

# Milkability characteristics of Jersey cows throughout the lactation and their effect on milking induced teat prolongation

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## Abstract

The aim of this study was to monitor milkability traits of Jersey cows over the course of lactation, and to investigate how milkability characteristics affected milking induced teat prolongation (MITP; %). For the purpose of the experiment, milkability parameters and teat length of 43 Jersey cows were monitored throughout the lactation. The effects of milk yield, milking time, lag time, average milk flow, and milk flow during various stages of milking on milking induced teat prolongation were evaluated. Jersey cows in this study achieved an average daily milk yield of 16.8 kg with an average milking time of 5 min. The average milk flow was 1.73 kg min<sup>-1</sup> and the occurrence of bimodal milk flows was 23.8 %. Milkability characteristics significantly affected MITP. Milk yield, lag time and milk flow at the beginning of milking affected the MITP of both pairs of teats, while average milk flow and milk flow during the second minute of milking showed significant differences only for MITP of front teats. Furthermore, MITP was not dependent on milking time nor milk flow after the second min of milking, but was strongly affected by milk yield and milk flow disturbances at the beginning of milking. Higher MITP was observed for high milk yields, low lag times, normal milk flows at the beginning of milking, and fast milk flows during the milking. Thus, the desired milkability characteristics caused higher MITP. The findings of this study suggest that the high teat prolongation during milking might be interpreted as a positive sign for milking efficiency.

**Key words:** milk flow; milk yield; milking efficiency; teat length; teat morphology

## Introduction

Jersey breed is getting more and more popular among European farmers thanks to their unique attributes and high quality milk. The smaller, more feed efficient, and climate resistant Jersey cow might be the solution to the challenges of profitability and sustainability confronting dairy business owners (AJCA, 2016). Jerseys generally have smaller udder morphology compared to Holstein, which can be attributed to their much smaller body frame (Dos Santos et al., 2016).

Neither Weiss et al. (2004) nor Antalík and Strapák (2010) did observe correlations among milkability traits and externally measurable teat characteristics like teat length or teat diameter. However, studies found connections between milking induced thickening of teats, milking efficiency, and worsening of udder health (Hamann and Mein, 1996; Zwervaeagher et al., 2013). Forces applied on the teats during milking result in physiological and pathological changes of their tissue like oedema or hyperkeratosis, which may counteract the normal teat defence mechanism (Stádník et al., 2010; Zwervaeagher et al., 2011). While teat end hyperkeratosis score continually worsened with increasing parity for Holstein and Simental cows (Bobić et al., 2018b), it had opposite trends for Jersey cows (Bobić et al., 2018a), which might suggest inter-breed differences in reaction to milking. Mechanically speaking, cow teats have a very high Poisson's ratio and teat tissue could be described as a fibrous structure rather than a homogeneous material like rubber, which allows them to greatly change their shape under pressure (Lees et al., 1991). Therefore, teats can both, change in diameter and change in length after a vacuum is extra hyphen.

Previous research on milking induced teat prolongation (MITP) was mostly focused on the evaluation of influence for various milking settings but studies had shown contrasting results. The pulsation ratio nor the pulsation patterns did not influence MITP (Gleeson et al., 2004). Lowering the vacuum level increased MITP in the study of Hamann et al. (1993), but had no effect in the study of Gleeson et al. (2004). In addition, Pařilová et al. (2010) observed higher MITP for higher vacuum level, and also higher MITP for increased overmilking. Teat liner dimensions also significantly influenced teat reaction to milking (Gleeson et al., 2004). Variations in used liners and milking settings might be the reason for different results for average MITP coming from various studies – e.g. -6 to -3 mm (Hamann et al., 1993); 1 to 3.2 mm (Pařilová et al., 2011); 2.5 to 2.6 mm (Stádník et al., 2010); 2.6 mm (Guarín and Ruegg, 2016); 4.8 mm (Zwervaeagher et al., 2013); 5.17 to 11.62 mm (Gleeson et al., 2004).

