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# STABILITY OF MILK FLOW KINETICS IN SHEEP DURING MACHINE MILKING

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## ABSTRACT

The goal of this investigation was to describe the milk flow kinetics in response to machine milking in ewes of Tsigai (TS, n = 13), Improved Valachian (IV, n = 12), Lacaune (LC, n = 12), TS x LC (50%, n = 12) and IV x LC (50%, n = 12) breeds and to determine a possible relationship with milk production. Individual stability of milk flow kinetics over the lactation was also evaluated. Milk flow data were recorded during three consecutive evening milkings in the middle of May (ewes on their 74±12 d in milk) and during one evening milking in the middle of next three months (June, July, and August). Three types of milk flow kinetics were described for evaluation (one emission 1P, two emissions 2P, and one milk emission with steady-state milk flow PL). On the basis of milk flow profiles during three consecutive evening machine milkings in May three groups of ewes were created for further study; the first group (2Pc): ewes with 2P pattern (n = 22), the second group (PLc): ewes with PL pattern (n = 32) and the third group (1Pc): ewes with 1Pc pattern (n = 7). The ewe was considered as having stabile milk flow profile when all milk flow types were the same in May and at least three of four were the same throughout lactation. The profile of milk flow kinetics of individual ewes was very stabile among three consecutive evening milkings in the middle of May but a pattern of milk flow changed throughout lactation. The ewes with stabile milk flow patterns over lactation represented 69 %. The highest stability was seen in the group 1Pc (100 %) and the lowest in the group PLc (55 %). 2Pc group showed milk flow pattern stability at 70 %. In total, the frequency of occurrence of 2P, 1P and PL for whole period was 39 %, 28 % and 33 %; respectively. These results provide an important evidence of difference in milking ability between two main sheep breeds used in Slovakia (Tsigai and Improved Valachian) and Lacaune breed.

**Key words:** ewes; milkability; milk flow; breeds

## INTRODUCTION

The machine milking started already during 1960s. Introduction of milking machines required a data related to the milkability of ewes and a searching for the best milking parameters. Therefore, many experiments dealing with milkability of mentioned breeds in Slovakia were done within 1960s - 1980s (Mikuš, 1974) in cooperation with France (Labussière, 1983; 1988). However, machine technology was not spread to farms in a larger extent from this time in Slovakia. Recently Tsigai and Improved Valachian are the most bred breeds in Slovakia.

Biological requirements of ewes and their response to machine milking are well described for many world breeds (Bruckmaier et al., 1997; Rovai et al., 2002, Dzidic et al., 2004; Casu et al., 2008). To improve a milkability of ewes in Slovakia and their milk production it is necessary to expand knowledge on physiological response to machine milking. Some useful parameters to

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evaluate milkability are obtained from the measurement of the milk flow rate kinetics (Labussière, 1988; Bruckmaier et al., 1997; Marnet and McKusick, 2001). Milk flow kinetic is related to milk production (Labussière, 1988; Rovai et al., 2002), especially in non- well genetically selected breeds, where it can indicate the occurrence of milk ejection reflex, which is crucial for complete milk removal and thus for milk production. Recently we have published preliminary results (Mačuhová et al., 2007; 2008) on milkability of TS and IV supporting findings observed in other breeds.

The first goal of this investigation was to measure milk flow kinetics in response to machine milking in pure TS, IV and LC breeds and their crosses. An individual stability of milk flow kinetics during short and longer periods of lactation was also evaluated.

## MATERIAL AND METHODS

### Animals

The study was performed at the experimental farm of the Slovak Agricultural Research Centre, Nitra, Slovakia. Ewes of the Tsigai (TS, n = 13), Improved Valachian (IV, n = 12), Lacaune (LC, n = 12), TS x LC (50%, n = 12) and IV x LC (50%, n = 12) breeds were selected from 400 ewe's flock. The included ewes were at their 1-3 lactations.

The ewes were milked twice a day at 8.00 and 20.00 hours. Machine milking took place in a 1 x 24 low-line side by side milking parlour with 12 milking units by one milking technician. Milking machine was set to provide 160 pulsations per minute in a ratio 50:50 with a vacuum level of 38 kPa. Vanguard cluster was used (0.73 kg of weight). Milking was performed without any contact of hands with the udder before cluster attachment (no stimulation and fore-stripping).

