	10	890	207.5
	3^{rd} a 4^{th}	17	1173	099.9	17	1096	104.8
Sum	-	27	924	11.1	27	993	116.2

The average area of the left udder cistern was 924 mm^2 and 993 mm^2 in the case of the right udder cistern. The effect of the genotype factor and the order of lactation was statistically non-significant except the influence of the lactation order factor in the area of the left udder cistern ($P<0.05$).

Ewes on the 3^{rd} and 4^{th} lactation had up to 74% more left udder cistern area (674 mm^2 and 1173 mm^2, respectively).

Differences between purebred IV ewes and the crossbreed IV x LC were non-statistically significant (Table I), which was probably due to the small number of studied animals and the relatively large variability. However, in both cases (left and right udder cisterns), the IV x LC crossbreed had a larger cistern than the purebred IV ewes, also when detecting the udder cistern with the method *from bottom*.

Bruckmaier et al. (1997) found significantly larger udder cistern areas with the method *from bottom*, as for the purebred East-Friesian sheep they indicate the sum of the left and right udder cistern areas at 4000 mm^2 and for the Lacaune sheep at 3300 mm^2. However, these values are not so surprising when we take into consideration that these two breeds are among the best breeds in the genofond of the world's dairy sheep.

Table III and Table IV show the results of the variance analysis and the estimated averages (LSM) of the left and right udder cistern areas determined with the method *from side* (data according to the publication Makovicky et al. 2019) and the method *from bottom* (current data). At the side method (Makovicky et al. 2019), the genotype factor had a statistically significant effect on the average of the left and right udder cistern area – the IV x LC crossbreed ewes had on average a 56% larger cistern (1366 mm^2 and 2136 mm^2, respectively). Even with the method *from bottom*, the difference was relatively large in favour of the crossbreed (1130 mm^2 and 788 mm^2, i.e. 43.4% larger), although not statistically significant.

Table III. Variance analysis of the left and right udder cistern areas of the ewes surveyed with the method from side (Makovicky et al. 2019) and from bottom (current data)

Source of variability	df	Average left and right udde cistern areas by the method from side (Makovicky et al. 2019) (mm^2)		Average left and right udder cistern areas by the method from bottom (mm^2)	
		MS	F	MS	F
Genotype (A)	1	299.2	13.65 +++	33.5	2.71 ns
Control measurement (B)	1	1.2	0.06 ns	35.5	2.87 ns
Lactation (C)					
AB	1	0.2	0.01	17.6	1.42 ns
Rest	23	21.9	-	12.4	-

Table IV. Estimated averages (LSM ± SE) of the left and right udder cistern areas of the ewes surveyed with the method from side (Makovicky et al. 2019) and from bottom (current data)

Source of variability	Group	Average left and right udder cistern areas by the method from side (Makovicky et al. 2019) (mm^2)			Average left and right udder cistern areas by the method from bottom (mm^2)		
		n	LSM	SE	n	LSM	SE
Genotype	IV	19	1366	111.3	14	788	098.0
	IV x LC	17	2336	176.3	13	1130	182.9
Lactation	1st a 2nd	14	1726	178.8	10	783	185.3
	3rd a 4th	22	1775	107.2	17	1135	093.6
Sum	-	36	1751	104.2	27	959	103.8

The correlation between the average left and right udder cistern areas identified by the method *from side* and *from bottom* was strong (r=0.764) and statistically highly significant (P<0.001), which suggests that after further verification the ultrasonographic diagnosis of udder cisterns with both methods could find broad application in the selection of sheep with good milkability (suitable for machine milking) worldwide, as recommended by Bruckmaier et al. (1997), Nudda et al. (2000) and Maria-Etancelin et al. (2001). The results obtained also suggest that the crossbreeding of the Improved Valachian with the Lacaune sheep can not only increase milk production and fertility in ewes (Margetin, 1997) but can also improve milking parameters.

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Abstrakt

Na základe predchádzajúcich meraní tej istej vzorky metódou zo strany (Makovicky et al. 2019) sa tentokrát použila metóda zdola na zisťovanie veľkosti cisterny vemien oboch polovíc vemena (celkovo 27 sonografických meraní) plemena Vylepšené Valachián (IV) a kríženec IV x Lacaune (IV x LC), v 3. a 5. mesiaci laktácie, s použitím ultrasonografu ALOKA 250 s 3,5 MHz sondou. Na vyhodnotenie získaných údajov (dĺžka, šírka a plocha vemien vemena) sa použila analýza variancie, pričom sa zohľadnil účinok genotypového faktora, kontrolné meranie a laktácia. Priemerná plocha ľavého vemena cisterny (LUC) a pravého vemena cisterny (RUC) detegovaná metódou zdola bola 924 mm^2 a 993 mm^2. Genotypový faktor mal štatisticky nevýznamný vplyv na veľkosť LUC aj RUC. Väčšie oblasti LUC a RUC sa však našli aj v prípade krížencov IV x LC. Priemerná plocha LUC a RUC meraná metódou zo strany (predchádzajúce merania) a metódou zdola pri kontrolných meraniach bola 1751 mm^2 a 959 mm^2. Korelácia medzi priemernými hodnotami LUC a RUC stanovenými metódou zo strany a zdola bola silná (r = 0,764).

Klíčová slova: bahnice, laktácia, vemenné cisterny, ultrasonografická technika, metóda zdola, genotypový efekt

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