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INCREASING MILK PRODUCTION IN COWS DEPENDING ON THE NUMBER OF MILKINGS PER DAY

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Abstract

The herd of Holstein cows, either daughters of cows inseminated with semen from non-pedigree bulls (control group) or daughters of pedigree bulls (experimental group), were randomly selected to be milked twice or three times a day. Amount of dry matter (DM), live weight (BW), milk production yield (FCM), milk fat content (FM) were recorded for two lactations. In general, cows in the experimental group produced more milk (P<.0l) than those in the control group and cows milked 3 times a day produced more milk than those milked 2 times a day (P<.0l). Actual milk production was greater (P<.0l) for both groups during the second lactation than during the first lactation. However, the average increase in FCM yield from the first to the second lactation was only about 12% for cows milked twice and 5% for cows milked 3 times. The experimental group of cows gave approximately 25% - 30% more milk during the first and second lactations than the control group cows. Dry matter consumed, regardless of body weight or milk fat percentage, was increased in the experimental group for milk yield. Milk production per DM unit was higher for cows in the experimental group than for the control group at 30, 90 and 200 days postpartum (DPP).

Milking three times a day increased the total milk yield by 14% and 6% during the first and second lactation, respectively.

Key words* : selection, milking frequency , dry matter intake (DMI), fat corrected milk (FCM) *purslane, photosynthesis, transpiration, stomatal conductance

INTRODUCTION

Continuous increases in operating costs and falling milk prices are constantly forcing dairy producers to increase production per unit of production. Increasing milking frequency from twice (2x) to three times (3x) per day (1, 2, 3, 6, 8, 10, 14) and selecting high-quality sires to produce successive generations of females (7, 9, 10, 11, 15, 16) are practices to increase milk yield or total milk efficiency (kilograms of 4% FCM per kilogram of DMI) in dairy cattle.

Milking three times a day has been shown to increase milk yield and yield in Holstein cows (1, 2, 6, 8, 14). This management practice to increase milk production is associated with a highly variable response, ranging from 6% to 25%, and may not be economical for all herds (6). The response to milk production through selection is more uniform and permanent (3, 9, 10, 11, 12, 15, 16), but results are much more difficult to achieve.

Various information is available regarding the response of dairy cattle to these management practices to establish a complete ration for all cattle for ad libitum consumption , as would be typical for commercial dairy production.

This study was designed to determine the potential contributions of these management actions and their interaction in increasing the efficiency and yield of milk

production in dairy cattle herds over multiple lactations.

MATERIALS AND METHODS

One hundred primiparous Holstein cows raised at SC Fenov SRL Dolj, were randomly selected to be milked 2x (04 ^{00} and 15 ^{00} h) or three times (06 ^{30} , 16 ^{00} and 23 ^{30} h) daily, for two lactations starting from calving. The milking intervals were optimal to adapt to the established work schedules. The animals were either daughters of sires selected for artificial insemination (with milk production, milk PO. =398 kg; selection group) or daughters of the fourth to fifth generation cows bred randomly from unselected bulls, originating from the farm herd (control group; estimated mean of the basic sire milk PO. = - 467 kg). Thus, the estimated genetic average as a difference in the ability to transmit traits for the two groups of bulls used to sire these cows was 865 kg of milk . The cattle were housed in open, free-stall barns and milked in a milking parlor. All animals were group-fed the same complete mixed diet (combined silage, hay and concentrate feed) with ad libitum access throughout all stages of lactation. The ration was delivered in strips twice daily using a technology trailer. Feed intake data were recorded for 10-day periods centered at 30, 90, and 200 days postpartum (DPP) using an electronic feed monitoring device, and DMI for these periods was calculated individually for each cow.

The cows' rations during the study averaged 48.8% DM, 15.9% CP, 10.9% digestible protein and 1.65 Mcal NEVkg based on DM. Daily milk yields were recorded biweekly BW. Milk fat test data were determined in our own laboratory and at DSVSA Dolj. Cows were observed twice daily for estrus during travel to and from the milking parlor. Cows were inseminated for the first time at the first detected estrus. Insemination was performed by one of two trained insemination operators. Data were collected during the first and second lactations.

Table 1. Distribution of animals within the experiment

Lactation	Daily frequency of milking	Genetic group		
		choose	Control	Total
First	2	33	18	51
	3	31	18	49
Total		64	36	100
Used	2	28	14	42
	3	24	17	41
Total		52	31	83

The distribution of cows within the experimental design is shown in Table 1. The data were analyzed by analysis of variance using the general linear models procedure of statistical analysis. The model took into account the genetic selection group, milking frequency, lactation stage, lactation number, all possible interactions, cow within genetic selection group x milking subclass frequency and error.

