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The effects of milking once daily throughout lactation on the performance of dairy cows grazing on pasture

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ABSTRACT

Two groups of 12 cows were fed and managed identically throughout the whole lactation, except that one group was milked twice daily, whereas the other group was milked only once daily. The cows were aged 3 years and older, and included 6 pairs of identical twins.

Yields of milk, fat and protein were: 4320 and 2810 kg milk; 208 and 144 kg fat; 162 and 110 kg protein for the twice and once daily groups respectively and the differences were significant. However in three pairs of twin cows, once daily cows produced more than 90% of the yield produced by their twice daily twin mates. Lactose concentrations were significantly higher for the twice daily group, 5.05 and 4.82% lactose. Somatic cell counts were significantly lower for the twice daily group throughout lactation, even though there appeared to be no difference in the incidence of infection measured at the end of lactation. The twice daily group lost weight and body condition during lactation, even though they appeared to eat slightly more feed than the once daily group which gained weight and body condition. The twice daily group had lower plasma concentrations of glucose during early lactation than the once daily group, but there were no differences in concentrations of calcium, magnesium or β hydroxybutyrate between the groups.

The results show that although once daily milking does cause significant decreases in yields of milk and its components, some cows were only slightly affected. Selection of tolerant cows, plus appropriate management such as longer lactations and higher stocking rates, may offer a useful method of increasing labour productivity and reducing costs of production.

Keywords Once daily milking, milk yield, milk composition, liveweight change, feed intake, cows.

INTRODUCTION

Cows are generally milked twice daily in New Zealand, a task which dominates life, labour and management on dairy farms. A change to once daily milking, if it was practicable, would therefore affect many aspects of dairyfarming.

The high productivity of labour is an important component of the low costs of production on New Zealand's dairy farms. The productivity of dairyfarm labour has increased dramatically since the 1930s, from about 2400 (in 1930) to 14,700 kg fat per person in 1990 (Holmes & Thomson, 1990). These increases have been associated with changes in milking methods (elimination of hand stripping and stimulation) and in milking sheds (introduction of herringbone sheds and later rotary sheds, with improved yards and gates).

Once daily milking may allow further increases in labour productivity, with consequent decreases in costs of production, provided that the effects on milk solids yield per cow are not too large.

The decreases in milk yield caused by once daily milking for short periods of a lactation have been reported by several authors (Wilson, 1965; Parker, 1966; Bryant, 1980; Morris *et al.*, 1991; Mackenzie *et al.*, 1990). However the effects of once daily milking throughout an entire lactation appear to have been studied in only one experiment in Sweden (Claesson, 1959). Milk yields were reduced by 40 to 50% by once daily milking with wide variation between responses by individual cows.

In one documented report in New Zealand, a predominantly Jersey herd milked once daily since 1986 averaged 132 kg milkfat per cow over four seasons (Harding, 1990).

The present experiment was intended to measure the effects of once daily milking throughout the entire lactation on milk

production, feed intake, udder health and liveweight changes by Jersey and Friesian cows, 3 years and older, grazing on pasture.

MATERIALS AND METHODS

Twenty four cows, aged 3 to 8 years (average 5.3 years) at calving in August 1990, were used in this experiment at the Dairy Cattle Research Unit, Massey University. These included 6 pairs of identical twins (3 Jersey, 1 Jersey x Friesian and 2 Friesians) and 6 pairs of unrelated Friesian cows, paired on the basis of their age and their milk production in the previous lactation. Cows within each pair were allocated at random to one or other of the two treatment groups, once daily or twice daily milking, with the treatments beginning immediately after calving.

All cows were milked at 0700, and the twice daily cows were also milked at 1600; the once daily cows were not brought to the milking shed in the afternoon. Cows in both treatment groups were grazed on the same paddock simultaneously, but on areas separated by an electric fence. Each group received a fresh area of pasture every morning. The yield and composition of milk produced by each cow was measured on one day per week, using Metatron Milk Meters (Westfalia) and a Milko Scan 140A Analyzer (A/S N Foss, Denmark).

The somatic cell count in milk taken from each cow at the morning milking was measured on one day per month, by the Livestock Improvement Corporation, Hamilton, using a Fossomatic Fluoro-optical counter (A/S N Foss, Denmark).

On two consecutive days in March, samples of milk were taken aseptically from each quarter of each cow for bacteriological analyses (Holdaway, 1990). Samples were taken on a third day from seven quarters for which the results on days 1 and 2 were not in agreement.