Effects of milking machine on teats are not well defined and additional research is required to better understand this relationship (Guarín and Ruegg, 2016). In the future, we need to determine the optimal range for milking induced teat prolongation (Gašparík et al., 2019). However, the effects of milkability on MITP are not well explored. The aim of this study was to monitor milkability

traits of Jersey cows over the course of lactation, and to investigate how milkability characteristics influence milking induced teat prolongation.

## Materials and methods

The study was carried out in accordance with Czech legislation for the protection of the animals against abuse (no. 246/1992) and with directive 2010/63/EU on the protection of animals used for scientific purposes.

### *Farms and animals*

The study was conducted in the production environment of a commercial dairy farm with Jersey cows in the Central Bohemian Region of the Czech Republic (436 meters above sea; rainfall 434 mm in 2018). The cows were housed in one stable with free stall housing and recycled manure solids as bedding. The cows were milked twice a day in the herringbone milking parlour with an automatic detachment system, where the critical milk flow for the automatic detachment system was set to 0.42 kg·min<sup>-1</sup>. The pulsation was set to a 60:40 ration with 55 pulses per min. The vacuum level was set to 42 kPa. Teat liners had a round design with 23 mm orifice diameter and were made of rubber with TIMEPRO© compound (Spaggiari Timepro adapt. 960036-01; Spaggiari Industria Gomma s.r.l.; Luzzara; Italy). Milking settings did not change during the tested period. Pre-milking teat preparation was done by applying pre-dip, then milking first streaks from each teat, followed by udder cleaning, without machine stimulation.

### *Experimental design*

For the purpose of the experiment, milkability parameters and teat length of 43 Jersey cows were monitored throughout the lactation (26 on their first lactation and 17 on second and higher lactation). All cows that calved on the farm during July and August 2018 were included into the experiment. The length of each teat on the udder was measured right before pre-milking preparation and immediately after (< 1 min) evening milking by calliper from the teat end to the teat basis. Overall, seven measurements were performed throughout the lactation for each cow in the test approximately at monthly intervals. Days in milk (DIM) range of tested cows for given measurement days were as follows: Measurement day 1 = 1 - 15 DIM (n = 43); Measurement day 2 = 30 - 51 DIM (n = 43); Measurement day 3 = 57 - 78 DIM (n = 42); Measurement day 4 = 90 - 107 DIM (n = 42); Measurement day 5 = 115 - 140 DIM (n = 42); Measurement day 6 = 147 - 170 DIM (n = 42); Measurement day 7 = 246 - 275 DIM (n = 40). Teat measurements were carried out by the same person during the whole experiment. Milking induced teat prolongation (MITP; %) was calculated as a relative change in teat length during milking:

$\text{MITP \%} = \frac{(\text{post-milking length} - \text{pre-milking length})}{\text{pre-milking length}} * 100$ .

## Data collection

Data about milk yield (MY; kg), milking time (min), average milk flow (AMF;  $\text{kg}\cdot\text{min}^{-1}$ ), partial milk flows within first two minutes of milking (during following schedule: 0-15 sec; 15-30 sec; 30-60 sec; 60-120 sec; 120 sec to end of milking;  $\text{kg}\cdot\text{min}^{-1}$ ), and lag time (time from the start of milking to the milk let-down in sec) were taken from "in-line real-time" milk analysers (Afilab with software Afifarm version CZE 4.1; Afimilk; Afikim; Israel) for each milking. However, only milkability data recorded during the time of the teat measurements were included into the evaluation for MITP. Bimodal milk flows were detected when two increments of milk flow were followed by a clear drop in milk flow by more than  $0.2 \text{ kg min}^{-1}$  within 1 min after the start of milking (Džidić et al., 2004). The milkings with no milk flow during the first 30 sec of milking were marked as "delayed milk flow" and were evaluated by GLM procedure within bimodal milk flow evaluation. Complementary data about milk fat and protein content were obtained from routine performance control of dairy cattle.

