Milking Frequency Effects in Early Lactation

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Take Home Messages:

- As little as 21 days of 4X milking early in lactation can increase yield throughout lactation.
- Prolactin increases at milking may be the mechanism to enhance mammary cell growth and thus milk yield
- Frequent milking early in lactation can improve yields throughout that lactation with little additional cost.

Introduction

Increasing the frequency of milk removal increases milk production in cattle as it does in many species (Pearson et al., 1979). Indeed, this is a common management approach to maximize production per cow and fully optimize capital investment in machinery and facilities. One obvious drawback is the increase in variable costs, mainly labor, required to reap the higher yield of milk. Traditionally, this technique has been employed throughout lactation, but recent evidence suggests that frequent milking appropriately timed within the lactation cycle can have persistent effects, and thus eliminate some of the higher costs while maintaining higher yields. This paper reviews the physiology behind the response, expected outcomes from increased milking frequency, and proposes easily adopted strategies to exploit frequent milking during early lactation to improve overall yields.

Increasing the number of milkings from 2 (2X) to 3 (3X) each day increases production in cattle across a range of production levels (Erdman and Varner, 1995). It is of interest that this appears to be a fixed response. That is, cows producing 20 kg/day when milked 2X will increase production about 3.5 kg/day when shifted to 3X; cows producing 40 kg/day would also increase production by 3.5 kg/day. So management decisions based on percentages can be deceiving, as the absolute response is not very different across production levels yet the percentage response actually decreases as average milk yield increases!

Research on Milking Frequency in Early Lactation

Israeli workers (Bar-Peled et al., 1995) observed higher production in cows milked 6X relative to 3X during the time that milking frequency was increased (Table 1). However, there was a striking persistency of the production response following a return to 3X from 6X. Cows milked 6X for the first 42 days of lactation continued to yield more milk even after milking frequency was reduced to 3X. Milk composition, though somewhat low, was not different between groups. Relative to those milked 3X, dry matter intake was increased in 6X cows. Cows milked 6X experienced a longer delay in return to positive energy balance and a longer time at a body condition score below 2.5 than those cows milked 3X. Collectively, cows milked 6X for only the first 6 weeks in milk had greater milk yield and feed efficiency for the entire lactation when compared with those milked 3X.

Table 1. Daily milk, components and lactation yield of cows milked 3X or 6X for the first 42 days of lactation and then 3X for the remainder of 305 day lactation. Daily yields were recorded during treatment (week 1-6) and after treatment for 12 weeks (week 7-18). Complete lactation records were from DHI testing (305 d). Data from Bar-Peled et al., 1995.

	3X	6X
Milk, week 1-6, kg	35.2	42.6[a]
Fat %, week 1-6	3.28	3.16
Protein %, week 1-6	3.13	3.07
Milk, week 7-18, kg	37.4	42.5[a]
Fat %, week 7-18	2.80	2.81
Protein, week 7-18	2.76	2.79
Milk, 305 d, kg	8,790	10,476[a]

[a]Significantly greater than 3X controls, P<.05

A recent experiment in Maryland confirmed under field conditions that milking cows 6X in early lactation produced persistent improvements in milk yield even after cows returned to 3X (Henshaw et al., 2000). For the first 42 days of lactation, cows were milked 3X at 8 hr intervals or 6X at approximately 4-5 hr intervals. After d 42 all cows were milked 3X for the rest of the study which lasted through 38 weeks of lactation. Relative to those milked 3X, multiparous cows milked 6X produced more milk throughout the study. On a percentage basis, milkfat was unaffected by treatment whereas milk protein was lower; protein and fat yield, however, were improved overall by 6X treatment. In addition, there was no adverse effect on reproduction as conception rate to the first synchronized ovulation was not different between groups.

Table 2. Milk, components and conception rate of cows milked 6X or 3X for the first 42 days of lactation. Data from Henshaw et al., 2000.

Treatment	Milk (kg/d)	Fat (%)	Protein (%)	Conception Rate (%)[a]
3X	38.2	3.87	2.98	23.3
6X	41.0[b]	3.92	2.87[c]	31.0

[a]Results from synchronized breeding at 69 to 76 days in milk.
[b]Significantly greater than 3X controls, P<.01.
[c]Significantly lower than 3X controls, P<.05.

In a recent field study, we found that as little as 21 days of higher frequency milking was enough to produce the persistent effect on later lactation milk yield (Table 3). Normally, cows were milked 3X at this farm. At calving cows were randomly assigned to 6X milking frequency for the first 21 days of lactation, and then returned to the 3X frequency of herd mates. Based on evaluation of DHI records, cows milked 6X had greater summit yields of milk, peak milk yield, and produced over 1,000 kg more milk for the actual 305 day lactation. Of perhaps greater interest was the effect on somatic cell counts in the cows milked 6X. Higher frequency milking was associated with a persistent decrease in somatic cell counts relative to those of cows milked 3X. Therefore, not only was production enhanced by 6X milking for 21 days, but udder health was also improved.

From a practical standpoint then, the question arises as to the impact of 4X frequency relative to a typical 2X scheme. Here again, we have found that 4X milking improves production relative to 2X (Dahl et al. 2002). Cows on 4X consumed more dry matter than 2X cows, but this was not a significant effect, although relatively small animal numbers may have limited the ability to detect significant responses. Our data is consistent with a preliminary report by Hale et al. (2002; Table 4) that indicated cows milked 4X for 21 days gave more milk than those on 2X. In addition, Hale et al. (2002) reported that the higher frequency milking could be delayed until day 4 of lactation and a positive milk yield response was still observed compared with 2X cows.