Liveweight and body condition score (assessed by eye on a scale from 2, very thin to 8, very fat) were recorded monthly for each cow. Herbage mass was measured daily before and after grazing for each treatment group using a rising plate pasture meter. From these measurements, and the area grazed daily, herbage intake was calculated for each group on each day.

During late October, and again in January, each cow was given an intraruminal slow-release chromium capsule (Captec NZ). Faecal samples were collected daily from each cow, in the paddock, over two periods of 5 days beginning 7 days after administration of the capsules.

The faecal samples were analysed to measure the concentration of chromium and daily faecal output was calculated for each cow (Parker, *et al.*, 1989). Samples of herbage were collected each day during the periods of faecal collection, and these were subjected to *in vitro* digestibility analysis. This latter data together with the data for faecal output, were used to calculate daily feed intake by each cow.

Blood samples were taken from the tail vein of each cow on three occasions in August, September and October. The plasma concentrations of β -hydroxybutyrate, glucose, magnesium and calcium were measured, using a Cobas Fara II autoanalyser.

The data were subjected to analyses of variance, with pairs treated as blocks.

RESULTS

The mean values for yields of milk and its main components, and for the concentrations of these components calculated over the whole lactation, are presented in Table 1.

The once daily group produced lower yields of milk, fat, protein and lactose ($P < 0.01$) and the milk contained a lower concentration of lactose ($P < 0.01$). The concentrations of fat and protein were slightly higher in the milk from the once daily group, but these differences were not significant ($P > 0.05$).

The absolute differences in daily yields per cow between the two groups remained relatively constant throughout the whole lactation (approximately 6 l milk, 0.25 kg fat, 0.20 kg protein and 0.30 kg lactose per cow daily). Similarly the differences in milk composition between the two groups remained relatively constant throughout lactation.

TABLE 1 Mean values (\pm SEM), for the whole of lactation, for milk production by cows in the two treatment groups.

	Treatment		SEM	Significance of difference
	Twice daily	Once daily		
Days in milk	253	251		
Yield (kg/cow)				
Milk	4320	2810	± 197	**
Fat	208	144	± 9	**
Protein	162	110	± 7	**
Lactose	217	136	± 10	**
Composition (%)				
Fat	4.93	5.14	± 0.27	NS
Protein	3.79	3.93	± 0.08	NS
Lactose	5.05	4.82	± 0.05	**

* $P < 0.05$ ** $P < 0.01$

The mean values for changes in liveweight and body condition score over the whole lactation are presented in Table 2.

The once daily group gained more weight and body condition than the twice daily group ($P < 0.01$).

TABLE 2 Mean values, for the whole of lactation, for change in liveweight and body condition score by cows in the two treatment groups.

	Treatment		SEM	Significance of difference
	Twice daily	Once daily		
Values measured before calving				
Liveweight	442	437		
Body condition score	4.6	4.7		
Changes measured from before calving to last month of lactation				
Liveweight	-17	+40	±7	**
Body condition score	-0.2	+1.6	±0.3	**

The mean values for dry matter intake measured by the plate meter for each group or by chromic oxide for each cow, are presented in Table 3. The group mean values show slightly larger values for DMI by the twice daily group. The values measured for individual cows in November and January show larger values for DMI by the twice daily group on both occasions. In November 10 cows out of the 24 cows did not retain the chromium capsule, so that faecal output data were available for only 14 cows. In January, all cows retained the capsules, and the difference between the groups was nearly significant ($P < 0.10$).

TABLE 3 Mean values for dry matter intake (kg DM/cow daily) (a) calculated daily for each group using the plate meter (b) calculated in November and January from faecal outputs by each cow.

	Treatment		SEM	Significance of difference
	Twice daily	Once daily		
a)Calculated for the groups using the plate meter				
September to December	15.5	14.4		
January to April	12.9	12.9		
Average	14.2	13.7		
b)Calculated for each cow from faecal outputs				
November	18.1	16.6		
	(8)†	(6)†		
January	12.3	11.3	±0.4	P<0.10
	(12)†	(12)†		

†Numbers of cows for which data were collected successfully.

The mean values for somatic cell count (SCC) in each month are shown in Table 4. The values for the once daily group were higher in every month ($P < 0.05$ or < 0.01). However the bacteriological analyses in March failed to show any consistent difference in the incidence of infected quarters between the two groups. Only two cases of clinical mastitis were recorded during the experiment, both in the once daily group.

DISCUSSION

The yields of milk, fat, protein and lactose produced by the once daily cows were equivalent to 65, 69, 67 and 63% respectively of the yields produced by the twice daily cows. These relative values are higher than the corresponding values reported by Claesson *et al.*, (1959), of about 50 and 60% for cows in their

TABLE 4 Mean values for somatic cell count in milk (\log_{10} cells/ml) taken at the morning milking, for cows in the two treatment groups.