RESULTS AND DISCUSSIONS

Table 2 shows lactation yields and 4% FCM yields for selection and control cows milked two or three times per day, over all lactation records longer than 200 days (DIM). In general , cows in the experimental group produced more milk (P<.01) than their counterparts in the control group, and cows milked three times per day produced more than those milked twice per day (P<.01). Actual milk production was higher (P<.01) for both groups during the second lactation than during the first lactation.

In general , cows in the experimental group produced more milk (P<01) than their counterparts in the control group and cows milked 3 times a day produced more than those milked 2x a day (P<01).

TABLE 2. Lactation yields and 4% FCM yields for selection and control cows milked twice or thrice daily.

Lactation	Daily frequency of milking	Genetic group							
		choose				Control			
		Total milk [2]	% fat [3]	Total fat [4]	FCM [2]	Total milk [2]	% fat [3]	Total fat [4]	FCM [2]
First	2	6952.7	3.6	250.3	6535.6	5143.2	3.7	190.3	4911.8
	3	7364.0	3.6	265.1	6435.8	6435.8	3.5	225.0	5949.3
Used	2	7845.5	3.7	290.3	7492.7	5571.8	3.7	206.2	5321.4
	3	7921.4	3.5	277.2	7326.6	6619.1	3.5	231.6	6121.6

[2] Cows in the selection group are larger than control cows (P<.01), milking three times a day is larger than milking twice a day (P<0l), second lactation is larger than first lactation (P<.01), genetic group x milking frequency (P<.05), genetic group x lactation number (P<.05).
[3] Milking twice a day is greater than milking three times a day (P<.05).
[4] Selection cows are larger than control cows (P<.01)

Actual milk production was higher (P<.01) for both groups during the second lactation than during the first lactation. However, the average increase in FCM yield from the first to the second lactation was only about 12% for cows milked twice and 5% for cows milked three times. The experimental group of cows gave about 10% more FCM in the second lactation than the first and the experimental group gave about 10% more FCM in the third lactation than the first. control yields increased by only 5% . Cows in the experimental group produced 25 and 30% more milk than cows in the control group during the first and second lactations, respectively. In the experimental group, the interaction of group x lactation number (P<.05) resulted from the increase in milk production during the second lactation, which was greater for the experimental group than for the control group.

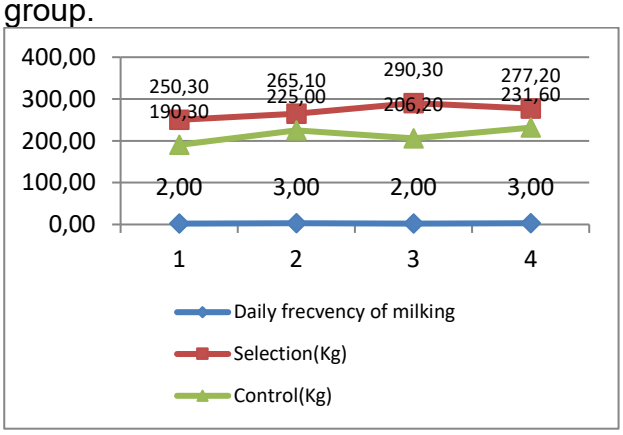

Figure 1 Total fat for selection and control cows milked twice or thrice daily

Milking 3 times daily increased FCM yield by 14 and 6% during the first and second lactations, respectively. A genetic group x milk frequency interaction (P<.05) resulted because control cows had a greater response to 3x daily milking than cows in the experimental group. Milking 3 times daily increased yield by 21 and 15%, respectively, in the first and second lactations in control cows. However, milking 3 times daily only increased yield by 6% in the first lactation in experimental cows and not at all during the second lactation, suggesting that the energy content of the diet was inadequate to support higher milk production.

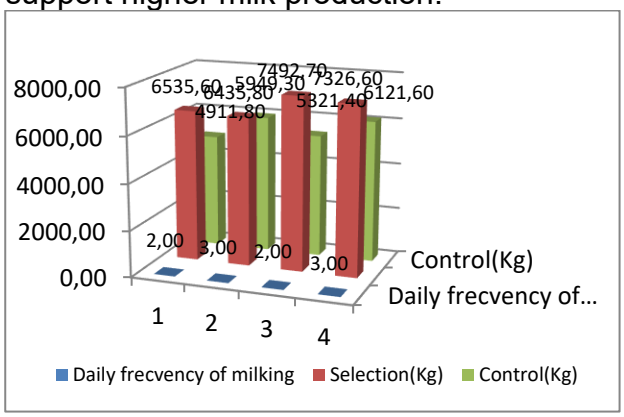

Figure 2 Fat corrected milk (FCM) for selection and control cows milked twice or thrice daily

Table 3 shows the extended 305-day yields for both treatment groups for two lactations. Total milk production, milk. Fat , and FCM milk were higher (P<.01) for selection cows than for controls and for those milked 3x than for those milked 2x (P<.01). Selection for milk production increased.

