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Effects of once daily milking in later lactation on cows with either low or high initial somatic cell counts

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ABSTRACT

The present study was carried out in order to measure the effects of once daily milking on somatic cell count (SCC) of cows which had either low SCS or high SCC at the start of the experiment in late lactation. Thirty six cows were used, 18 with low SCC and 18 with higher SCC. Nine cows from each group were randomly allocated to once or twice daily milking for the four week experimental period in March. The yields of milk, fat, protein and lactose were significantly reduced by once daily milking ($P < 0.01$) in both groups. However, the effects of once daily milking on yields was larger for high SCC cows (interaction $P < 0.01$). Once daily milking significantly increased the concentration of protein ($P < 0.001$) in both groups and fat ($P < 0.01$) in only the low SCC group. Once daily milking significantly reduced the concentration of lactose, the effect being larger in the high SCC group (interaction $P < 0.001$). SCC (per ml) was increased by once daily milking, but the effect was significant only in the high SCC group (interaction $P < 0.10$). The total number of cells produced per day were not affected by once daily milking.

These results show that SCC can be used with confidence to identify subclinically infected cows in later lactation milked once or twice a day. The results also show that cows with a low incidence of subclinical mastitis can be milked once daily in later lactation, with much less effect on yield of milk and its constituents than would be expected in cows with a higher incidence of infection.

INTRODUCTION

Determination of SCC of bovine milk is an established technique for monitoring udder health in dairy herds and in many countries it is also used as one criterion for milk payment to producers.

Although SCC is usually elevated when an infection of the udder has occurred, it is also affected by a number of other factors. Once daily milking, for example, has been shown to cause an increase in SCC both in short periods of lactation and in full lactational studies (Mackenzie *et al.*, 1990; Holmes *et al.*, 1992). Since once daily milking is also associated with a decline in milk yield (Claesson *et al.*, 1959; Bryant, 1980; Morris *et al.*, 1991), it is possible that the increase in SCC is mainly due to a 'concentration effect' in which the number of cells entering the milk is not changed but the SCC is increased. However, there are no data which report the changes in SCC and milk yield in infected or uninfected cows milked once or twice a day in late lactation. Thus, this trial was undertaken in late lactation to study the effects of once daily milking and to measure the interaction between the effects of mastitis and once daily milking on SCC and milk yield. The results were intended to assist with sound interpretation of SCC data for all cows, regardless of milking frequency.

MATERIALS AND METHODS

Thirty six predominantly Friesian cows aged between 2 and 10 years (average 5 years) in late lactation at the Dairy Cattle Research Unit, Massey University, were used in the experiment which began in March 1993. Based on their mastitis status and SCC records, these cows were grouped into 18 low SCC and 18 high SCC cows. Cows within each group were then randomly allocated to either of the two treatments,

once or twice daily milking. Cows were grazed together on ryegrass/white clover pastures throughout the experiment.

The twice daily milked cows were milked at 0600 hours and 1500 hours while once daily milked cows were milked at 0600 hours. Milk samples were taken on two days per week. The yield and composition of milk produced by each cow were measured using Metatron Milk Meters (Westfalia) and a Milko Scan 140A Analyser (A/S N Foss, Denmark), while SCC in milk was measured by the Livestock Improvement Corporation, Hamilton, using a Fossomatic Fluoro-optical Counter (A/S N Foss, Denmark). Data were adjusted by covariance using the values measured before the treatment period as the covariate. Because of the marked skewness of the frequency distribution of somatic cell concentration in milk (Ali and Shook, 1980), the SCC data were transformed (Log₁₀ transformation) prior to analysis. All the data were subjected to analysis of variance using the Statistical Analysis System (SAS) computing package (SAS Institute, 1987).

On two consecutive days at the beginning and again the end of the experiment, samples of milk were taken aseptically from each quarter of each cow for bacteriological analyses (Holdaway, 1990). Analyses were repeated on the third day for samples which had contrasting results on the first and second day. A summary of the working plan is given in Table 1.

RESULTS

The incidence of infection in the two treatment groups measured at the beginning and the end of experiment for low SCC and high SCC cows are shown in Table 2. In both groups the once daily milked cows showed an increase in the incidence of infection, whereas in the twice daily milked cows there was a decrease in the incidence of infection at the end of treatment period. These changes in quarters infected were

TABLE 1: A simple chronological plan of the experiment.

Period	Week of experiment	Measurements
Pre-treatment (2 weeks) (All cows milked twice daily)	1	- Identification of cows with high and low SCC - Bacteriology of 36 selected cows, 2 consecutive days
	2	- Milk yield and composition, SCC
Treatment (4 weeks) (Milked twice or once daily)	3-6	- Milk yield and composition, SCC
Post-treatment (1 week) (All cows milked twice daily)	7	- Bacteriology repeated

TABLE 2: Prevalence (%) of infection within quarters of cows in the low or high SCC groups, and milked once or twice daily, at the beginning and end of the experiment (number of quarters in each category by infection status = 36)

	Twice Daily			Once Daily		
	Start (%)	End (%)	Difference (%)	Start (%)	End (%)	Difference (%)
Low SCC cows						
Major pathogens ⁺ *	0	0	0	0	0	0
Minor pathogens ^{**}	56	44	-12	47	53	+6
Uninfected	44	56	+12	53	47	-6
High SCC cows						
Major pathogens ⁺ *	25	11	-14	22	28	+6
Minor pathogens ^{**}	58	42	-16	61	67	+6
Uninfected	17	47	+30	17	5	-12

* *Staphylococcus aureus**Streptococcus uberis**Streptococcus dysgalactiae*^{**} *Corynebacterium bovis*Coagulase negative *staphylococcus*⁺ Quarters may also have harboured minor pathogens

larger for the high SCC cows (5 and 11% more respectively). The high SCC group milked once daily had two clinical cases of mastitis in quarters during the experimental period.