	Treatment		SEM	Significance of difference
	Twice daily	Once daily		
September	4.82	5.20	± 0.11	*
October	4.91	5.31	± 0.11	*
November	4.94	5.56	± 0.10	**
December	4.95	5.50	± 0.09	**
January	5.16	5.64	± 0.11	**
February	5.03	5.63	± 0.12	**
March	5.32	5.89	± 0.10	**

TABLE 5 The number of quarters in three categories, measured in March for cows in the two treatments.

Bacterial category	Treatment	
	Twice daily	Once daily
No bacterial growth	17	17
Major * pathogens	6	6
Other** bacteria	25	25

* *Staphylococcus aureus*
Streptococcus uberis
Streptococcus dysgalactiae

** *Corynebacterium bovis*
Coagulase negative staphylococcus

TABLE 6 Mean values for plasma concentrations of β -hydroxybutyrate, glucose, magnesium and calcium (mmol/litre) on three occasions for cows in the two groups

	Treatment		SEM	Significance of difference
	Twice daily	Once daily		
β -hydroxybutyrate				
31 August	1.64	1.82	0.18	NS
21 September	1.30	0.94	0.15	NS
16 October	0.99	0.97	0.09	NS
Glucose				
31 August	2.55	2.75	0.16	P<0.10
21 September	2.97	3.30	0.22	**
16 October	3.35	3.71	0.07	**
Magnesium				
31 August	0.56	0.57	0.06	NS
21 September	0.71	0.76	0.03	NS
16 October	0.71	0.72	0.03	NS
Calcium				
31 August	2.15	2.25	0.07	NS
21 September	2.24	2.23	0.06	NS
16 October	2.27	2.32	0.03	NS

first or second lactation respectively, a difference which may be partly due to the older ages of the present cows, with none in first lactation.

There was considerable variation between individual twin pairs in their responses to once daily milking. For example, in the three pairs with the highest yields by the twice daily cows (225 kg fat and 180 kg protein), the once daily cows averaged only 51

and 52% of the yields by their twice daily mates. By contrast, in the three pairs with the lowest twice daily yields (178 kg fat and 130 kg protein), the corresponding relative yields by the once daily cows were 95 and 92%. In general for all cows, it seemed that the depression of milk yield by once daily milking was larger in cows which had been given larger yields in the previous lactation. No consistent effect of breed on the response to once daily milking could be detected in this small group of cows.

Wide variation was also reported by Claesson *et al.*, (1959), although in that case the treatment effect was smaller in pairs with higher yields by twice daily cows.

The decrease in lactose concentration in once cows daily is similar to that reported by Claesson *et al.*, 1959. Somatic cell count (SCC) was consistently increased by once daily milking, in agreement with the results of once daily milking in later lactation (Mackenzie *et al.*, 1990). (It should be noted that the SCC was measured at the morning milking for both groups of cows; the SCC at the afternoon milking for the twice daily were slightly (by about 0.2 \log_{10} units) higher than those reported here). SCC was not measured by Claesson *et al.*, (1959), but that study did report increases in the concentrations of whey proteins and chloride in milk from once daily cows which are logically consistent with the present increases in SCC for once daily cows. Nevertheless, in the present study, the incidence of clinical mastitis was low and bacteriological analyses in March indicated that the increases in SCC were not due to increased bacterial infection, because there were no differences between the groups in incidence of infection. The increases in SCC must have been due to the effects of physical and/or physiological conditions in the secretory tissue caused by once daily milking.

The metabolizable energy eaten by each group was estimated from their average yields of milkfat, liveweights and changes in liveweight. These calculations indicated that the twice daily cows should have eaten about 15 MJ ME (or 1.4 kg DM) per day more than the once daily cows. Differences of this magnitude were recorded in November and January by the faecal output method, but not by the plate meter over the whole of lactation. The increase in weight gain, and the small decrease in food intake by once daily cows suggest that in practise higher stocking rates could be used with once daily milking.

Once daily milking caused large decreases in milk yield, and some changes in milk composition which may be important for manufacturing properties. It also caused increases in liveweight gain, and small decreases in feed intake.

It is likely that genetic variation in tolerance of once daily milking exists in the present national herd, although this tolerance may be correlated with absolute milk yield. Factors which may be associated with this tolerance were discussed by Morris *et al.*, (1991).

Appropriate management, for example a higher stocking rate and longer lactations, and selection for tolerant cows might combine to make once daily milking an attractive component of low cost systems which will achieve relatively high yields per hectare in the future.

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