In the middle of April the ewes were relocated from farm stables to the pasture. Thus, during the period from April to September the ewes were stayed on the pasture between morning and evening milkings. During each milking the ewes received 0.1 kg of concentrate per head in parlour.

### Experimental Design

The experiment was conducted from May to August 2007. Milk flow data were recorded during three consecutive evening milkings in the middle of May (ewes on their 74±12 d in milk) and during one evening milking in the middle of next three months (June, July and August).

Milk flow kinetics was recorded individually using four electronic jars (1.5 l) collecting total milk produced at the milking. Within each jar there was a 2-wire compact magnetostrictive level transmitter (NIVOTRACK) (NIVELCO Ipari Elektronika Rt, Budapest, Hungary) connected to the computer. Milk level in the jar was continuously measured by a transmitter with recording signals on the computer once per a second. Thus, there were available data for further computer processing in Microsoft Excel file. Using four jars it was possible to milk out four ewes at the same time and 24 ewes in one line within 20 min.

Milk flow data were calculated using following formula:

$$\text{milk flow rate (l/min)} = (L_n - L_{n-4}) \times 15$$

L – milk yield in litres,
n – time in s, n > 3 s.

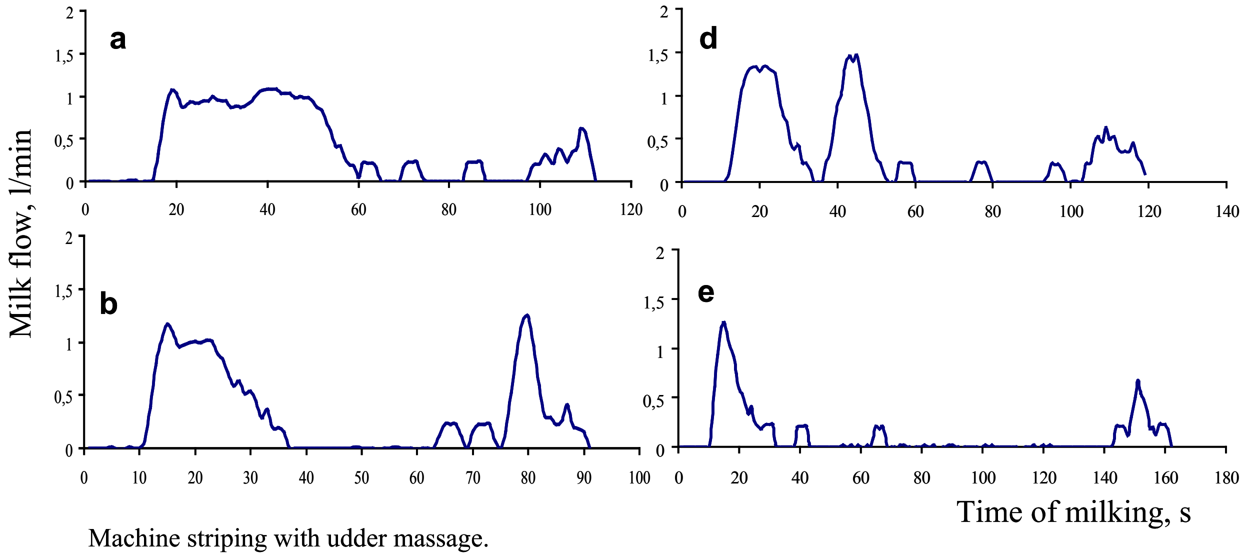
In bimodal milk flows the first emission of milk volume (FEM) was defined as a milk obtained during the first flow surge, currently recorded shortly after cluster attachment until milk flow decreased rapidly before another milk flow surge (within 30s to 40s).

During experimental measurements the clusters were attached immediately without any udder stimulation or pre-dipping and kept on teats 70 s since the attachment, even though no milk flow was detected (no increment of milk level in the jar), or longer if milk level in the jar was slightly increased. Afterwards, the machine stripping was performed with hand massage of the udder before the teat cup removal. The time of 70 s was expected to be sufficient to record the second emission of milk release when milk ejection occurred.

### Evaluation of milk flow profiles

Three types of milk flow were described for the evaluation (Fig. 1). The first type of milk flow represented one emission (1P) of milk from the udder with increasing milk flow, short steady-state milk flow (less than 10 s) and again decline in milk flow intensity. Two emissions (2P) of milk flow with clear decline of milk flow after first emission to zero value were considered as a bimodal milk flow. The milk flow with one milk emission and with steady-state (plateau) duration of milk flow longer than 10 s was classified as a plateau type of milk flow (PL).

