EFFECT OF PARITY AND LACTATION STAGE ON MILK FLOW CHARACTERISTICS OF SLOVAK SIMMENTAL DAIRY COWS

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Summary. This research is focused on the evaluation of milk flow traits of Slovak Simmental dairy cows, using electronic mobile milk flow meters - Lactocorders. All measurements were carried out on a farms located in the western Slovakia. We evaluated a total amount of 124 Simmental dairy cows. The Main group of Slovak Simmental dairy cows was divided according to parity and lactation stage respectively, into the experimental groups in order to carry out a comparison of traits and parameters of milkability, obtained by Lactocorder within these groups. The average total milk yield was 9.79 ± 3.89 kg per milking with an average milk flow rate of 1.80 ± 0.64 kg.min^{-1} and maximum milk flow rate of 2.66 ± 0.98 kg.min^{-1}. The total milk yield showed a positive correlations with average milk flow rate (r = 0.54+++) and with maximum milk flow rate (r = 0.31+++). In the second part of our study we divided the whole group of Simmental dairy cows (124) into 3 sub-groups according to parity. The highest average and maximum milk flow rates were reached by the dairy cows in the second lactation (1.83 ± 0.69 kg.min^{-1} and 2.71 ± 1.03 kg.min^{-1} respectively). On the other hand, the dairy cows in the second lactation reached also the highest percentage of bimodal milk flow curves (32 %). In the case of dividing the dairy cows according to lactation stage, the highest average and maximum milk flow rates were measured in the group of dairy cows "from 100 to 200 days in milk" (2.22 ± 0.69 kg.min^{-1} and 3.09 ± 1.01 kg.min^{-1}). We detected a significant influence of lactation stage on total milk yield, average milk flow rate and duration of main phase of milking (r = -0.52+++, -0.30+++, and -0.32+++).

Keywords: milkability; lactocorder; Slovak Simmental cattle.

EILIŠKUMO IR LAKTACIJOS STADIJOS ĮTAKA SLOVAKIJOS SIMENTALIO KARVIŲ PIENINGUMUI

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Santrauka. Elektroniniais pieno davikliais laktokoderiais tirtas Slovakijos Simentalio veislės karvių pieningumas. Tyrimai atlikti vakarinės Slovakijos galvijų fermose. Iš viso ištirtos 124 Simentalio veislės melžiamos karvės. Gyvuliai buvo suskirstyti pagal eiliškumą ir laktaciją, kai lyginamas pieningumas, jo kokybė laktokoderiais. Vidutinis primilžis iš karvės per vieną melžimą buvo 9,79±3,89 kg vidutiniu pieno atidavimo greičiu 1,80 ± 0,64 kg/min^{-1} ir maksimaliu pieno atidavimo greičiu – 2,66±0,98 kg/min^{-1}. Nustatyta pozityvi koreliacija tarp melžimo greičio (r = 0,54 +++) ir maksimalaus pieno atidavimo greičio (r = 0,31 +++). Toliau bandymo metu visos melžiamos Simentalio karvės (124) buvo suskirstytos į tris pogrupius pagal eiliškumą. Didžiausias melžimo greitis pasiektas melžiant antros laktacijos karves (1,83±0,69 kg/min^{-1} ir 2,71±1,03 kg/min^{-1}). Ilgiausias melžimo periodas taip pat buvo antros laktacijos karvių – nuo 100 iki 200 dienų (2,22±0,69 kg/min^{-1} ir 3,09± 1,01 kg/min^{-1}). Nustatyta, kad laktacijos stadija daro ženklią įtaką bendram pieningumui, pieno išsiskyrimo greičiui ir pagrindinei pieno išskyrimo fazei (r = -0,52 +++; -0,30 +++ ir -0,32 +++).

Raktažodžiai: pieningumas, laktokoderiai, Slovakijos Simentalio galvijai.

