

Influence of different milking regimes on milk secretion

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Summary

Milk secretion and milk yield are affected by the degree of udder evacuation (UE), milking interval (MI), and milking frequency (MF). Milk yield and milking performance are also affected by intramammary infections. This study compares the effects of conventional (CON) and automated (VMS) milking regimes on milk secretion and milk yield (CON: 84 days, MF: 2.0; VMS: 252 days, MF: 2.7). The milk secretion activity per cow was significantly higher in the VMS group ($P < 0.0001$) than in the CON group. During the entire study period, the average daily milk yield per cow was significantly ($p < 0.05$) higher (5 %) in the VMS group than in the CON group. Overall, the data show that increasing milking frequency to 2.7 times daily will increase the secretion rate, mainly due to the short MI (< 8 h).

Introduction

The preparation of a cow for milking varies widely across dairying countries. Premilking udder preparation should include aspects of teat skin sanitation, detection of clinical mastitis and stimulation (evoking the milk ejection reflex). The teat cleaning device of the VMS is suitable to evoke an effective milk ejection within 1 minute (Reinecke, 2002; Dzidic et al., 2004). The premilking manual preparation time for the CON group was about 1 minute, too. Despite some differences in physical forces applied, the premilking preparation time was nearly identical in both milking systems (VMS; CON). It is known that udder evacuation as such can be regarded as a very strong stimulus in which the milking frequency per day and the degree of udder evacuation play the dominant roles (Hamann et al., 2004).

Therefore, the introduction of automated milking systems was expected to increase the milk yield per cow significantly because the average milking frequency would be increased, too (Amos et al., 1985; Barnes et al., 1989). This assumption was based on the theory that the secretion rate changes linearly with time for any MI. Today we know that this is not the case (Halm, 2003).

Moreover, VMS indicates advantages compared to CON with respect to the stereotyped application of the milking unit and the use of a quarter milking design. Yet, also disadvantages may occur as udder cleaning often is not complete and teat disinfection is difficult to evaluate.

This study was performed to compare the effects of the VMS and the CON systems on milk secretion rate, milk yield and certain milk parameters.

Materials and Methods

A total of 66 cows were randomly distributed either to a conventional (CON) or voluntary milking system (VMS), both by DeLaval: 32 cows were milked in 2 x tandem parlour and 34 cows in a VMS. Measurements were made and quarter foremilk samples (QFM) taken 5 times at 21-day intervals twice daily (at 6:00 and 16:00 h) in the CON group; in the VMS group, measuring and sampling were carried out continuously for 24 h (milking frequency (MF) of 2.7 times/day) 13 times at 21-day intervals. Udder health was categorized according to the following cytoabacteriological parameters as defined by the German Veterinary Society (DVG, 1994): normal secretion (NS): SCC < 100,000/ml and a bacteriologically negative (bn) sample; latent infection (LI): SCC < 100,000/ml and a bacteriologically positive (bp) sample; unspecific mastitis (UM): SCC > 100,000/ml and a bn sample; mastitis (M): SCC > 100,000/ml and a bp sample. Other parameters determined were NAGase and electrical conductivity in QFM; milk yield (by weight) per quarter (VMS) or udder (CON); Milking interval (MI) and milking frequency (MF) were also recorded. SAS software was used for the statistical analysis (t-test and variance analysis).

Results

Quarter yield determination could only be performed in the VMS group. The interaction between udder health status and milk secretion rate per hour at udder quarter level can be seen from Table 1.

Tab. 1: Udder health category and secretion (g/h) per quarter in VMS (n = 4520)

Udder health category	No. of measurements	Secretion (mean; g/h)	Significance (p < 0.05)
Normal secretion (NS)	2819	329.74	
Latent infection (LI)	668	296.75	< 0.05
Unspecific mastitis (UM)	572	264.03	< 0.05
Mastitis (M)	461	267.72	< 0.05
Normal secretion (NS)	2819	329.74	
LI + UM + M	1701	277.88	< 0.01

Healthy quarters (NS) had always a significantly higher milk secretion rate compared to diseased quarters.

The secretion rate (g/h & quarter) was significantly different ($p < 0.001$) between MI < 6 h and MI 6 - 8 h. All other MI's were not significant different to MI 6 - 8 h. At all MI's hind quarters indicated significantly ($p < 0.001$) greater secretion rates compared to front quarters. Fig. 1 details the data.