On the basis of milk flow profiles during three consecutive machine milkings in May three groups of ewes were created. All ewes showed the same milk flow patterns during recorded three continuous milking, excepting 7 ewes that had one milk flow different from two others. These ewes were grouped on the basis of the same two milk flow profiles only. The first group was represented by the animals with two emissions of milk 2P (2Pc, n = 22), the second one by the animals with plateau PL (PLc, n = 32) and third one by the ewes with one




Plateau milk flow with long (a), or at least 10 s (b) steady state phase.
2Pdal milk flow curves (d), 1Pdal milk flow pattern (e).

**Fig. 1: Examples of two types of plateau (PL), one 2Pdal (2P)| and one 1Pdal (1P) milk flow patterns**

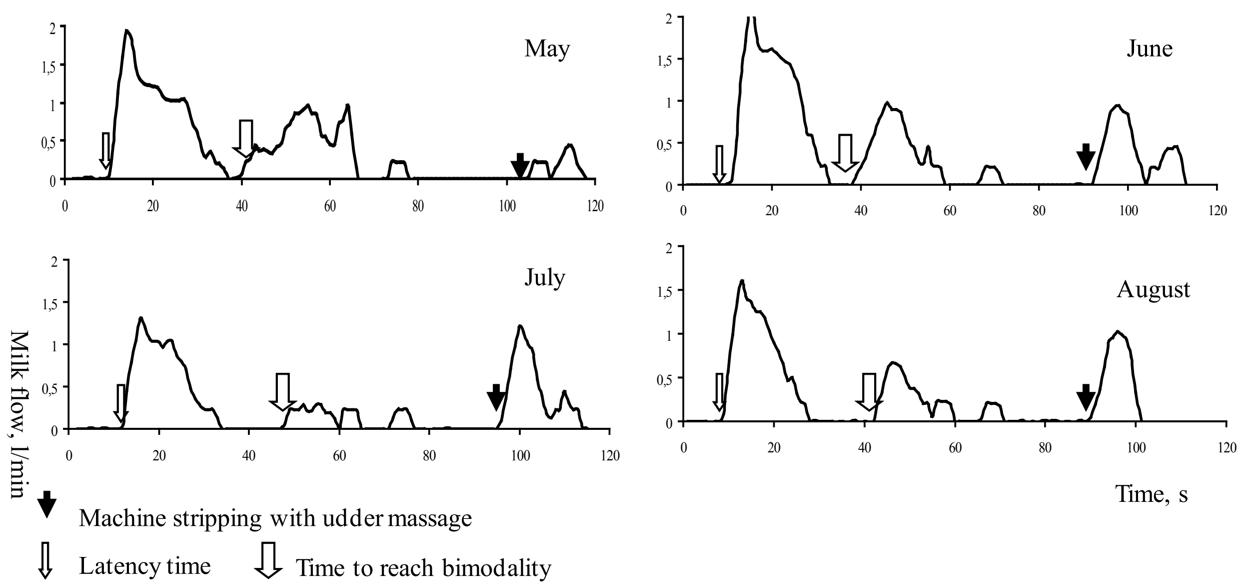



**Fig. 2: Example of milk flow stability throughout lactation. One Improved Valachian ewe with production rate more than 0.5 l per milking is shown**

emission 1P of milk only (1Pc, n = 7), and the animals within mentioned groups were assumed to have the same type of milk flow throughout the whole lactation.

Within selected groups, the stability of milk flow type throughout lactation was also evaluated. The ewe was considered as having stabile milk flow profile when three of four recorded milk flows (four months) were of the same type (Fig. 2).

## RESULTS

As described in Material and methods, the milk flow kinetics of individual ewes was very stabile within three consecutive evening milking. The milk flow type of ewes was also relatively stabile from May to August. The ewes with stabile milk flow represented 69 %. The highest stability was seen within 1Pc group (100 %) and lowest within PLc group (55 %). 2Pc group ewes showed milk flow type stability at 70 % (Fig. 2). The distribution of single milk flow types for each month of the experiment is shown in Fig. 3. There was a clear increase of 1P and decrease of PL types of milk flow curves throughout lactation. 2P milk flows showed a decrease in incidence from June. Totally, the frequency of 2P, 1P and PL milk flow types for a whole period was 39 %, 28 % and 33 % respectively.

