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MACHINE MILKING AND DAILY CHANGES OF COW'S TEAT CONDITION

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ABSTRACT

The paper deals with daily changes of teat parameters of dairy cows caused by machine milking. Ultrasonographic scanner GE Medical Systems LOGIQ 100 PRO with linear array VE 5 – 5 MHz probe was used for scanning the teats. The scanning was conducted on a dairy farm in Križevci on 27 cows, nineteen of them of Holstein breed and eight of Simmental breed or SimmentalxHolstein crossed breed. The cows were housed in a free stall barn and milked in a herringbone 2x3 milking parlour with Alfa-Laval milking equipment with Duovac milking units. Teat scanning was done just before morning milking and immediately after milking on the right side of the udders for front and rear teats. A total of 432 measurements were carried out during the experiment. The following parameters were measured: teat canal length (TCL), teat end width (TEW), teat cistern width (TCW) and teat wall thickness (TWT). As fifth parameter ratio between teat wall thickness and teat cistern width (TWT/TCW) before and after milking was calculated. Length of teat canal for the front right teat increased in average for 15.44% after milking, and 24.38% for the rear right teat. Teat end width of the front and rear right teat increased after milking for 3.7% and 3.32%, respectively. Mean teat cistern width of the front right teat decreased after milking for 24.41% while for the rear right teat mean decrease was 25.83%. Teat wall thickness of the front and rear right teat increased after milking for 7.86% and 15.81% respectively. The ratio between teat cistern width and teat wall thickness and teat cistern width changed for the right front teat from 0.647 before milking to 0.924 after milking, and for the right rear teat from 0.649 to 1.013. Testing of significance of differences of teat dimensions before and after machine milking showed significant differences for all teat parameters, with the exception of teat end width for front right teat (P = 0,069).

Key words: dairy cows / machine milking / teat condition / ultrasonographic scanning

1 INTRODUCTION

Machine milking is a daily routine procedure in the dairy farms usually conducted twice a day during lactation. As a consequence of vacuum and pulsations applied in the milking procedures, certain changes of the teat tissue appear, such as teat end congestion, changes in teat dimensions, teat colour changes, formation of callus ring on top of the teats, teat texture changes etc. Some of these are short-term changes and the udder usually recovers between two milking, and some can be long-term changes that could lead to chronic changes resulting in greater manifestations of mastitis. "Changes in teat thickness are minimal when milk is removed via a catheter inserted in the teat canal or by hand. Therefore, an increase in thickness values after machine milking can be interpreted as a response of the teat tissue to the machine milking action" (Gleeson *et al.*, 2004). Specifically, cow's teats are the first line of defence against mastitis (Neijenhuis *et al.*, 2001). Ultrasound examination is a useful tool to monitor changes machine milking causes in teat tissue (Neijenhuis *et al.*, 1999). Changes in the pliability of teat tissue caused by congestion or oedema may change the resistance of the teat canal to bacterial invasion (O'Shea, 1987). Increasing thickness of the teat after milking more than 5% increases microbial colonization of the teat ca-

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nal (Zecconi *et al.*, 1992). In order to determine the influence of machine milking on teat condition of dairy cows, the research on changes in some teat parameters during machine milking was conducted.

2 MATERIAL AND METHODS

The research was conducted on a dairy farm in Križevci, Croatia, with 27 dairy cows. Nineteen of them were Holstein breed and eight of them were Simmental breed or Simmental × Holstein crossed breed, all of them assigned for ultrasound teat scanning. Three cows of Holstein breed were in first lactation, six in the second, five in the third, one in the fourth and four in the fifth. Two Simmental cows were in the second lactation, three Simmental × Holstein crossed breed cows in the first lactation, two in the third and one in the fourth lactation. The cows were kept in a free-stall barn (Fig. 1) and milked twice a day in a herringbone milking parlour 2x3 with Alfa-Laval milking equipment with Duovac milking units. Vacuum level was set to 46 kPa, pulsation rate 60 min^{-1} and pulsation ratio 65:35.

Figure 1: *Free-stall barn with dairy cows (photo: M. Stojnović)*

Ultrasound scanner GE Medical Systems LOGIQ 100 PRO (Fig. 2) with linear array 5 MHz probe VE 5 was used for scanning the teats.

Scanning was conducted before the morning milking and immediately after milking at the front and rear right teat of the udder in the period from 15.4.2009. up to 14.5.2009. The total number of measurements was 108 scans × 4 parameters, which gave us 432 data. The following parameters were recorded:

- length of the teat canal (TCL)
- teat end width(TEW),
- teat cistern width (TCW) and
- teat wall thickness at 1 cm from the end of teat cistern (TWT).