The 305-d FCM yield increased by 25 and 30%, respectively, during the first and second milkings 3 times per day, increasing the projected yields by 13 and 8%, respectively. Similarly, the 305-d FCM and milk fat yield increased (P<01) from

the first to the second lactation. The interaction of group x milking frequency (P<01) indicated that control cows responded with a greater increase in standardized yield to milking 3 times per day than did selection cows. Control cows milked 3 times per day produced 22 and 17% more milk during the first and second lactations than cows milked 2 times per day. Selection cows produced only 6% more milk during the first lactation and had no increase during the second lactation in response to milking 3 times per day. It is well established that selection for a single trait for milk production results in increases in yields on multiple levels (9, 10, 11, 12, 15, 16). Recent studies of the effects of milking three times daily have reported increases ranging from 6% to more than 25% (1, 2, 6, 8, 14). In studies of the response to milking three times daily in primiparous cows, increases of 6% (8), 19% (1), and 25% (2) have been reported. Thus, the dramatic response of the control cows and the relatively poor response of the selection cows in the present study during the first lactation are well within these previous reports. The results indicate that milking three times a day alone did not provide a sufficient stimulus to uniformly increase milk production for all animals in this study and indicate that this response to this practice is strongly dependent on the level of herd management on the farm. One factor that may have caused the response to be lower than those reported in other studies was that milking intervals were slightly less than optimal.

The more favorable response of the control cows to the increased milking frequency may have resulted from two causes. First, the milk production of the control cows was sufficiently low that the diet provided the additional nutrients needed to increase milk synthesis under the stimulus of 3 times daily milking. Conversely, the higher yielding cows in the selection group did not have a sufficient increase in DMI to satisfy the higher energy requirement.

Second, (15) reported that control cows in a similar experimental design had lower udder capacity, and the udders of selection cows were more pliable, suggesting that there are differences in the proportion of mammary parenchymal tissue between the two genetic groups. Thus, it is possible that udder conformation and control capacity in the cows in the present study group was a limiting factor in achieving higher yields, and the additional reduction in intramammary pressure associated with 3x daily milking may have provided an increased premise for milk synthesis.

The mean percentage of milk fat was higher (P<.05) for cows milked twice a day than three times a day (3.68 % vs. 3.53%), but was not affected by selection for milk production. The mean percentage of fat remained unchanged between the first and second lactations . Actual milk fat production was higher (P<.01) in the selection cows than in the controls but was not significantly affected by milking three times a day.

Milk fat production increased (P<0.01) from the beginning to the second lactation. The fact that milking 3 times a day decreases milk fat percentage is also evidenced in other studies where milk fat was reduced by approximately .1% in cows milked 3 times (1, 14). Other authors (2, 8) did not detect any decrease in milk fat associated with milking 3 times a day. In the present study, the increase in milk production in response to milking 3 times compensated for the reduction in milk fat percentage, and there was no difference in total fat yield between cows milked 2 times a day and cows milked 3 times a day.

Mean BW was not significantly different between genetic groups, but they did differ (P<01) by week of lactation and by number of milkings. The mean changes in BW in cows milked 2 or 3 times for both lactations mean that BW was not significantly affected by milking frequency, although cows milked 3 times per day tended to be lighter than those milked 2 times per day during both lactations.

Table 3 Standardized lactation (305 d) yields [1] and 4% FCM yields for selection and control cows milked twice and thrice daily.

Lactation	Daily frequency of milking	Genetic group					
		choose			Control		
		Total 305 d milk [2]	Total fat [2]	FCM [2]	Total 305 d milk [2]	Total fat [2]	FCM [2]
First	2	7036.8	2533	6614.2	5220.5	193.2	4986.2
	3	7482.3	269.4	7033.9	6521.8	228.2	6031.7
Used	2	7940.9	293.8	7583.4	5625.0	208.1	5371.9
	3	8146.4	285.1	7535.1	6818.6	238.7	6307.9

[1] Least squares means.
[2] Selection cows are larger than control cows (P<.01), twice daily milking = ug is larger than twice daily milking (P<.01), second lactation is larger than first lactation (P<.01), genetic group x milking frequency (p<.01).