## Statistical evaluation

Statistical software SAS 9.4 (SAS Institute Inc., 2013) was used for the statistical evaluation. Basic statistics were calculated by the UNIVARIATE procedure. The MIXED procedure was used for the main evaluation,

therefore to evaluate milkability effects on MITP. The best model for evaluation was selected based on Akaike Information Criterion. Significant effects on MITP related to the cow organism found in the study Gašparík et al. (2019) were applied for the model - fixed effect of measurement day (1-7) and regression on teat length before milking, without the effect for lactation number. Furthermore, the model included the random repeated effect of the animal. Lastly, the fixed milkability effect was added into the model equation. Milkability effects were evaluated individually and were divided into groups as follows – MY (divided into quartiles based on frequency; <6.3, 6.31 - 7.50, 7.51 - 9.01, >9.01 kg); milking time (divided into quartiles based on frequency; <3.71, 3.71 - 4.4, 4.41 - 5.41, >5.41 min); lag time (0-14 sec; 15-29 sec; 30+ sec); AMF (divided into quartiles based on frequency; <1.422, 1.422 - 1.728, 1.729 - 2.045, >2.045  $\text{kg min}^{-1}$ ); beginning of milking (normal flow; bimodal flow; delayed flow); milk flow during the second min of milking (divided into quartiles based on frequency; <1.651, 1.651 - 2.250, 2.251 - 2.736, >2.736  $\text{kg min}^{-1}$ ); and milk flow after second min of milking (divided into quartiles based on frequency; <1.231, 1.231 - 1.515, 1.516 - 1.847, >1.847  $\text{kg}\cdot\text{min}^{-1}$ ). The Tukey-Kramer method was used for the evaluation of differences of least square means. Significance level  $P < 0.05$  was used to evaluate the differences between groups.

## Results and discussion

The popularity of Jersey cattle among dairy farmers is increasing. However, milkability characteristics differ greatly compared to more commonly bred Holstein and

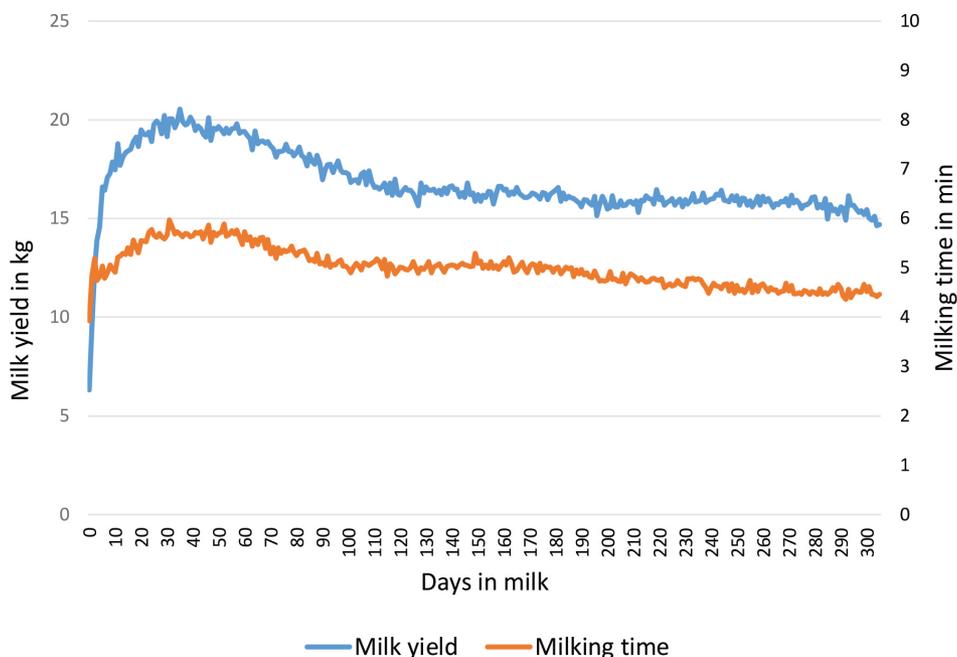


Figure 1. Milk yield (kg) and milking time (min) of tested Jersey cows throughout the lactation period of 300 days