Table 3. Milk, components and conception rate of cows milked 6X or 3X for the first 21 days of lactation. Data summarized from DHI records.

Treatment	Summit Milk (kg)	Peak Milk (kg)	305 Day Yield (kg)	Lactation Average *SCS
3X	46.7	51.1	12,255	3.12
6X	55.1[a]	57.0[b]	13,373[c]	2.31[d]

[a,b,c]Significantly greater than 3X controls, P<.02, .07, and .08, respectively.
[d]Significantly lower than 3X controls, P<.13.
*Linear Somatic Cell Score

Table 4. Milk production of cows milked 2X, 4X from day 1 (4X – d1) or 4X from day 4 (4x – d4) for the first 21 days of lactation. Values represent average production of 10 cows during (d 1 – 21) and after (d 22- 280) treatment. Data from Hale et al. (2002).

	2X	4X – d1	4X – d4
Milk, kg/d, day 1-21	33.7	42.3[a]	38.3[a]
Milk, kg/d, day 22-280	36.1	39.0[b]	38.8[b]

[a]Significantly greater than 2X controls, P<.02.
[b]Significantly greater than 2X controls, P<.04.

▪ Physiology Behind the Response

There are two physiologic explanations for the impact of frequent milk removal on production (Stelwagen, 2001). The first is the potential physical effect of increasing intramammary (IM) pressure to reduce the rate of milk synthesis within mammary epithelial cells. The IM pressure hypothesis suggests that physical forces of milk accumulating within the alveoli causes a compression of the secretory cell and this in turn reduces cellular metabolism and milk component synthesis. Indeed, the milk synthesis rates are fastest immediately after milking and decline with time to about 36 hours when secretion essentially stops. More recently a hormone-like factor, secreted by mammary epithelial cells, has been implicated as a suppressor of milk synthesis. This feedback inhibitor of lactation (FIL) acts in a self-limiting fashion to reduce milk synthesis. As milk accumulates in the gland between milkings, so does FIL accumulate, and thus it increasingly suppresses milk component production by the very cells that secrete it. Both IM pressure and FIL would be reduced by more frequent milking, and increases in milk yield would result relative to less frequent milking. However, these mechanisms may not be responsible for the impact of frequent milking during early lactation, as those responses persist in the absence of continued high frequency milk removal.

A more general response to milking frequency is the effect on secretion of prolactin. Circulating concentrations of prolactin increase acutely after each milking. Evidence from our work with photoperiod, another factor that can be used to manipulate prolactin, suggests that an increase in prolactin early in lactation may increase the number of secretory cells within the mammary gland for that lactation (Dahl et al., 2001). It appears that mammary cell growth reaches a peak in late pregnancy but continues into the first few weeks of lactation. Because milk production is a function of the number of mammary secretory cells (Capuco et al., 2001), starting lactation with a greater number of secretory cells should increase yield. More importantly, this increase would be expected to persist because cell loss is a constant throughout lactation. Prolactin is thought to have a stimulatory effect on mammary cell development, and the higher prolactin in response to more frequent milking early in lactation may thus explain the persistent effect of this practice on yield.

Table 5. Predicted milk response and potential economic benefit ($CDN) derived from milking all cows 4X for the first 21 days of lactation in a 120 cow herd.

Response	1.5 kg	2.3 kg	3.0 kg
Quota[a]	$.35	$.53	$.69
Labor[b]	.17	.17	.17
Feed[c]	.14	.22	.29
Supplies[d]	.08	.08	.08
Milk revenue[e]	.87	1.33	1.74
Marginal profit/cow[f]	.13	.33	.51
Marginal profit/farm[g]	$4,758	$12,078	$18,666

[a]Cost of additional quota.
[b]Labor cost of $C10/hour; 4 hours/cow/lactation.
[c]Dry matter at $.19/kg; 0.5 kg DM for each kg of milk increase.
[d]Cost for supplies for an extra 42 milkings distributed over entire 305 day lactation.
[e]Milk at $0.58/kg.
[f]Estimate is for each day of a typical 305 day lactation.
[g]Calculated from profit/cow for 305 day lactation for 120 cow herd.

▪ Management Suggestions

Increasing the frequency of milking early in lactation is simple to implement. In a 2X or 3X scheme, fresh cows can be milked first and last at each milking to achieve either a 4X or 6X frequency. While this may not yield exact 6 or 4 hour intervals between each milking, it is likely to provide appropriate stimulation such the persistent increases in milk production are observed. Shorter intervals between milkings, however, may require a longer lag until milking unit attachment. Bruckmaier and Hilger (2001) reported that milk ejection efficiency was inversely related to elapsed time since the previous milking. Preparation routine times must therefore be lengthened when the time since the last milking is reduced, in order to optimize milk ejection.

The question then becomes one of duration – that is, how long should the producer milk at increased frequency? Evidence from recent experiments suggests that the increased frequency need only be imposed for the first 21 days of lactation. For example, if typically cows are milked 2X at 12 hr intervals, then fresh cows only could be milked at the beginning and end of each milking. In a herd of 120 milking cows, estimate that 10 cows would calve each month, so at any time 7-8 cows would be milked 4X. This would not require any additional labor to be hired, yet the research indicates that an amount of production close to continuous 3X milking can be achieved. Table 5 presents expected returns on adopting early lactation frequent milking in a typical 120 cow herd. Assuming a 2.3 L/cow/day response yields an additional potential profit of $CDN 100.65/cow with a milk price of $CDN 0.58/kg.

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