THE EFFECT OF MILK EJECTION OCCURRENCE BEFORE OR DURING MACHINE MILKING ON MILKABILITY AND MILK COMPOSITION OF EWES

Ján Antonič[2], Lucia Mačuhová[1], Michal Uhrinčať[1], Vladimír Tančin[1,2]
[1]*Animal Production Research Centre Nitra, Hlohovecká 2, 951 41 Lužianky Slovak Republic*
[2]*Slovak University of Agriculture in Nitra, Trieda A. Hlinku 2, 949 01 Nitra, Slovak Republic*

Corresponding author: Vladimír Tančin
E-mail: tancin@cvzv.sk; Phone: +421 903 546 401

Abstract. The objective of this study was to evaluate the effect of milk ejection reflex occurrence before the cluster attachment on teats on milkability parameters and milk composition of ewes. Milk flow data were recorded from 24 ewes of the Tsigaj (TS, n = 12) and Improved Valachian (IV, n = 12) on their 80±15 DIM. The experiment was performed during three successive evening milkings. Ewes were divided into a two groups. During the first milking the first group (6 TS, 6 IV) was treated by 5 IU *i.m.* of oxytocin and the second group by physiological saline 60 seconds before the cluster attachmenV. The application of oxytocin (OT) and saline (SA) in both groups was changed in cross over design on the third evening milking. Milk flow kinetics was recorded individually using four electronic jars collecting the milk during milking. Milk samples for composition analysis were taken after milking of ewe. There were no differences between two treatments when total milk, machine milk and stripped milk yield were compared though not significantly the data were higher at OT. OT significantly increased maximal milk flow rate (OT vs. SA: 0.930 vs. 0.628 $l.min^{-1}$) (p<0.001), milk yield in the thirty (OT vs. SA: 0.117 vs. 0.072 l) (p<0.001) and sixty second of milking (OT vs. SA: 0.136 vs. 0.106 l) (p<0.05) and reduced milking time from 50.63 s to 31.54 s (p<0.01). Statistically significant difference (p<0.05) was also observed at a higher fat content (OT vs. SA: 8.977 vs. 8.484 %). In conclusion, the milk ejection reflex occurrence before milking has a high impact on the milkability and the fat content in milk.
Keywords: ewes, milk flow, oxytocin.

PRIEŠ MELŽIANT APARATU ARBA MELŽIMO METU SUŽADINTO PIENO ATLEIDIMO REFLEKSO POVEIKIS AVIŲ PIENO KIEKIUI IR SUDĖČIAI

Ján Antonič[2], Lucia Mačuhová[1], Michal Uhrinčať[1], Vladimír Tančin[1,2]
[1]*Gyvulinės kilmės produktų tyrimų centras, Nitra, Hlohovecká 2, 951 41 Lužianky, Slovakijos Respublika*
[2]*Slovakijos žemės ūkio universitetas, Trieda A. Hlinku 2, 949 01 Nitra, Slovakijos Respublika*

Santrauka. Šio darbo tikslas buvo įvertinti, kaip prieš uždedant ant spenių melžiklį atsiradęs pieno atleidimo refleksas veikia primelžto avių pieno kiekį ir sudėtį. Pieno tekėjimo parametrai buvo nustatyti 24 Tsigaj (TS, n = 12) ir Improved Valachian (IV, n = 12) veislių pieningoms avims. Bandymas vyko trijų iš eilės vakarinių melžimų metu. Avys buvo suskirstytos į dvi grupes. 60 sek. prieš uždedant melžiklį, pirmojo melžimo metu pirmos grupės avims (6 TS, 6 IV) panaudotas 5 IU *i. m.* oksitocinas, o antros grupės avims – fiziologinis tirpalas. Trečio melžimo metu viskas padaryta atvirkščiai. Pieno srovės greitis buvo matuojamas individualiai, panaudojus keturis elektroninius pieno surinkimo indus. Pamelžto pieno pavyzdžiai paimti sudėties analizei. Vertinant bendrą pieno kiekį, melžimo aparatu primelžto ir liekaninio pieno kiekį, labai nežymus skirtumas tarp naudotų preparatų poveikio buvo oksitocino naudai. Tačiau oksitocinas ženkliai padidino maksimalų pieno srovės greitį (OT vs. SA: 0,930 vs. 0,628 $l.min^{-1}$) (p<0,001), pieno kiekį trisdešimtą (OT vs. SA: 0,117 vs. 0,072 l) (p<0,001) ir šešiasdešimtą (OT vs. SA: 0,136 vs. 0,106 l) (p<0,05) melžimo sekundę, o melžimo laiką nuo 50,63 sek. sutrumpino iki 31,54 sek. (p<0,01). Statistiškai reikšmingi skirtumai (p<0,05) pastebėti ir vertinant pieno riebalų kiekį (OT vs. SA: 8,977 vs. 8,484 proc.). Daroma išvada, kad prieš melžiant sužadintas pieno atleidimo refleksas ženkliai padidino primelžto pieno kiekį ir pieno riebalų koncentraciją.
Raktažodžiai: avys, pieno srovė, oksitocinas.