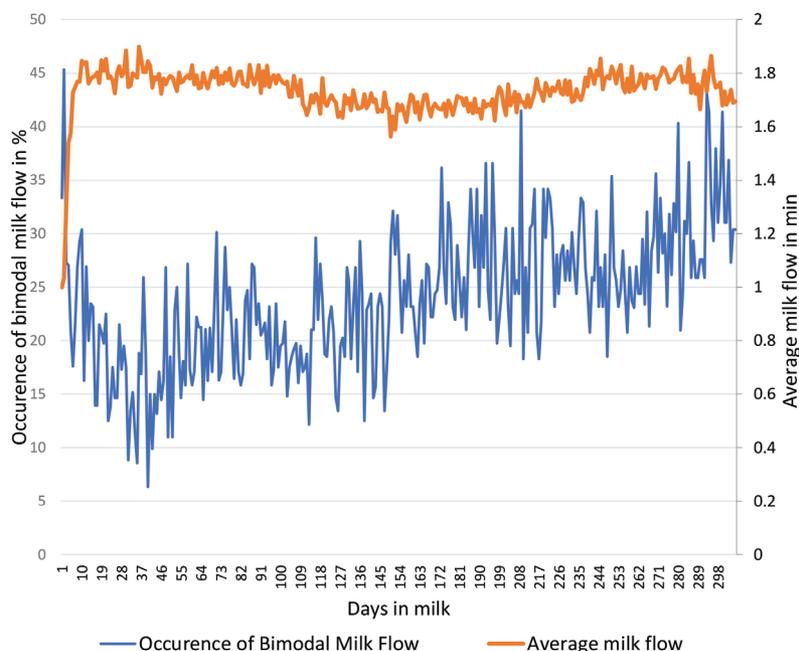
Fleckvieh breeds, and are only scarcely described in scientific literature. In this research, the milk yield (MY) and milkability characteristics of tested Jersey cows were monitored throughout the whole lactation. Development of MY and milking time can be seen in Figure 1, while AMF and the occurrence of bimodal milk flows are presented in Figure 2. Jerseys showed very balanced lactation persistency. Daily MY quickly increased after calving, reaching an average MY of more than 15 kg since 5<sup>th</sup> DIM. The highest average daily MY was observed for 39<sup>th</sup> DIM with 20.14 kg, although an average MY above 19 kg was consistently achieved from 20<sup>th</sup> DIM until 62<sup>nd</sup> DIM. The average MY during the mid-lactation was 16.31 kg (100 - 200 DIM) and only decreased to an average of 15.76 kg for the late lactation (200 - 305 DIM). The cows on second and higher lactation had an average MY of 18.8 kg, while the first lactation cows averaged 15.6 kg. The average fat content was 5.54 % and protein content was 4.58 %.

For comparison, the average daily MY for the Czech population of Holsteins was 33 kg and for Czech Fleckvieh it was 24.9 kg (Kvapilík et al., 2019). Even the average daily MY for the Czech population of Jersey was relatively high at 23.5 kg, although the average milk fat content was only 4.72 % (Kvapilík et al., 2019). These results might suggest that the American variants of Jersey cows, which are larger, have higher MY and lower milk contents (AJCA, 2016), are more popular than the European variants. Jersey introduction into the United States had focused on the selection of animals for milk and butterfat production under intensive commercial farming systems while Island variant of Jersey cattle is reared in smaller, pasture-based farming systems (Huson et al., 2020), which led to a significant production gap. These differences might be reduced in the future, as genetics are being brought to

Europe from the USA to help with inbreeding problems and further develop the breed. On the other hand, similar intensive breeding efforts with Holstein-Friesian cattle had led to the decrease in the diversity within the population and to inbreeding depression, which impaired its functional traits. In addition, as shown by the research, production traits are negatively correlated with functional traits such as reproduction, health, and longevity (Solarczyk et al., 2021), and we need to be aware of these mechanisms with further development of Jersey breed. In this study, lower average MY might have also been caused by the higher percentage of cows on the first lactation in this study compared to normal population distribution.