Introduction. Milkability can be classified into the so called "functional traits of cattle". Functional traits can be described as the attributes which influence the production and the economy of rearing by decreasing of input costs. In addition to milkability there can be classified traits like calving easy, stillbirth, diseases resistance, longevity or adaptability to environment (Pedersen, 1997; Rensing, 2005). Dairy farmers place considerable emphasis on milkability, because slow milking cows are hindering the milking process of the herd, especially in milking parlours. At auctions, where daily milk yield as well as milkability of freshly calved heifers is announced, milkability had a significant impact on the price (Krogmeier et al., 2006). In addition to economical aspects of milk production and monitoring of milking efficiencies for farmers, recording of milk flow is used for evaluation and development of milking machines and in setting parameters for their use (Thomas et al., 1991; Rasmussen, 1993). Milkability is sufficiently heritable as to make breeding sensible. Many researchers have obtained moderate to high estimates of heritability for milkability traits which range from $h^2 = 0.17$ up to $h^2 = 0.49$ for average milk flow rate and from $h^2 = 0.21$ up to $h^2 = 0.55$ for maximal milk flow rate (Boettcher et al., 1998; Rupp and Boichard, 1999; Gade et al., 2006; Dodenhoff and Emmerling, 2008).

On the other hand, there is evidence that faster milking cows have higher infection risk for mastitis (Grindal and Hillerton, 1991). In connection with milking speed, it is known, that it is not possible to exceed the biological thresholds of this attribute, because this could have a negative influence on relaxing of teat muscles. Göft et al. (1994) and Fűrst (2000) reported that the result of this situation is opening the "input gate" for microbes and bacterium to the mammary gland.

Objectives of this research were to evaluate milk flow traits of Slovak Simmental dairy cows measured by electronic mobile milk flow meters – Lactocorders, to make a comparison of these traits among groups of cows divided according to parity and lactation stage and to find out correlations between chosen traits and parameters of milkability and milking.

Materials And Methods. All of our evaluations done by Lactocorder were carried out on the 2 farms located in the western Slovakia during one week. Measuring was performed by two electronic mobile milk flow meters – Lactocorders, which were installed between milking equipment and milking tube before each milking. We evaluated a total amount of 124 Slovak Simmental dairy cows. In the second part of our study, we divided the whole group of Simmental dairy cows according to parity and lactation stage respectively:

1) Parity
a) Cows in the first lactation (n = 60),
b) Cows in the second lactation (n = 22),
c) Cows in the third and greater lactations (n = 42).
2) Lactation stage
a) Up to 100 days in milk (n = 28),
b) From 100 to 200 days in milk (n = 31),
c) More than 200 days in milk (n = 65).

The cows were milked two times a day. Lactocorder evaluates only a so called main phase of milking, which begins after exceeding the milk flow 0.5 $kg.min^{-1}$ and ends when milk flow drops down below 0.2 $kg.min^{-1}$. The samples for somatic cell count were collected by Lactocorder during each measuring and than sent (for analyses) to laboratories in Žilina (Breeding service of Slovak republic).

In our study, these parameters were measured and evaluated:

- Total milk yield [kg]
- Average milk flow rate [$kg.min^{-1}$]
- Maximum milk flow rate [$kg.min^{-1}$]
- Duration of main phase [min]
- Duration of incline phase [min]
- Duration of plateau phase [min]
- Duration of decline phase [min]
- Bimodality - steep decrease of milk flow in time up to 96 seconds after the beginning of milking [%]
- The quantity of milk acquired during first minute of milking [kg]
- Somatic cell count [$cells.ml^{-1}$]

The results of our measuring were processed by program pack "LactoPro 5.2.0" (Biomelktechnik Swiss). We used Microsoft Excel and SAS 9.1 for analyses and data calculation. Pearson correlation analyses were performed by using the CORR procedure (SAS 9.1)

Results And Discussion. We evaluated a total amount of 124 Slovak Simmental dairy cows. We detected and analysed 10 parameters and traits related to milkability, milking process and milking readiness. The average total milk yield was 9.79 ± 3.89 kg per milking, with an average milk flow rate of 1.80 ± 0.64 $kg.min^{-1}$ and maximum milk flow rate of 2.66 ± 0.98 $kg.min^{-1}$ (Table 1). Dodenhoff and Emmerling (2009) also evaluated milkability traits in Fleckvieh dairy cows. Average milk flow rate ranged from 1,51 $kg.min^{-1}$ to 2,18 $kg.min^{-1}$ depending on parity and lactation stage. Milk flow rate reached its peak at around day in milk 20, and then decreased steadily towards the end of lactation (Dodenhoff and Emmerling, 2009).