Mean BW differed (P<.01) by lactation week and lactation number in both groups. Mean DM was higher (P<.01) in the selection cows than in the control but was not affected by milking frequency. Mean DMI was different (P<.0I) between the three lactation stages, was highest at 90 DPP during both lactations, and was also higher (P<.0I) during the second lactation than in the first lactation.

Overall, absolute ratios of kilograms of FCM per kilogram of DMI were higher (P<.05) for the selection cows than for the control cows. Also, a milking frequency x lactation number interaction (P<.05) indicated higher milk yield per kilogram of DMI in cows milked 3 times compared with cows milked 2 times per day, in the first lactation, but not in the second lactation. Selection cows had calculated yield ratios that were approximately 9% higher than those for the control cows during both the first and second milkings. Cows milked 3 times per day had efficiency approximately 14% higher than cows milked 2 times per day during the first lactation, but there was no difference during the second lactation.

Selection for milk resulted in increases in milk production that persisted throughout both lactations and actually increased during the second lactation. Because cows were group-fed the same complete ration, differences in yield must be attributed to increases in DMI. A previous study (7) showed that cows with high genetic capacity for milk differed only in the gross energy content of the diet and not in the utilization of the component forages. Those authors (7) suggested that the increased milk yield associated with selection is based on the somatotropin-controlled tissue balance system (ST) and other endocrine mechanisms that regulate catabolism and the availability of metabolites for milk synthesis. This is an attractive hypothesis, as a subpopulation of selected cows in this study had increased ST compared with that of control cows, but ST was not altered by 3x milking (10). This phenomenon may explain why selected cows had high gross efficiencies and were able to sustain this efficient increase during both lactations.

Despite the higher DMI, the selection cows in the present study were much more efficient in the ratio of milk production to DMI. The experimental group consumed approximately 10% more DM, but produced between 25 and 30% more milk than the control cows, over two lactations. Dry matter intake was not affected by milking frequency, in agreement with previous reports (2, 8, 10).

These authors suggest that milk production increased and milk yield is due only as long as tissue reserves are able to subsidize the nutrients needed for milk production.

TABLE 4. Measures of reproductive efficiency for selection and control cows milked twice or thrice daily.

Lactation	Daily frequency of milking	Genetic group					
		choose			Control		
		Days to first AI	Open Days [2]	Conception rate [2]	Days to first AI	Open Days [2]	Conception rate [2]
First	2	73	100	2.2	74	98	2.0
	3	71	108	2.3	72	99	2.2
Used	2	70	103	2.2	71	101	2.2
	3	66	107	2.2	68	105	2.2

[2] For cows that remain pregnant.

The limited response of selection cows milked 3 times a day in this single herd study would seem to indicate that the added stimulus of increased milking frequency was not sufficient to elicit a pronounced milk yield response in cattle already approaching maximum efficiency for the level of nutrient intake ration.

Table 4 presents the reproductive performance measures in both treatment groups during both lactations. Neither milk production selection nor increased milking frequency modified days to first estrus, inseminations per gestation, or days of service period. Performance in cattle has also been studied (9) and no negative effects on labor or the costs required to maintain efficient reproduction have been reported. Milking 3 times per day had no effect on reproductive efficiency in this study or others (2, 8). However, (1) indicated that milking 3x was associated with longer periods of fertility in first lactation cows and a higher number of reproductions per conception in the second lactation, in cows from the same herd.

CONCLUSIONS

The results of this study indicate that both the management practices followed, selection and increased milking frequency, milk production increased , yield and production efficiency being without loss of efficiency and reproductive function. In comparison, selection cows had higher milk yield , a recommendable alternative for increasing yield and efficiency of milk production on farms. It is important to point out that it was found that these conclusions are based on results obtained in a single batch and may not have direct application to all dairy cow breeding management systems.

However, the continued use of high-genetic sires is accompanied by physiological changes in the regulation of metabolism in cattle, which favors the loss of adipose tissue for a higher milk fat yield and, thus, the ability of these cattle to continue to be efficient producers and transmit these superior performance traits to subsequent generations cannot be sustained.

The more efficient selection group responded positively to increased milking frequency during one lactation, but was unable to maintain the response for a second lactation under the group feeding regime used in this study. These results indicate the importance of grouping cows into productive groups. The more performing animals are, with higher milk yields, then feeding should be done according to the level of production, because when challenged by management practices to obtain higher production, these individuals may sometimes not respond. This is because individuals plus variants will not be able to fully compensate for the eventual inadequate ration in terms of the amount of dry matter in it - DMI.

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