However, milking time for the higher yielding breeds is also prolonged, which means that more Jerseys can be milked per hour (average milking time in this study = 5 min) compared to Holstein (6.9 min, Sandrucci et al., 2007; 6.25 min, Stádník et al., 2010; 7.33 min, Gašparík et al., 2019) or Fleckvieh cows (6 min, Stádník et al., 2010). Average milking time increased during the lactation peak (5.7 min; 20-60 DIM), but was steadily kept under 5 min since 185<sup>th</sup> DIM (Figure 1). Furthermore, AMF remained stable for the entire lactation with an average of 1.73 kg min<sup>-1</sup>. The average AMF never surpassed 2 kg min<sup>-1</sup>, and stayed at 1.79 kg min<sup>-1</sup> even during the lactation peak. A slight drop was observed during the mid-lactation with an average of 1.69 kg min<sup>-1</sup> (100 - 200 DIM), but AMF increased to 1.75 kg min<sup>-1</sup> during the late lactation (200 - 305 DIM). Therefore, AMF of Jerseys in the test was more comparable to the breeds like Pinzgauer (1.76 kg min<sup>-1</sup>, Antolík and Strapák, 2010) than to the fast flowing breeds like Holstein (2.38 - 2.47 kg min<sup>-1</sup>, Sandrucci et al., 2007).

The average occurrence of bimodal milk flows was 23.8 % during the lactation, but only 16.5 % during the lactation



**Figure 2.** The average milk flow (min<sup>-1</sup>) and the occurrence of bimodal milk flow (%) of tested Jersey cows throughout the lactation period

peak. The occurrence of bimodal flows increased towards the late lactation and averaged at 28.2 % (200 - 305 DIM). The occurrence was lower compared to studies on Holstein cows, e.g. Sandrucci et al. (2007) with 35.1 % or Tamburini et al. (2010) with 31.2 % occurrence. Bimodality is significantly dependent on the pre-milking routine (Sandrucci et al., 2007). As presented in Figure 2, the occurrence was inconsistent and changed daily, and was most probably affected by different milkers at the farm. Tamburini et al. (2010) also suggested that bimodality could be considered as a signal of altered milk emission and a risk factor for intramammary infections. Samoré et al. (2011) observed negative effect of bimodal milk flow on milk yield and somatic cell count for dairy cows, and the

same results were also observed for dairy goats (Šlyžienė et al., 2020). Šlyžienė et al. (2020) concluded that the occurrence of bimodality is unprofitable and should be avoided during milking.

For the main evaluation, the model equation was statistically significant for all tested milkability variants ( $P < 0.05$ ). Milkability effect in the model equation was not significant in all tested variants, but these results were retained to offer a comprehensive view of milkability influence on MITP. Milkability effects of milking time and milk flow after the second min of milking were not significant in the model equation. Effects of MY, lag time, AMF, beginning of milking, and milk flow during the second min of milking were significant ( $P < 0.05$ ).

**Table 1.** Effect of milk yield (kg), milking time (min), and lag time (sec) on MITP of rear and front teats (%), evaluated in MIXED procedure