Introduction. There are still many sheep farms in Slovakia which use traditional milking by hands. But recently, many farms changed milk removal from hand to machine milking. For this reason, we have little knowledge about suitability of Slovak breeds for machine milking. From our previous investigations we found out that up to 40 % of ewes of two important sheep breeds in Slovakia (Tsigai, Improved Valachian) are without milk ejection reflex during machine milking (Mačuhová et al., 2007, 2008; Tančin et al., 2011). The milk ejection reflex is necessary for rapid and complete milk removal (Zamiri et al., 2001; Negrao and Marnet, 2003). This can influence the results of production controls, because these measurements do not distinguish whether it was a sheep with or without milk ejection reflex. In the traditional milking procedure, the physiological needs of animals are not considered and clusters are attached without previous pre-milking stimulation.

As mentioned above under the traditional conditions of machine milking there are different responses of ewes to machine stimulation. On the base of milk flow kinetic we could observe one peak milk flow (expecting only cisternal milk – no ejection reflex), two peaks (expecting cisternal and alveolar milk – milk ejection occurrence) and plato (steady state milk flow) (Bruckmaier et al., 1997). Thus high variability of different physiological responses to machine stimulation represented by milk flow kinetics and parameters of milkability could be measured within breed or flock (Kulinová et al., 2012; Tančin et al., 2011). On the other hand, there is high stability (repeatability) of milk flow kinetic during machine milking (Tančin et al., 2011) within a short (few days) period. Therefore the kinetic of milk flow could be a useful tool to evaluate the response of dairy animals to milking technology and manipulation (Tančin et al., 2007; Vorobjovas et. al., 2010).

The aim of the work was to compare the milkability parameters and milk composition of dairy ewes of two breeds Tsigaj and Improved Valachian between the traditional milking procedure (cluster attachment without any pre-stimulation) and milking with milk ejection occurrence before cluster attachment.

Material and methods

Animals and Milking Management Twenty-four adult lactating dairy ewes of two breeds Tsigaj (TS, n = 12) and Improved Valachian (IV, n = 12) with healthy udders from the experimental farm of the Animal Production Research Centre in Nitra, Slovakia, were used in this study. They were selected from flock of 400 dairy ewes. The included ewes were on their 3–8th lactation. Ewes had similar stage of lactation (80±15 DIM – day in milk). Before the experiment started, the ewes were milked twice daily at 8 a.m. and 8 p.m. Machine milking took place in a 1x24 low-line side by side milking parlour with 12 milking units. Milking machine was set to provide 160 pulsations per minute at a 50:50 ratio and vacuum level of 39 kPa. During each milking, the ewes received 0.1 kg of concentrate per head parlour.

Experimental procedure. The experiment was realized in June. The experiment was performed during three successive evening milkings. Ewes were divided into two groups. During the first evening milking, the first group (6 TS, 6 IV) was treated by 5 IU *i.m.* of oxytocin and the second group by physiological saline 60 seconds before the cluster attachmenV. The application of oxytocin (OT) and saline (SA) in both groups was changed in cross-over design on the third evening milking. Milk flow kinetics was recorded individually using electronic jars continuously collecting the milk during milking. After milking, the milk samples were collected for composition analysis. Within a jar there was a 2-wire compact magnetostrictive level transmitter (NIVOTRACK) (NIVELCO Ipari Elektronika Rt, Budapest, Hungary) connected to computer. The milk level in the jar was continuously measured by transmitter with recording of signals on computer once per second. Thus there were available data for further computer processing in Microsoft Excel file.