The occurrence of bimodality (which can be characterised as a steep decrease of milk flow in time up to 96 seconds after the beginning of milking) was 27.4 %. According to Tančin and Bruckmaier (2001) the high percentage of bimodal milk flow curves indicates not well prepared cows for machine milking. Bimodality was positively correlated with duration of the incline phase (r = 0.65+++) and negatively correlated with duration of the plateau phase (r = - 0.34+++). Similar results were recorded by Sandrucci et al. (2007), who collected a total of 2 486 milk flow curves in 82 Italian Holstein-Friesian dairy herds. Approximately one–third (35.1 %) of these milk flow curves was classified as bimodal. In accordance with our results, the duration of the incline phase showed a positive correlation with bimodality (r = 0.58) as a consequence of the longer time required to reach the plateau phase when a transient reduction of milk flow occurred (Sandrucci et al., 2007). A previous study by Antalík and Strapák (2010) relating milkability of Slovak Pinzgau cattle, also showed positive correlation between bimodality and duration of the incline phase (r = 0.74+++). On the other hand, Antalík and Strapák (2010) determined negative correlation between bimodality and the quantity of milk acquired during first minute of milking (r = - 0.46+++). In our present study this relation was not confirmed. A difference between an „optimal" and „bimodal" milk flow curve is shown in the Figures 1 and 2.

In the second part of our research we divided the whole group of Slovak Simmental dairy cows (124) into 3 sub-groups according to parity. The aim of this part of the study was to compare detected parameters among these units. The highest milk yield per milking was reached by the dairy cows in the third and greater lactations (10.40 ± 4.67 kg). On the other hand the lowest milk yield per milking was reached by the dairy cows in the first lactation (9.37 ± 3.15 kg) as we expected. This is in accordance with Dodenhoff and Emmerling (2008) who also detected that Flecvieh dairy cows in later lactations reached higher milk yields per milking, but towards the end of lactation, cows in the first lactation had milk yields comparable to cows in later lactations.

The highest average and maximal milk flow rates were reached by the dairy cows in the second lactation (1.83 ± 0.69; 2.71 ± 1.03), but the differences between

milk flow rates among all "parity groups" were very close. The occurrence of bimodality was the highest in the group of dairy cows in the second lactation (32 %). The lowest occurrence was detected in the primiparous dairy cows (25 %) (Table 2). Strapák et al. (2009) evaluated milkability traits by Lactocorder in Holstein dairy cows. The appearance of bimodal milk flow curves ranged from 50 to 56 % depending on parity. The highest percentage of bimodality was detected in the group of cows in the third and greater lactations. Antalík and Strapák (2010) measured bimodality in Slovak Pinzgau dairy cows. The occurance of bimodal milk flow curves ranged from 20 to 45.45 % depending on parity. The highest percentage of bimodality was detected in the group of cows in the second lactation.