Effect	Groups	Rear Teats MITP %	Front Teats MITP %
		LSM ± SE	LSM ± SE
Milk yield (kg)	<6.31	19.43 ± 2.07 <sup>A</sup>	8.83 ± 1.36 <sup>A</sup>
	6.31 - 7.50	16.13 ± 1.86 <sup>A</sup>	12.27 ± 1.32
	7.51 - 9.01	20.67 ± 1.96	14.38 ± 1.29 <sup>B</sup>
	>9.01	25.19 ± 1.99 <sup>B</sup>	14.34 ± 1.42 <sup>B</sup>
Milking time (min)	<3.71	18.41 ± 1.30	12.40 ± 1.19
	3.71 - 4.4	17.26 ± 1.54	11.32 ± 1.38
	4.41 - 5.41	18.29 ± 1.46	13.08 ± 1.32
	>5.41	18.73 ± 1.60	12.48 ± 1.44
Lag time (sec)	0 - 14	21.21 ± 2.05 <sup>A</sup>	14.99 ± 1.82 <sup>A</sup>
	15 - 29	18.37 ± 1.04 <sup>A</sup>	12.62 ± 1.01 <sup>A</sup>
	30+	10.06 ± 2.20 <sup>B</sup>	7.91 ± 1.95 <sup>B</sup>

Different letters in columns within effects mean statistical significance A-B...  $P < 0.05$ . MITP - Milking induced teat prolongation in %; LSM - least squares means; SE - standard error of least squares means

**Table 2.** Effect of milk flows ( $\text{kg min}^{-1}$ ) during various stages of milking on MITP of rear and front teats, evaluated in MIXED procedure

Effect	Groups	MITP %	MITP %
		LSM ± SE	LSM ± SE
Average milk flow ( $\text{kg min}^{-1}$ )	<1.422	16.58 ± 1.53	10.26 ± 1.41 <sup>A</sup>
	1.422-1.728	17.70 ± 1.47	11.75 ± 1.34
	1.729-2.045	17.32 ± 1.46	12.93 ± 1.33
	>2.045	20.11 ± 1.54	14.88 ± 1.42 <sup>B</sup>
Beginning of milking	Normal flow	19.05 ± 1.04 <sup>A</sup>	13.07 ± 1.01 <sup>A</sup>
	Bimodal flow	17.80 ± 1.47 <sup>A</sup>	12.48 ± 1.34
	Delayed flow	10.17 ± 2.25 <sup>B</sup>	8.03 ± 1.98 <sup>B</sup>
Milk flow during the second min of milking ( $\text{kg min}^{-1}$ )	<1.651	16.15 ± 1.50	10.30 ± 1.36 <sup>A</sup>
	1.651-2.250	18.20 ± 1.48	12.03 ± 1.32
	2.251-2.736	16.88 ± 1.49	11.78 ± 1.34
	>2.736	20.24 ± 1.52	15.45 ± 1.38 <sup>B</sup>
Milk flow after the second min of milking ( $\text{kg min}^{-1}$ )	<1.231	16.39 ± 1.48	11.90 ± 1.33
	1.231-1.515	17.80 ± 1.48	11.94 ± 1.32
	1.516-1.847	18.10 ± 1.44	11.43 ± 1.27
	>1.847	19.45 ± 1.53	14.50 ± 1.38

Different letters in columns within effects mean statistical significance A-B...  $P < 0.05$ . MITP - Milking induced teat prolongation in %; LSM - least squares means; SE - standard error of least squares means

It might be worthwhile to look for possibilities to optimize the milking machine settings per udder quarter by analysing the responses of certain milk removal parameters (Ipema et al., 2005). One of these milk removal parameters could be milking induced teat prolongation (MITP). The focus of this research was to evaluate the effect of milkability parameters on MITP with MIXED procedure. Milk yield proved to be strongly significant for MITP, and we observed significant differences in MITP of front and rear teats. Teats prolonged the most during high yield milkings, when MITP of rear teats was 25.19 % and of front teats was 14.34 %, which was significantly higher compared to the lowest yielding group (+5.76 % for rear teats and +5.51 % for front teats;  $P < 0.05$ ; Table 1). Front teats MITP showed an increasing trend with increasing milk yields, although for rear teats this trend was disrupted by the second lowest MY group.