From the measured parameters, the following data were evaluated: total milk yield (TMY, l), machine milk yield (MMY, l), stripped milk yield (SMY, l), stripped milk yield fraction (SMYF, %), milking time (MT, s), milk flow latency (MFL, s), maximal milk flow rate (MMFR, l.min^{-1}), time of maximal milk flow rate (TMMFR, s), milk yield in 30 s (MY30S, l), milk yield in 60 s (MY60S, l).

Milk composition were analyzed for percentage of fat, fat fraction of dry matter (fat of DM), protein, lactose, dry matter and fat-free dry matter with MilkoScan FT120 (Foss, Hillerød, Denmark) and somatic cells count (SCC) with Somacount 150 (Bentley Instruments, Inc., Chaska, Minnesota) analyzer. The results were analyzed by Pared T-test of dependent samples of Statistica program (version 8.0, StatSoft. Inc.)

Results. In total, 48 milk flow data and 48 milk samples were evaluated and analyzed. OT treatment before cluster was attached to the udder significantly influenced some of the measured parameters of milkability (Table 1). There were no differences between two treatments when total milk, machine milk and stripped milk yield were compared. However we could find a tendency of higher values at OT. Also SMY and SMYF% were not affected by treatment. OT treatment significantly increased maximal milk flow rate (OT versus SA: 0.930 vs. 0.628 l.min^{-1}, $p<0.001$) and milk yield in the thirty-second (OT vs. SA: 0.117 vs. 0.072 l, $p<0.001$) as compared with SA treatment. OT treatment also reduced milking time on 31.54 s as compared with SA 50.63 s. ($p<0.01$). The milk yield in 30 s is closely related with milk yield in 60 s. In both mentioned times we measured higher milk yield in sheep after oxytocin administration.

Significant difference was also found in components of milk (Table 2). Higher fat content was found at OT treatment (OT vs. SA: 8.98 vs. 8.48 % $p<0.05$) as compared with SA. Fat content as percentage of milk dry matter was also greater at OT than at SA treatment (OT vs. SA: 44.85 vs. 43.46 %, $p<0.05$). There were not differences between OT and SA treatments in the content of other milk components (protein, lactose, fat-free dry matter) and SCC in milk, though dry matter had a tendency to be higher in OT ($p<0.07$).

Discussion. From the physiological point of view the milking starts without milk ejection in ewes because no pre-stimulation is applied. From previous investigation (Mačuhová et al., 2008, Marnet et al., 1998), which monitored milk flow kinetics or took blood samples for OT level analysis (Marnet et al., 1998; Negrao et al., 2003) it was established, that ewes, depending on breed, had no milk ejection reflex before cluster attachment or even during milking. Based on our results it should be emphasized that occurrence of milk ejection reflex before cluster attachment significantly changed some parameters of milkability and content of fat. The importance of pre-stimulation in dairy cows is well known (Tančin and Bruckmaier, 2001) but we could not find similar study in dairy sheep. On the other hand, in dairy goats pre-stimulation had no importance on milk flow due to high volume of cistern (Bruckmaier et al., 1994).

Table 1. **Differences between milking characteristics after oxytocin and physiological saline treatment**

Parameter	Treatment	Mean	Std. dev.	N	p	significant
TMY, l	oxytocin	0.251	0.071	24	0.282941	-
	physiological saline	0.234	0.082			
MMY, l	oxytocin	0.146	0.068	24	0.246333	-
	physiological saline	0.129	0.077			
SMY, l	oxytocin	0,105	0,058	24	0.965808	-
	physiological saline	0,105	0,055			
SMYF, %	oxytocin	42,21	18,29	24	0.143971	-
	physiological saline	46,87	20,14			
MT, s	oxytocin	31.54	24.85	24	0.005862	++
	physiological saline	50.63	27.84			
MFL, s	oxytocin	17.00	28.20	24	0.355169	-
	physiological saline	21.96	27.64			
MMFR, $l.min^{-1}$	oxytocin	0.930	0.469	24	0.000837	+++
	physiological saline	0.628	0.437			
TMMFR, s	oxytocin	14.792	3.934	24	0.094364	-
	physiological saline	20.208	15.562			
MY30S, l	oxytocin	0.117	0.061	24	0.000206	+++
	physiological saline	0.072	0.058			
MY60S, l	oxytocin	0.136	0.066	24	0.037476	+
	physiological saline	0.106	0.069			