The technique of teat scanning consisted of immersing the teat in lukewarm water in a plastic bag and indirect recording with a probe on the outer lateral side, using contact gel to obtain a clear picture. Setting reference points on the frozen image obtained values of the teat parameters, as shown in Fig. 3 and 4.

Figure 2: *Ultrasound scanner (photo: M. Stojnović)*

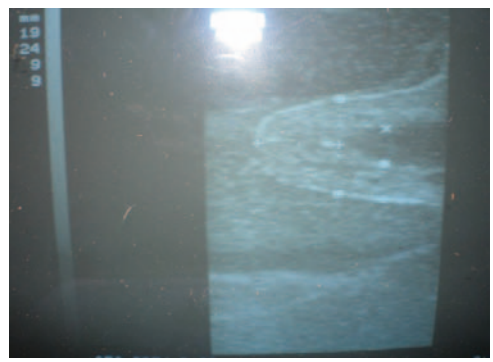

Figure 3: *Ultrasound scanning of teat (photo: D. Alagić)*

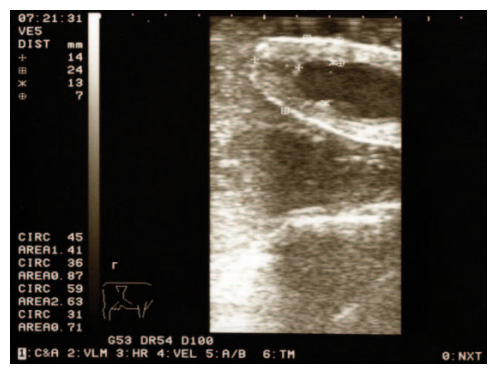

Figure 4: *Teat image from ultrasound scanner with referent points*

The measured data were statistically analyzed using MS Excell statistical software package (Papić, 2005).

Average values of measured parameters, standard deviation, coefficient of variation and standard error were calculated. The statistical significance was tested using *t*-test. The data are presented in tables showing meas-

Table 1: *Statistical data of the measured parameters for the front right teat*

	Before milking				After milking			
Parameter	M mm	s mm	SEM mm	CV %	M mm	s mm	SEM mm	CV %
TCL	11.037	2.192	0.422	19.86	12.741	2.194	0.422	17.22
TEW	21.037	1.911	0.368	9.08	21.815	2.354	0.453	10.79
TCW	10.926	2.526	0.486	23.12	8.259	2.521	0.485	30.52
TWT	7.074	1.492	0.287	21.09	7.63	1.214	0.234	15.91

Table 2: *Statistical data of the measured parameters for the rear right teat*

	Before milking				After milking			
Parameter	M mm	s mm	SEM mm	CV %	M mm	s mm	SEM mm	CV %
TCL	10.63	1.925	0.37	18.1	13.222	2.501	0.481	18.92
TEW	21.222	2.19	0.421	10.32	21.926	2.018	0.388	9.2
TCW	11.185	2.704	0.52	24.17	8.296	2.198	0.423	26.5
TWT	7.259	1.375	0.264	18.95	8.407	1.421	0.273	16.78

ured values and calculated differences in the parameters due to machine milking.

3 RESULTS AND DISCUSSION

Tables 1 and 2 present statistics of the measured parameters of the front and rear teats. Mean values (M), standard deviations (s), standard errors of the mean (SEM) and coefficients of variations (CV) are presented in both tables.

Variability of the results is low to moderate, ranging from 9.08% for teat end width of the front right teat before milking to 30.52% for teat cistern width of the front right teat after milking.

Tables 3 and 4 present the differences of the mean values of ultrasound scanning of teat parameters of 27 dairy cows before and after machine milking. The differences between parameters before and after milking were tested by *t*-test.

As shown in table 3, the least difference between parameters for the front teats is for teat end width (3.7%) followed by teat wall thickness (7.86%). The difference in teat end width was not statistically significant. Statistically significant differences were recorded for teat cistern width which decreased after milking for 24.41% in average, for teat canal length which increased after milking for 15.44% averagely, and for teat wall thickness which increased after milking for 7.86% in average.

The results of measured parameters for the rear teats presented in table 4 show significant differences of all measured parameters. Teat end width increased in average 3.32%, still being under 5% change, which is, according to Zecconi *et al.* (1992), the limit for greater risk of bacterial teat duct colonization and greater possibility of mastitis incidence. Gleeson *et al.* (2005) recorded similar increase in teat end width during machine milking with narrow-bore milking system of 4.4% averagely.

Teat wall thickness increased after milking 15.81%, teat canal length 24.38%, while teat cistern width decreased 25.83%.