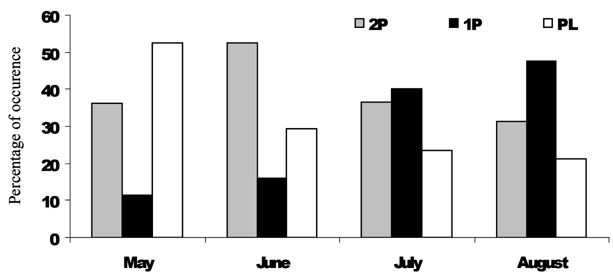



**Fig. 3: Distribution of ewes on the basis of milk flow type within each month**

## DISCUSSION

Milk flow kinetics of individual ewes was very stabile within three consecutive evening milking and also relatively stabile within the lactation. All animals in 1Pc group showed the same milk flow type (1P) throughout lactation indicating high stability of 1P milk flow pattern. In such animals only cisternal milk volume is expected to be removed (Labussière, 1988) indicating no milk ejection response to machine stimulation. When only milk volume is removed from cistern, we assume that it is not possible to expect larger differences in milk flow pattern throughout lactation. Support for this conclusion comes from our earlier data showing that the duration of milk flow time was 45 s including 15 s of latency time (Mačuhová et al., 2008). During such short milk flow it is hard to expect milk ejection without udder pre-stimulation before cluster attachment. The release of oxytocin in response to liner stimuli was measured between 20 s to 60 s (Bruckmaier et al., 1997; Marnet et al., 1998).

The highest percentage of 1P milk flows was found in TS and IV indicating on (1) possible lower sensitivity to udder stimulation by a machine or (2) both breeds are less adapted to machine milking. These findings agree with our preliminary research (Mačuhová et al., 2007; 2008) describing relatively high frequency of 1P flow occurrence in TS and IV ewes. Also Rovai et al. (2002) found higher percentage of 1P in Manchega and Spanish breed less adapted to machine milking compared to the LC breed. Milk emission parameters are genetically determined and there is a good possibility to improve them through a selection (Casu et al., 2008). Therefore, there is a question if culling of ewes with 1P flow could improve physiological response of purebred TS and IV to machine milking. It is hardly to conclude without further detailed physiological studies concerning adaptability of TS and IV to machine milking.

The ewes of the 2Pc group showed 78 % stability of milk type throughout lactation. Thus, some of the ewes with 2P flows changed to 1P at the end of lactation. Ewes with bimodal curves and reduced milk production over lactation could be more sensitive to negative milking conditions causing inhibition of oxytocin release (Tancin and Bruckmaier, 2001), thus resulting in 1P flow. On the other side, with reduction of milk production at the end of lactation the time to induce oxytocin release is prolonged (Bruckmaier and Hilger, 2001) and we could not detect second milk emission in some ewes within 70 s of cluster attachment.

The lowest stability of milk flow pattern throughout lactation was found in the PLc group (55 %). Such type of milk flow is also considered as an indicator of well-adapted ewes to machine milking. As it is mentioned in the work of Marnet and McKusick (2001), second peak is no longer visible due to either increased milk production or decreased average milk flow. In our experiment PL changed later in lactation to 1P or 2P flow. The change of PL to 1P indicates that the former PL was probably caused by limitation of milk flow through teat canal. Ewes of the PLc group showed lower peak flow rate when compared with other ones. The change of PL to 2P indicates that former PL represented positive physiological response to milking. Such ewes had a milk ejection but second emission was masked probably also due to a low milk flow from cisterns (as mentioned above), or with large amount of milk volume the cistern was enough filled up with milk at the time of milk ejection (Marnet et al., 1998). This could also explain our findings where peak flow rate was more stabile throughout lactation in the PLc group compared to other two groups.

## CONCLUSION

The profile of milk flow kinetics of individual ewes was very stabile among three consecutive evening milkings in the middle of May but a pattern of milk flow can change throughout lactation depending on the milk production, decline and sensitivity of the milk ejection reflex or udder sensitivity to oxytocin. The highest stability throughout lactation (100%) showed type of milk flow with one emission followed by bimodal (70%) and plateau (55 %) types. Further physiological studies using higher number of animals involved in the experiment are required to describe ability for machine milking.

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