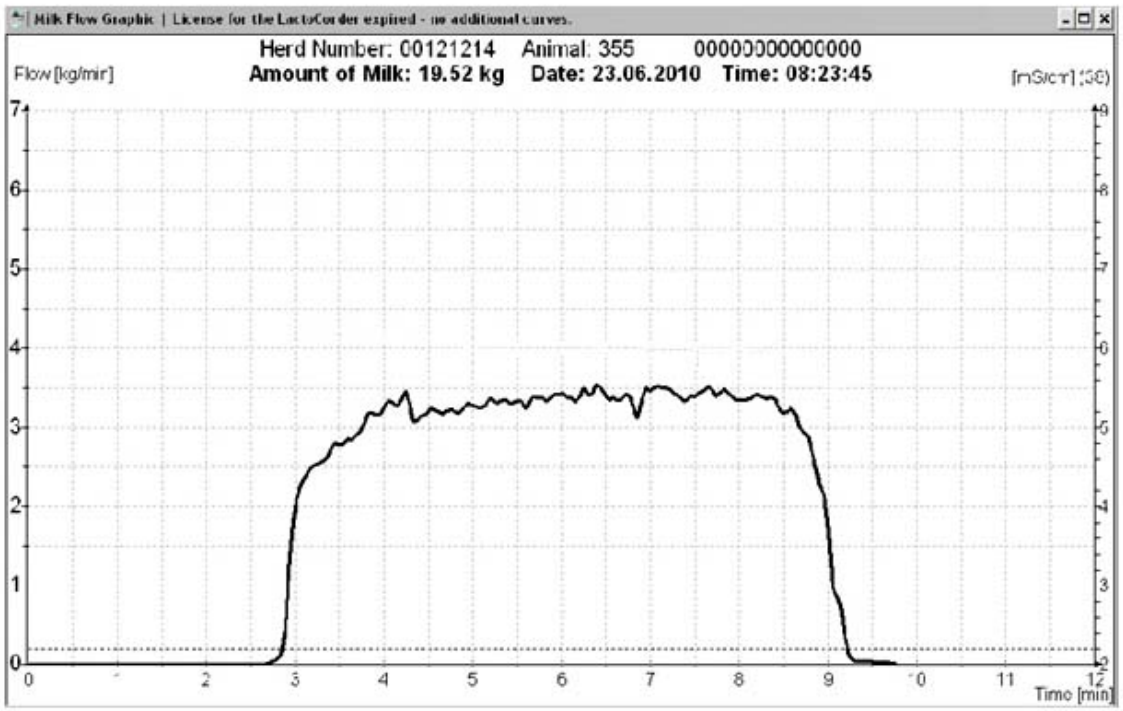

Figure 1 **An example of milk flow curve without bimodality**

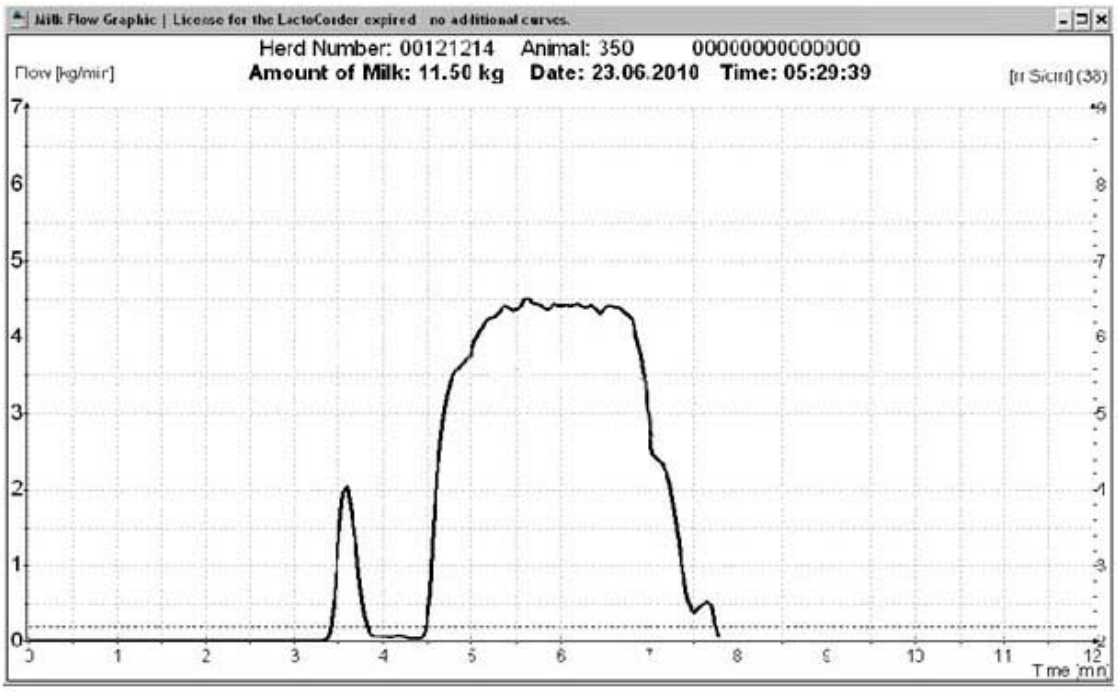

Figure 2 **An example of milk flow curve with bimodality**

Table 1. **Milk flow parameters and traits of milking of the whole group of Slovak Simmental dairy cows** (n = 124)