TABLE 3: Daily mean values (\pm SEM; covariance adjusted) for milk production by cows in the low or high SCC groups, and milked once or twice daily.

	Twice		Once		Pooled SEM	Significance		
	Low SCC	High SCC	Low SCC	High SCC		SCC Group	Frequency	SCC x Freq.
Yield/cow								
Milk (l)	13.9 ^a	14.0 ^a	11.9 ^b	10.4 ^c	0.30	**	***	**
Fat (kg)	0.70 ^a	0.71 ^a	0.64 ^b	0.54 ^c	0.02	*	***	**
Protein (kg)	0.52 ^a	0.52 ^a	0.47 ^b	0.41 ^c	0.01	**	***	**
Lactose (kg)	0.67 ^a	0.68 ^a	0.57 ^b	0.48 ^c	0.01	*	***	**
Total Somatic cells ($\times 10^9$)	2.8 ^a	11.7 ^b	3.2 ^a	10.4 ^b	1.3	***	NS	NS
Composition								
Fat (%)	5.04 ^a	5.15 ^a	5.39 ^b	5.22 ^a	0.08	NS	**	NS
Protein (%)	3.78 ^a	3.79 ^a	3.97 ^b	3.96 ^b	0.03	NS	***	NS
Lactose (%)	4.83 ^a	4.86 ^a	4.75 ^b	4.61 ^c	0.02	**	***	***
SCC ($\text{Log}_{10}/\text{ml}$)	5.19 ^a	5.92 ^b	5.35 ^a	6.35 ^c	0.11	***	***	NS (10%)

*** Significant difference at probability < 0.001

** Significant difference at probability < 0.01

* Significant difference at probability < 0.05

NS No significant difference

NB: Means within the same line but with different superscripts are significantly different at probability < 0.05

The mean values for the yields of milk and its main components measured during the 4-weeks treatment period are given in Table 3. Milking once daily significantly reduced yields of milk, fat, protein and lactose in both groups ($P < 0.01$). The average decreases per cow in the low SCC group were 14% milk, 9% fat, 10% protein and 15% lactose, while in the higher SCC group, the decreases were approximately 26%, 24%, 21% and 29% for milk, fat, protein and lactose, respectively; the interaction was significant ($P < 0.01$). Total numbers of somatic cells secreted per cow daily were not affected by once daily milking treatment in either of the groups.

The protein concentration was significantly increased ($P < 0.001$) by once daily milking in both groups, whereas the fat concentration was increased only in the low SCC group ($P < 0.01$). Once daily milking decreased lactose concentration in both groups but the depression was larger in the high SCC group (interaction $P < 0.001$). The effects of once daily milking on SCC was observed only in the high SCC group where a significant increase in SCC ($P < 0.001$) was recorded (interaction $P < 0.10$).

DISCUSSION

Over the 4 weeks of once daily milking, the daily milk, fat, protein and lactose yields, as expected, decreased significantly relative to the twice daily milked group. The decrease in milk and milk components when cows are milked once a day are similar to those observed in the previous studies (Bryant, 1980; Njaritta, 1989; Carruthers and Copeman, 1990; Morris *et al.*, 1991), but there are variations in the extent of yield depression between studies. The effect of once daily milking on yields was larger for cows with high SCC than for those with low SCC (interaction $P < 0.01$). This suggests that the functional impairment to the secretory cells caused by once daily milking acted multiplicatively with the impairment caused by inflammation, as indicated by high SCC, not simply in additive fashion. Thus, these results suggest that herds of cows with low levels of subclinical infection can be milked once a day in later lactation with small effect on yields compared to herds with high levels of infection.

Changes in the concentrations of fat, protein and lactose follow the trends observed in other studies (Claesson *et al.*, 1959; Wilson, 1965; Bryant, 1980; Holmes *et al.*, 1992). They reflect changes in both the synthetic activity of the secretory epithelial cells and the activity and integrity of the epithelium. These changes are complex but can be explained in terms of the model for milk secretion proposed by Linzell and Peaker (Linzell and Peaker, 1971; Peaker, 1978). Thus a decrease in lactose synthesis will lead directly to a decrease in milk yield. Further reductions in yield would be expected if there are losses of lactose into the interstitium through leaks in the epithelium as a result of either infection or stretching of the epithelium in response to once daily milking. The decreases in lactose concentration, however, are due to an inability of the epithelium to maintain normal sodium and potassium concentrations in the milk. This is exacerbated in the presence of infection plus once daily milking, either because the activity of the epithelial cells is impaired or the movement of sodium into the milk via leaks is in excess of the capacity of the cells to remove it. The slight rise in fat concentration on once daily milking suggests that fat synthesis is less affected than lactose synthesis. In contrast, the interpretation of the changes in protein concentration is complicated by the potential for variation in both the rate of synthesis of those proteins synthesised in the gland and the movement of serum proteins into the milk.

The total somatic cells secreted per cow daily was not affected by once daily milking treatment in either group, contrary to the expectation that once daily milking would increase the total number of somatic cells secreted due to increase in severity of inflammation in cows which were already infected (Mackenzie *et al.*, 1990). Apart from increasing the incidence of infection, once daily milking also increased the severity of infection in the infected group as evident from the occurrence of clinical mastitis in two quarters, but this did not alter the magnitude of somatic cell infiltration into the gland. The observed increase in the concentration of SCC (log SCC/ml) for the once daily milked cows in the high SCC group can be explained by the 'concentration effect' theory since the total number of somatic cells secreted into the milk was not affected by milking frequency, and a larger decrease in milk yield (26%) was recorded in this group relative to the low SCC group (14%).

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