Surprisingly, milking time had no significant influence on MITP. Results of MITP for milking time groups were similar, and the differences were within standard error. Lag time, therefore the time between the start of milking until the start of milk flow, significantly affected MITP of rear and front teats (Table 1). If lag time exceeded 30 sec, MITP significantly decreased (-11.15 % for rear and -7.08 % for front teats;  $P < 0.05$ ). There were no significant differences in MITP between lag time 0-14 sec and 15-29 sec, although a decreasing trend was observed with an increasing lag time.

Detailed evaluation on how the milk flow during various milking stages can affect MITP is presented in Table 2. Intensity of milk flow significantly affected MITP, when higher milk flow caused higher MITP. This trend can be observed for all four milk flow parameters – AMF ( $P < 0.05$ ), the milk flow at the beginning of milking ( $P < 0.05$ ), the milk flow during the second min of milking ( $P < 0.05$ ), and also for the milk flow after the second min of milking (no significance). Although, AMF and the milk flow during the 2<sup>nd</sup> min of milking showed statistically significant differences for front teats, and only a tendency for rear teats. The milk flow at the beginning of milking (0 to 60 sec) had the strongest effect, as it significantly affected MITP of rear and front teats. When the milk flow was delayed, MITP of the rear teat significantly decreased compared to the optimal case, therefore during normal milk flow ( $P < 0.05$ ). A reduced MITP was observed during the occurrence of bimodal milk flow compared to the normal milk flow, however the differences were not significant and just showed a tendency. The fastest milking teats showed around +5 % higher MITP compared to slowest milking teats ( $P < 0.05$  for front teats), when the milk flow reached plateau phase during the second minute of milking. Milk flow after the 2<sup>nd</sup> min of milking did not significantly affect MITP, but again, the highest numerical MITP values were observed for the fastest milking teats (Table 2). Low milk flow during this period might indicate a longer decline phase or severity of overmilking.

To summarize, MITP was not dependent on milking time or milk flow in the second half of milking, but was significantly affected by MY and milk flow disturbances at

the beginning of milking. The highest MITP was observed for high milk yields, low lag time, normal milk flow at the beginning of milking, and fast milk flow during the milking. Therefore, the desired milkability characteristics caused a higher MITP. Changes in teat diameter were recommended by Hamann and Mein (1996), and later by Zwertvaegher et al. (2013) to point out ineffective milking. Perhaps MITP could be used for this purpose as well. The length would be easier to measure automatically by milking robots as some of them are already equipped with laser measurement technology. A negative MITP should be undesirable and even MITP of less than 10 % might point out ineffective milking for Jersey cows. The results suggested, that the front teats could be a better indicator of milking efficiency, when their MITP showed significant differences based on MY, lag time, AMF, the beginning of milking, and the milk flow during the second min of milking. Rear teats' MITP showed significant differences for less parameters, although rear teats tended to prolong more with higher differences among groups. There are many differences amongst milking characteristics between front and rear teats, which could be potentially consequential to MITP. Rear teats have significantly higher MY and milk flow compared to front teats (Weiss et al., 2004; Tančin et al., 2007), which could be the reason for the higher MITP.

Based on the results it could be stated that high MITP is a positive factor, which indicates good milking efficiency. Teats prolong the most during high milk flow and then tend to thicken, as the milk flow is low to none (Isaksson and Lind, 1992). Therefore, high MITP would be caused by high MY, and fast milk flow without any disturbances. Low MITP could indicate delayed milk flow, longer decline phase, overmilking, slow milk flow, and low MY. Some of these milking defects, mainly overmilking, the occurrence of bimodal milk flows, and long decline phase, are considered to be risk factors for mastitis (Sandrucci et al., 2007; Tančin et al., 2007). Similar, although opposite, is the case with milking induced teat thickening, when increased milking induced teat thickening has negative implications for udder health and milking efficiency (Zwertvaegher et al., 2013). Even though, low or negative milking induced teat thickening is a positive sign, Zwertvaegher et al. (2013) hypothesized the existence of a critical threshold for the maximum reduction in teat barrel diameter below which udder health is negatively affected. In the case of MITP, we also believe that excessive MITP might have negative lasting effects on teat morphology and its defence mechanisms. Teats tend to continually prolong and widen during the course of production life (Guarín and Rugg, 2016), but naturally some will prolong or widen more than others. Widening and prolonging of teats during production live might be influenced by teat reaction to the individual milkings, when teats with good milking efficiency will prolong and ineffective milkings will cause teats to widen. Most of the cows are subjected to more than 1000 milkings over their production lives, and the ratio between effective and ineffective milkings might affect the interplay between widening and prolonging of teats during the production life. The changes in the

