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Influence of milking indicators on teat parameters

Parilova, M., Jezkova. A., Stadnik, L.
Department of Animal Science, Czech University of Life Sciences, Kamýcká 129, 16521, Prague 6 – Suchdol, Czech Republic, jezkova@af.czu.cz

Introduction

There were 51 cows (26 Danish Red and 25 Holstein) included in this study. In total 330 teat measurements of 165 cows were statistically processed. The influence of milking vacuum and milk flow level when detaching the cluster on milking performance and teat characteristics were studied in four separate experiments. All these experiments were carried out in free-stall barn with automatic milking system using ultrasonograph Aloka with linear probe (7.5 MHz) for scanning teats, Vernier calliper for taking measurements of teat, Lucia software, SAS software. It is evident that milking vacuum and over milking influenced external and internal teat parameters.

Objective

Milking vacuum and detachment level are ones of the most important factors that influence teat condition and udder health of dairy cows. Milking vacuum is the major factor in keeping the milking unit to the cow during milking process.

The aim of this work was to evaluate the influence of different milking vacuum and detachment level on milking performance i.e. yield, machine-on time, peak flow, teat characteristics measured via Venire calliper, i.e. teat length, teat diameter at the base and half way between the base and the top of the teat and teat characteristics measured via ultrasound, i.e. teat canal length, teat end width, teat wall thickness and teat cistern width.

In the statistical model the influence of breed, lactation stage, parity, and teat position are to be considered as well.

Material and methods

There were 51 cows (26 Danish Red and 25 Holstein) included in this study. All cows had clinically healthy udders. In total, 330 teat measurements of 165 cows were measured and statistically processed. Of cows included in this experiment 30 % were in the first lactation, 34 % in the second lactation and 36 % in the higher lactation. The influence of milking vacuum and milk flow level when detaching the cluster on milking performance and teat characteristics were studied in free-stall barn with AMS at Kvægbrugets Forsøgscenter Forskningscenter Foulum, Tjele, Denmark. The DeLaval automatic milking system was used.

Technical equipment

- ultrasonograph ALOKA SSD-500 with linear probe UST-5561 (7.5 MHz) (ALOKA Co., Ltd, Tokyo, Japan)

used for scanning teats

- digital video camcorder CANON DM-MV600i (CANON, Japan)

used for recording scannings
- rubber cup for the probe to be placed in during the scanning
- Vernier calliper

used for taking external measurements of teats
- Pinnacle Studio software (version 8, Pinnacle Systems, Inc., Mountain View, California, USA)

used for choosing the best image of scanned teat
- Lucia software (version 4.1, Laboratory Imaging, s. r. o., Prague, Czech Republic)

used for measurements of the teat parameters
- SAS software (version 8, SAS Institute, Inc., Cary, USA)

All cows that entered the AMS and were accepted for milking during the measuring period were measured. In observed cows, following teat parameters and milking characteristics were measured:
- teat length
- teat diameter at the base of the teat
- teat diameter half way between the teat end and the base of the udder
- teat canal length
- teat end width
- teat wall thickness
- teat cistern width
- total and quarter milk yield
- machine-on time on cow and quarter level
- peak flow on cow and quarter level
- milking interval.

The influence of milking vacuum and milk flow level when detaching the cluster on milking performance and teat characteristics were studied in four separate experiments.

Experiment 1

Vacuum level was adjusted at 39 kPa and detachment level at 100 g.min^{-1} (74 teats were measured

Experiment 2

Vacuum level was adjusted at 39 kPa and detachment level at 400 g.min^{-1} (74 teats were measured

Experiment 3

Vacuum level was adjusted at 45 kPa and detachment level at 100 g.min^{-1} (92 teats were measured

Experiment 4

Vacuum level was adjusted at 45 kPa and detachment level at 400 g.min^{-1} (90 teats were measured

Teat parameters were measured directly after teat premilking preparation and immediately after removal of the milking cluster. To be able to take measures AMS had to be set to stop after premilking preparation and after teat disinfection at the end of milking. All the measurements were taken by one person.

For all watched characteristics and parameters, basic statistical data were determined: minimal (min) and maximal (max) value during each experiment, average value (mean), standard deviation (s) and median (med). The number (n)of measurements is mentioned as well.

The MIXED procedure was used to test treatment effects on total milk yield, quarter milk yield, machine on time, peak flow rate, teat length, teat thickness at the base and half way between the teat end and the base of udder, teat canal length, teat end width, teat wall thickness, teat cistern width and differences between teat characteristics measured before and after milking. The effect of independent class variables: milking vacuum (KPA), detachment level (DETACH), interaction between milking vacuum and detachment level (KPA x DETACH), milking interval and quarter position (QUARTER) on dependent variables (Y) were tested.