- non significant; + p<0.05; ++ p<0.01, +++ p<0.001

Table 2. **Comparison of milk composition after treatment by oxytocin and by physiological saline**

Parameter	Treatment	Mean	Std. dev.	N	p	significant
Fat, %	oxytocin	8.977	0.853	24	0.031071	+
	physiological saline	8.484	0.832			
Fat of DM, %	oxytocin	44.851	2,473	24	0,027219	+
	physiological saline	43,455	2,613			
Proteins, %	oxytocin	5.713	0.607	24	0.783785	-
	physiological saline	5.698	0.616			
Lactose, %	oxytocin	4.700	0.187	24	0.689808	-
	physiological saline	4.686	0.205			
Fat-free dry matter, %	oxytocin	11.288	0.587	24	0.720327	-
	physiological saline	11.256	0.629			
Dry matter, %	oxytocin	19.989	1.160	24	0.062595	-
	physiological saline	19.497	1.105			
SCC, ln_x	oxytocin	11.491	0.996	24	0.759606	-
	physiological saline	11.438	0.998			

- non significant; + p<0.05; ++ p<0.01, +++ p<0.001

It is not surprising that milking time was shorter after OT application than after SA treatment. Ewes with two emissions of milk in SA treatment change to one emission in OT treatment causing shorter milking time. To our knowledge there was only one work performed by Labussière et al. (1969) with oxytocin pre-treatment before milking. We have confirmed the results of the latter authors. Also our results are in accordance with previous investigations, where pre-milking stimulation reduced milking time (Bruckmaier et al., 1997) and ewes with one emission had significantly shorter time of milking than ewes with two emissions of milk (Mačuhová et al., 2008). Thus, OT injection compensate pre-milking stimulation, which results in the presence of alveolar milk in the cistern, before the cisternal milk was removed and both fractions (cisternal and alveolar) were milked together (Džidić et al., 2004). This is also confirmed by higher milk yield in 30 and in 60 s of milking, which clearly demonstrates that alveolar milk fraction was expulsed into cistern by OT treatment. However not significant increases of total and machine milk yield indicate that the used dose of OT was within physiological range and therefore the residual milk volume probably was not influenced. Higher milk yield was probably caused by ewes which during SA treatment had one peak flow kinetic due to lacking oxytocin release in response to machine stimulation during milking.

The MMFR during OT treatment was significantly higher as compared to SA treatment. These results indicate a relatively high potential of teat canal to release milk available in the cistern. To test further potential of teat canal, the ewes should be at the beginning of lactation with much higher milk production.

Oxytocin had a positive effect on fat content. We observed an increasing fat content after OT application. It is a well known fact that after 24 hours between both milkings the main milk fat yield is stored in alveoli because fat has a lower density and for fat milk balls it is more difficult to pass from the alveoli into the tank than for other components of milk such as casein (McKusick et al., 2002; Labussière, 1969; Rovai, 2001). The main part of synthesized milk fat is collected in the alveoli and can be removed only after milk ejection – stimulation of the udder by milking equipment or pre-milking stimulation (McKusick et al., 2002). On the other hand, there was no effect of OT and SA treatments on the content of other milk components (protein, lactose, fat-free dry matter) and SCC in milk. Also in our study in dairy cows the milk components, except fat and dry matter, were stabile during milking with or without milk ejection occurrence before cluster attachment (Tančin et al., 2007).

Conclusions

The milk ejection reflex has a high impact on the milk composition and on complete and fast milk removal. However, further study of physiological importance of milk ejection occurrence before cluster attachment should be carried out, especially in relation to different milk flow kinetic (ewes with different milk flow emission) under the usual milking conditions, on milkability and milk composition.

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