udder may be irreversible if cows are exposed to improper milking for a long period, and these cows are at a much higher risk of mastitis or culling (Pařilová et al., 2011).

## Conclusion

Milkability characteristics significantly affected MITP. Rear and front teats had similar reaction, however MITP of front teats showed significant differences for more milkability parameters. Furthermore, MITP was neither dependent on milking time nor on milk flow after the 2<sup>nd</sup> min of milking, but was significantly affected by MY and milk flow disturbances at the beginning of milking. The highest MITP was observed for high milk yields, low lag times, normal milk flow at the beginning of

milking, and fast milk flow during the milking. Results of this study suggest that high teat prolongation during milking is a positive sign for milking efficiency. Milkability characteristics of Jersey cows differed greatly compared to more commonly bred breeds like Holstein and Fleckvieh. Even though their MY is lower, they offer fast milking time, low occurrence of bimodal milk flows, and balanced lactation persistency.

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## Muzna svojstva krava Jersey pasmine tijekom razdoblja laktacije i utjecaj na produljenje sisa izazvano mužnjom

### Sařetak

Cilj ovog istrařivanja bio je praćenje muznih svojstava krava Jersey pasmine tijekom razdoblja laktacije te utvrditi utjecaj parametara muznih svojstava na produljenje sisa izazvano mužnjom uzrokovano mužnjom (MITP; %). U tu svrhu su tijekom razdoblja laktacije određivani muzni parametri i duljina sisa u 43 krave Jersey pasmine. Pritom se određivao utjecaj kolićine mlijeka, vremena mužnje, brzine otpuštanja mlijeka, prosječnog protoka mlijeka te protoka mlijeka u različitim stadijima laktacije na produljenje sisa izazvano mužnjom. Jersey krave na kojima je provedeno istrařivanje imale su prosječnu dnevnu kolićinu mlijeka od 16,8 kg uz prosječno trajanje mužnje od 5 min. Prosječan protok mlijeka iznosio je 1,73 kg min<sup>-1</sup>, a pojava bimodalnog protoka mlijeka bila je 23,8 %. Muzna svojstva pokazala su statistički znaćajan utjecaj na MITP. Kolićina mlijeka, brzina otpuštanja mlijeka i protok mlijeka na početku mužnje utjecali su na MITP oba para sisa, dok su prosječan protok mlijeka i protok mlijeka tijekom druge minute mužnje znaćajno utjecali samo na MITP vrijednosti prednjih sisa. Nadalje, nakon druge minute mužnje, MITP se nije pokazao ovisnim ni o trajanju mužnje, niti o protoku mlijeka, ali je bio pod jakim utjecajem kolićine mlijeka te varijacijama u protoku zabilježenim na početku mužnje. Više vrijednosti MITP zabilježene su kod viših kolićina mlijeka, bržeg otpuštanja mlijeka, normalnog protoka mlijeka na početku mužnje i brzih protoka mlijeka tijekom mužnje. Stoga se može reći kako su poželjna muzna svojstva uzrokovali više MITP vrijednosti. Prema rezultatima ovog istrařivanja visok stupanj produljenja sisa tijekom mužnje bi se mogao protumaćiti kao dobar znak za procjenu učinkovitosti mužnje.

**Ključne rijeći:** protok mlijeka; kolićina mlijeka; učinkovitost mužnje; dućina sisa; morfologija sisa

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