Trait	$\bar{x}$	Min	Max	s_x
Total milk yield [kg]	9.79	2.17	22.47	3.89
Milk flow rate [kg.min^{-1}]	1.80	0.6	3.71	0.64
Maximum milk flow rate [kg.min^{-1}]	2.66	0.83	5.82	0.98
Duration of main phase [min.]	5.53	2.33	12.69	2.28
Duration of incline phase [min.]	0.77	0.05	1.77	0.39
Duration of plateau phase [min.]	2.66	0.05	10.36	2.12
Duration of decline phase [min.]	2.10	0.33	6.44	1.02
The quantity of milk acquired during first minute of milking [kg]	1.73	0.3	3.84	0.75
Somatic cell count [cells.ml^{-1}]	349000	3000	9550000	964000
Bimodality [%]	27.4			

Table 2. **Milk flow parameters and traits of milking of Slovak Simmental dairy cows divided according to parity**

Trait	Parity		
	1.	2.	3 and <
Number of cows [n]	60	22	42
Total milk yield [kg]	9.37 ± 3.15	9.78 ± 4.07	10.40 ± 4.67
Milk flow rate [kg.min^{-1}]	1.80 ± 0.65	1.83 ± 0.69	1.80 ± 0.62
Maximum milk flow rate [kg.min^{-1}]	2.68 ± 1.03	2.71 ± 1.03	2.61 ± 0.90
Duration of main phase [min.]	5.42 ± 2.22	5.34 ± 2.13	5.79 ± 2.47
Duration of incline phase [min.]	0.75 ± 0.37	0.79 ± 0.40	0.79 ± 0.43
Duration of plateau phase [min.]	2.50 ± 1.72	2.36 ± 2.15	3.07 ± 2.56
Duration of decline phase [min.]	2.19 ± 1.08	2.20 ± 0.84	1.93 ± 1.01
Bimodality [%]	25	32	29
The quantity of milk acquired during first minute of milking [kg]	1.77 ± 0.83	1.63 ± 0.66	1.73 ± 0.70
Somatic cell count [cells.ml^{-1}]	171000 ± 458000	458000 ± 650000	546000 ±1476000

There was found no significant correlation between parity and average or maximal milk flow rate.

Slovak Simmental dairy cows in 1st and 2nd lactations reached higher average and maximum milk flow rates in comparison with Dodenhoff ´s et al., (1999) 1st and 2nd lactations Flecvieh. On the other hand Braunvieh (Dodenhoff et al., 1999) reached in both cases higher average and maximum milk flow rates in comparison with Slovak Simmental.

Slovak Simmental in the first lactation reached higher milk flow rates in comparison with Antalík and Strapák ´s (2010) first lactation Slovak Pinzgau. Average milk flow rate of 1st lactation Slovak Simmental was 0.21 kg.min^{-1} higher than 1st lactation Slovak Pinzgau. On the other hand Slovak Simmental in second lactation reached lower average and maximum milk flow rates in comparison with second lactation of Slovak Pinzgau (Antalík and Strapák, 2010). Average milk flow rate of 2nd lactation Slovak Simmental was 0.03 kg.min^{-1} lower in comparison with 2nd lactation Slovak Pinzgau.