Milking characteristics on cow level were tested by the following model
Y = KPA + DETACH + KPA x DETACH + BREED + LACTATION_STAGE + PARITY + MILKING INTERVAL

For milking characteristics on quarter level, teat characteristics measured via Vernier calliper and difference between values measured before and after milking model was used using independent variable quarter position (QUARTER):
Y = KPA + DETACH + KPA x DETACH + BREED + LACTATION_STAGE + PARITY + MILKING INTERVAL + QUARTER

For teat canal length measured via ultrasound teat length (TL) was added as an effect to the model based on correlation between teat length and teat canal length. Following model was used:
Y = KPA + DETACH + KPA x DETACH + BREED + LACTATION_STAGE + PARITY + MILKING INTERVAL + QUARTER + TL (TLDIF)

For teat canal length difference instead of teat length (TL) teat length difference (TLDIF) was used in previous model (3).

Teat diameter middle was added as an effect to the model based on correlation between teat end width and teat diameter half way between the base of udder and top of the teat:
Y = KPA + DETACH + KPA x DETACH + QUARTER + PARITY + BREED + LACTATION_STAGE + TDM (TDMDIF)

Teat wall thickness and teat cistern width were tested in following model using teat diameter base (TDB) and teat diameter middle (TDM). Both these diameters were added to the model as effects based on correlations between teat wall thickness and these two diameters:
Y = KPA + DETACH + KPA x DETACH + QUARTER + PARITY + BREED + LACTATION_STAGE + TDB (TDBDIF) + TDM (TDMDIF)

Spearman’s correlation coefficients were assessed among observed characteristics and parameters and the tightness of this relation was evaluated.

Results and conclusion

Based on results obtained from measurements of observed milking characteristic and teat parameters we can conclude that vacuum and milking with or without overmilking influence machine on time and peak milk flow on both cow and quarter levels. Further it is evident that milking vacuum and overmilking influenced external and internal teat parameters. During milking teats became longer and narrower. Evaluation of influence of milking vacuum and overmilking on selected milking characteristics and teat parameters is as follows:

Milking vacuum has influence on milking duration and peak flow on both cow and quarter level. Higher vacuum shortened milking duration and increased peak flow on both levels (cow and quarter). It does not influence milk yield neither on cow or quarter level. Milking vacuum influenced two of three measured external teat parameters: teat diameter measured in the base of the teat and half way between udder base and teat tip. Difference between these diameters measured before and after milking was not influenced by milking vacuum. Change in teat length measured before and after milking was higher when vacuum of 45 kPa was used. Teat canal length, teat end width and teat cistern width was larger when using higher milking vacuum. Influence of milking vacuum on change in mentioned parameters was not confirmed. Change in teat length measured before and after milking was higher when vacuum of 45 kPa was used (0.31

cm and significantly ($P<0.05$) longer by 72.22 % compare to teats milked with 39 kPa). Teat canal length, teat end width and teat cistern width was larger when using higher milking vacuum. On cow level milking time was shorter with using vacuum of 45 kPa and higher detachment level (212 s). Teats prolonged most when over milking and vacuum of 45 kPa was applied (4.62 cm compare to lower milking vacuum – 4.58 cm).

Detachment level has not any influence on milk yield, machine-on time and peak milk flow neither on cow or quarter level. It was found that overmilked teats were longer and narrower in both observed diameters. In addition there was found that change in teat diameter measured in the base of the teat was larger in non-overmilked teats. Further it was found that overmilked teats had longer teat canals and narrower teat ends compare to non-overmilked teats. Teat canal length was significantly ($P<0.05$) longer (12,28 mm) in over milked teats compare to non-over milked teats (11.95 mm). Teat end of over milked teats was significantly wider ($P<0.01$) than in non-over milked teats (21.44 vs. 21.13 mm).

Interaction between milking vacuum and detachment level influences milking duration and peak milk flow on both cow and quarter levels. Milk yield is not affected by adjusted milking conditions. On cow level milking time was shorter when using vacuum of 45 kPa and higher detachment level. Peak milk flow on cow level was also higher with higher vacuum level and was quite similar for both detachment levels. On quarter level machine-on time had similar trend like on cow level. In addition peak milk flow was also higher in experiment with higher vacuum used. Interaction of milking vacuum and detachment level affected external teat parameters; teats were longer in overmilked cows in both vacuum levels. Both teat diameters were narrower in overmilked teats in both vacuum levels. Interaction of detachment level and milking vacuum affected change in teat length and teat diameter measured in the base of the teat. Teats prolonged most when overmilking and vacuum of 45 kPa was applied. The largest change in teat diameter measured in the base was found when using vacuum of 39 kPa and detachment level of 400 g.min^{-1}. All observed internal teat parameters were affected by interaction of vacuum and detachment level. Shortest teat canal was found in teats when vacuum of 39 kPa and no overmilking was applied. The only change in internal teat parameters which was influenced by interaction of vacuum and detachment level was change in teat canal length measured before and after milking. The smallest change was found when milking vacuum of 39 kPa and no overmilking was applied to the teats.

There exists only very low correlation between quarter milking characteristics (milk yield, machine-on time and peak mil flow) and external and internal teat parameters. Whereas between two of three quarter milking characteristics (milk yield and machine-on time) and differences in both teat diameters measured before and after milking exist negative correlation.

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