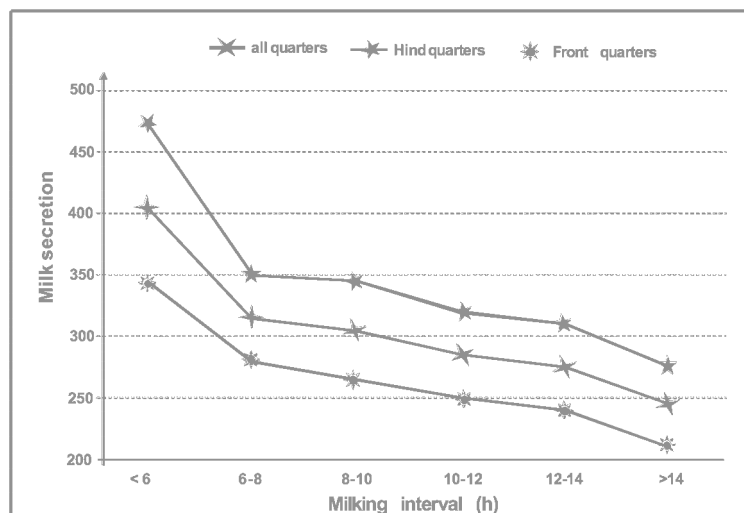
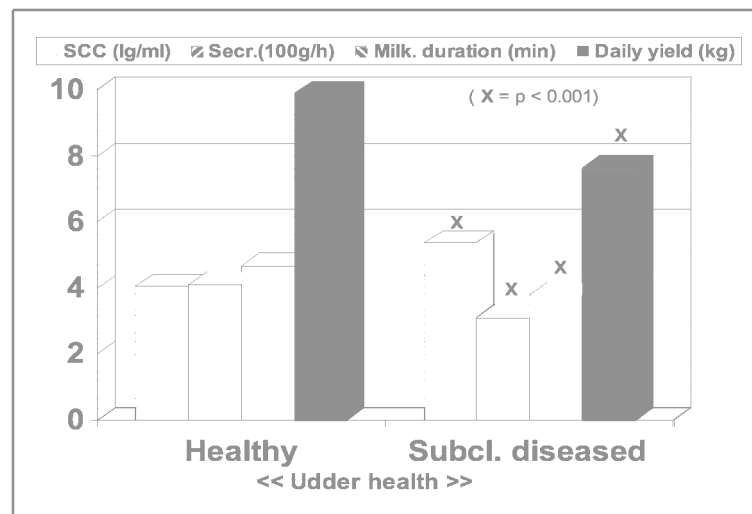


Fig. 1: Milk secretion rates (g/h & quarter) at quarter level (VMS)

In addition to the evaluation of the influence of diseased quarters on secretory activity based on prevalence data, secretory parameters of 16 identical quarters were investigated before (60 d) and after subclinical mastitis (60 d). As shown in Fig. 2 all tested parameters (SCC, secretion rate (g/h & quarter, milking duration (min) and daily yield were significantly different ($p < 0.001$) between the categories: healthy and subclinical diseased. The status “subclinical diseased” had a mean milk yield reduction by 22 % compared to the category “healthy”(NS).

**Fig. 2: Comparison of 16 quarters– before (60 d) / after subclinical mastitis (60 d)**

The secretion rate in g per hour and cow was calculated to compare the secretion rates of cows belonging either to CON or to VMS. The following step consisted in calculating the mean daily yield (kg) per cow in CON or VMS group. The statistical comparison of both parameters is detailed in Table 2.

Tab. 2: Performance (secretion g/h cow) and daily yield (kg) in CON and VMS

Performance parameter	CON (means) (n = 1270)	VMS (means) (n = 4520)	Significance (p < 0.05)
Lactation no.	2.35	2.34	0.4100
Lactation day	172.20	184.66	< 0.0001
Secretion/cow & h	1174.77	1231.50	< 0.0001
Daily yield/cow	28.27	29.69	< 0.0005

Mean secretion rate per cow (g/h & cow) and daily yield (kg) per cow were significantly higher in the VMS group than in the CON group. The statistical significant difference in daily milk yield was 1,4 kg (= 5 %). The significant difference between the mean cow secretion rate in VMS and CON groups was mainly related to the two MI's of less than 8 hours under VMS conditions. The highest secretion rate could be observed for the shortest MI (Fig. 3.).

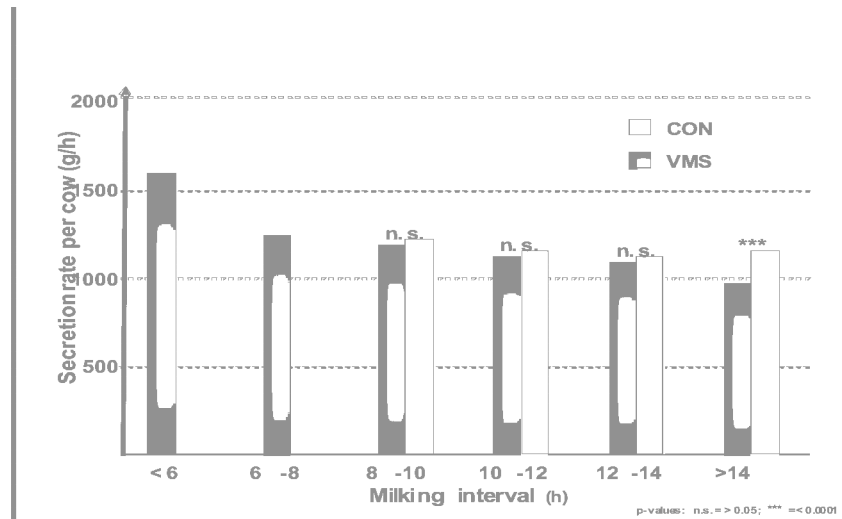


Fig. 3: Secretion rate per cow (g/h) at different MI's (CON/VMS)

The cytobiochemical quality of QFM samples was significantly different between CON and VMS for the parameters el. conductivity and NAGase (Tab.3). Yet, all mean values for the three parameters tested showed a physiological level.