In the third part of our research we divided the main group of Slovak Simmental dairy cows (124) into 3 subgroups according to lactation stage. The highest milk yield per milking, average and maximal milk flow rates were reached by the dairy cows from group "from 100 to 200 DIM" (12.44 ± 3.25 kg; 2.22 ± 0.69 kg.min^{-1}; 3.09 ± 1.01 kg.min^{-1}). On the other hand, the lowest milk yield per milking and average milk flow rate were detected in the group of cows "more than 200 DIM" (7.8 ± 2.82 kg; 1.60 ± 0.50 kg.min^{-1}) (Table 3). Positive correlations were found between total milk yield and average milk flow rate and also between total milk yield and maximal milk flow rate (r = 0.54+++ and 0.31+++ resp.). Based on our results and also on a previous study carried out by Antalík and Strapák (2010), it can be indicated that there is a relation between total milk yield and milk flow traits. This is one of the reasons, why cows from groups "up to 100 DIM" and "more than 200 DIM" (with lower milk yields per milking) reached also lower average milk flow rate in comparison with group of cows "from 100 to 200 DIM". Our results are in accordance with Sandrucci et al. (2007), who also found a positive correlation between total milk yield and maximal milk flow rate (r = 0.33). Similar results were published by Mijic et al. (2003) who detected a positive correlation between total milk yield and average milk flow rate in Holstein Friesan and Simental breeds (r = 0.39; r = 0.49). Juozaitienė et al. (2006) observed highly significant positive correlations between milk yield and milking speed (0.491+++) and between milk yield and high milk flow (0.670+++) in Lithuanian Red and Red

and White cattle.

The highest percentage of bimodal milk flow curves was detected in the group of cows "more than 200 DIM" (34 %). The lowest appearance of bimodality was measured in the group of cows "from 100 to 200 DIM". There were found negative correlations between *"*days in milk*"* and milk yield per milking (r = -0.52+++), duration of main phase of milking (r = -0.32+++) and average milk flow rate (r = -0.30+++).

Table 3. **Milk flow parameters and traits of milking of Slovak Simmental dairy cows divided according to lactation stage**

Trait	Lactation stage		
	<100	100 - 200	>200
Number of cows [n]	28	31	65
Total milk yield [kg]	11.47 ± 4.22	12.44 ± 3.25	7.8 ± 2.82
Milk flow rate [kg.min^{-1}]	1.81 ± 0.67	2.22 ± 0.69	1.60 ± 0.50
Maximum milk flow rate [kg.min^{-1}]	2.51 ± 0.83	3.09 ± 1.01	2.53 ± 0.98
Duration of main phase [min.]	6.61 ± 2.52	6.00 ± 2.62	4.85 ± 1.75
Duration of incline phase [min.]	0.74 ± 0.32	0.73 ± 0.36	0.80 ± 0.44
Duration of plateau phase [min.]	3.31 ± 2.03	3.36 ± 2.60	2.05 ± 1.71
Duration of decline phase [min.]	2.56 ± 1.45	1.90 ± 0.87	2.01 ± 0.80
Bimodality [%]	21	19	34
The quantity of milk acquired during first minute of milking [kg]	1.76 ± 0.72	2.07 ± 0.76	1.56 ± 0.72
Somatic cell count [cells.ml^{-1}]	107000 ± 144000	204000 ± 272000	522000 ± 1295000

Conclusions

In our study we evaluated the effect of parity and lactation stage on milk flow characteristics of Slovak Simmental dairy cows (n = 124). We found significant negative correlations between "days in milk" and milk yield per milking (r = -0.52+++), duration of main phase of milking (r = -0.32+++) and average milk flow rate (r = -0.30+++). On the other hand, no significant correlations were detected between parity and milk flow traits. The highest average and maximal milk flow rates were measured in the group of cows in second lactation. The occurrence of bimodality (which can be characterised as a steep decrease of milk flow in time up to 96 seconds after the beginning of milking) was also the highest in the group of dairy cows in the second lactation (32 %). The lowest occurrence was detected in the primiparous dairy cows (25 %). In the case of "lactation stage" the highest average and maximal milk flow rates were reached by dairy cows from the group "from 100 to 200 DIM". The highest occurrence of bimodality was detected in the group of cows "more than 200 DIM" (34 %). The lowest appearance of bimodality was measured in the group of cows "from 100 to 200 DIM".

Acknowledgment

Supported by the Grant Agency VEGA foundation of the Ministry of Education of Slovak Republic (Project No.1/0695/09).

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Received 17 February 2011
Accepted 12 May 2011