The teat wall thickness/teat cistern width ratio

Table 3: *Measured parameters of the front right teat*

front right teat	TCL	TEW	TCW	TWT	TWT/TCW
before milking (mm)	11.037	21.037	10.926	7.074	0.647
after milking (mm)	12.741	21.815	8.259	7.630	0.924
difference (mm)	1.704^{**}	$0.778^{n.s.}$	-2.667^{***}	0.556^{*}	0.277
difference (%)	15.44	3.70	−24.41	7.86	42.81

Significance level: * P≤ 0.05 ,** P≤ 0.01, *** P≤ 0.001, n.s. not significant

Table 4: *Measured parameters of the rear right teat*

rear right teat	TCL	TEW	TCW	TWT	TWT/TCW
before milking (mm)	10.630	21.222	11.185	7.259	0.649
after milking (mm)	13.222	21.926	8.296	8.407	1.013
difference (mm)	2.592***	0.704*	−2.889***	1.148***	0.364
difference (%)	24.38	3.32	−25.83	15.81	56.09

Significance level: * P≤ 0.05, ** P≤ 0.01, *** P≤ 0.005

(TWT/TCW) changed from 0.647 to 0.924 for the front right teat and from 0.649 to 1.013 for the rear right teat. Relative change of the ratio was 42.81% for the front right teat and 56.09% for the rear right teat, which indicates that teat cistern width decrease was relatively higher than teat wall thickness increase, since they change in the opposite direction during milking.

When comparing relative changes in teat end width and teat canal length during milking, it is obvious that the changes of teat canal length (15.44% and 24.38%) were bigger than the changes of teat end width (3.7% and 3.32%), which matches with the conclusion of Neijenhuis *et al*. (2001) that teat tip is more under stress during milking in length than in width and with the conclusion of Neijenhuis (2004) that the changes in teat end width are relatively small compared with the other teat parameters.

Tables 5 and 6 show teat parameters before and after milking according to breed and teat position. The difference in teat-end width for front teat of Simmental breed and Simmental × Holstein crossed breed cows is 9.58%, which indicates greater possibility of bacterial teat duct colonization and a greater possibility of machine milking induced mastitis incidence for these cows.

The differences in teat parameters before and after milking between breeds were tested by F-test and *t*-test and they showed no statistical significance, as well as the differences between front and rear quarters of udder.

4 CONCLUSIONS

The results obtained by ultrasound scanning of dairy cows teat parameters before and after milking procedures indicate the following:

- Machine milking causes daily changes of the teat in dairy cows.
- Length of the teat canal (TCL) after milking increased on average by 15.44% in the front right teat, ie by 24.38% at the rear right teat.
- Teat end width (TEW) on average increased after

Table 5: *Teat parameters of Holstein breed cows*

Parameter	TCL		TEW		TCW		TWT	
Teat position	front	rear	front	rear	front	rear	front	rear
before milking (mm)	10.895	10.474	21.105	20.895	11.105	10.474	7.053	7.316
after milking (mm)	12.263	12.947	21.368	21.895	8.632	7.789	7.421	8.579
difference (mm)	1.368	2.473	0.263	1.000	−2.473	−2.685	0.368	1.263
difference (%)	12.56*	23.61***	1.25n.s.	4.79**	−22.27***	−25.63***	5.22n.s.	17.26**

Significance level: * P≤ 0.05, ** P≤ 0.01, *** P≤ 0.005

Table 6: *Teat parameters of Simmental breed and Simmental × Holstein crossed breed cows*

Parameter	TCL		TEW		TCW		TWT	
Teat position	front	rear	front	rear	front	rear	front	rear
before milking (mm)	11.375	11.000	20.875	22.000	10.500	12.875	7.125	7.125
after milking (mm)	13.875	13.875	22.875	22.000	7.375	9.5	8.125	8.000
difference (mm)	2.500	2.875	2.000	0.000	−3.125	−3.375	1.000	0.875
difference (%)	21.98**	26.14**	9.58***	0.00n.s.	−29.76***	−26.21***	14.04n.s.	12.28n.s.

milking by 3.7% in the front right teat, ie 3.32% at the rear right teat.

- Teat cistern width (TCW) decreased after milking by an average of 24.41% for the front right teat, and by 25.83% on the rear right teat.
- Teat wall thickness (TWT) was increased after milking an average of 7.86% for the front right teat, and by 15.81% on the rear right teat.
- The teat wall thickness/teat cistern width ratio (TWT/TCW) increased relatively by 42.81% at the front right teat, and by 56.09% at the rear right teat.
- Relative change of teat end width after machine milking was less than 5%, indicating that there was no increased possibility of colonization of the teat canal by pathogenic micro-organisms with the exception of front teats of Simmental and Simmental × Holstein crossed breed cows, where relative change of teat end width after machine milking reached 9.58% in average.
- The differences in relative change of measured parameters after machine milking between breeds and between quarters of udder were not statistically significant.

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