Tab. 3: Cytobiochemical quality of milk components with CON and VMS (MI: 12 -14 h; NS quarters; QFM samples; mean values)

Cytobiochemical parameter	CON (n = 584)	VMS (n = 665)	Significance (p < 0.05)
Electrical conductivity	6.04 mS/cm	6.15 mS/cm	0.00096
NAGase	0.24 lg U	0.29 lg U	0.0053
Cell count (SCC)	4.45 lg/ml	4.38 lg/ml	0.1096

Discussion

The results of this study confirm earlier data showing that milk secretion rate in dairy cows is influenced by the duration of the milking interval (MI). Fig. 4 shows clearly that the secretory activity of quarters was not linear in relation to milking interval durations (Halm, 2003). The reference for this calculation consisted in the mean linear milk secretion per hour (daily yield per quarter divided by 24 h). The expected value was compared to the actual secretion rate/h at any MI. The differences were expressed as percentage.

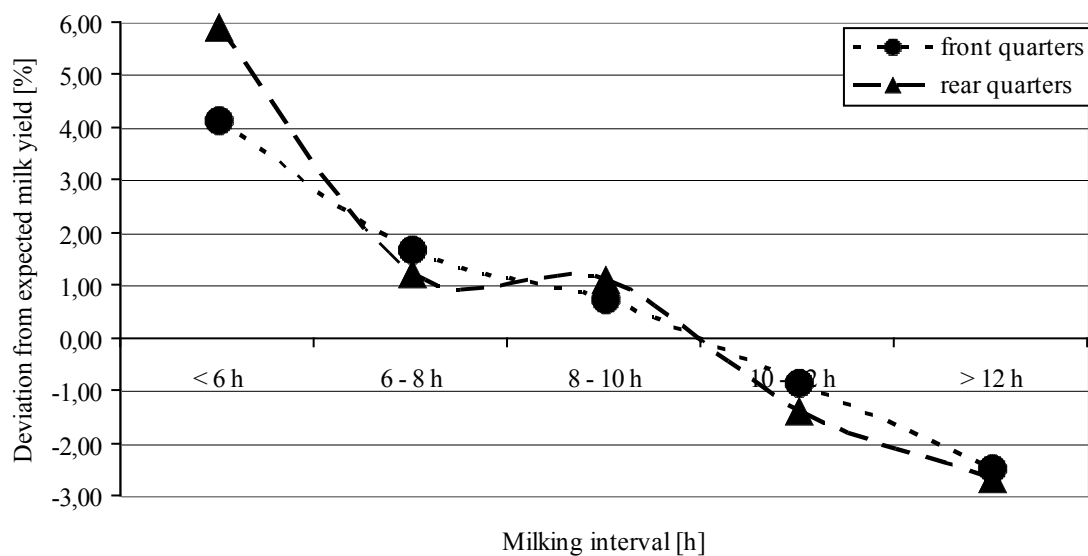


Fig. 4: Milk secretion pattern of front and rear quarters in relation to milking interval

Therefore, any evaluation of secretion rates in cows should be related to MI.

At the quarter level, there was a significant decrease ($p < 0.05$) in secretion rate in connection with subclinical mastitis characterized either by a cell count $> 100,000$ cell/ml milk and/or by bacteriologically positive findings. These data confirm earlier studies showing that there is a significant interaction between cell count level and secretion rate (Halm, 2003).

Overall, there was a significant increase in daily yield of about 5 % with VMS. However, this increase was mainly observed in the VMS with MI's of less than 8 h (Fig. 3). For example, the secretion rate was 1625 g/h with a MI < 6 h, while it was 972 g/h with a MI of 14 h (Schridde, 2006).

All milk components measured here were within the physiological ranges, despite significant differences between the systems.

Implication

The overall conclusion of the study is that automated milking systems do not cause udder health problems or lead to important changes in milk components. A mean milking frequency of 2.7 times per day in the automated system (VMS) was associated with an increase in daily milk yield of at least 5 % per cow compared to a conventional milked control group (CON). Milk secretion followed a non-linear secretion pattern which seems to be conditioned by the milking interval changes. Subclinically diseased udder quarters showed a significant reduction in milk yield by 15 – 22 % , depending on the duration of the subclinical mastitis. Some of the results may contribute to a discussion on maximizing milk yield and optimizing milking routines.

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