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Temporary alterations to postpartum milking frequency affect whole-lactation milk production and the energy status of pasture-grazed dairy cows

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ABSTRACT

This study investigated the immediate and long-term effects of temporary alterations to postpartum milking frequency (MF) on milk production, body condition score (BCS), and indicators of energy status in pasture-grazed cows supplemented with concentrates. Multiparous Holstein-Friesian cows (n = 150) were randomly assigned to 1 of 5 groups at calving: milked twice daily (2×) throughout lactation (control), or milked either once daily (1×) or 3 times daily (3×) for 3 or 6 wk immediately postpartum, and then 2× for the remainder of lactation. During wk 1 to 3 postpartum, cows milked 1× produced 15% less milk and 17% less energy-corrected milk (ECM) than cows milked 2×. This immediate production loss increased to 20% less milk and 22% less ECM during wk 4 to 6 postpartum for cows that remained on 1× milking; these animals also produced less than 1× cows switched to 2× milking after 3 wk. During wk 8 to 32, when all cows were milked 2×, those previously milked 1× had sustained reductions in milk (−6%) and ECM (−8%) yields, which were not affected by the duration of reduced postpartum MF. In contrast, cows milked 3× postpartum had 7% greater milk yields during wk 1 to 6 compared with 2× controls, irrespective of the duration of increased MF. Milk yields also remained numerically greater (+5%) during wk 8 to 32 in cows previously milked 3×. Nevertheless, yields of ECM were not increased by 3× milking, because of lower milk fat and protein contents that persisted for the rest of lactation. In addition, indicators of cow energy status reflected an increasing state of negative energy balance with increasing MF. Cows milked 1× postpartum had greater plasma glucose and lower plasma nonesterified fatty acid concentrations during the reduced MF, and plasma glucose remained lower for 2 wk after cows had switched to 2× milking. Moreover, BCS was improved relative to 2× controls from wk 5 to 6. In contrast, cows milked 3× had lower plasma glucose concentrations, greater plasma nonesterified fatty acid concentrations, and greater BCS loss during wk 1 to 3; however, greater body fat mobilization was not sustained, indicating that additional energy supplements may be required to achieve better milk production responses. In conclusion, temporary 1× milking had lactation-long negative effects on milk and milk component yields but improved cow energy status and BCS, whereas temporary 3× milking immediately increased milk yield but did not improve milk fat and protein yields in pasture-grazed cows.
Key words: milking frequency, early lactation, dairy cow, energy status

INTRODUCTION

Substantial evidence exists that the milking frequency (**MF**) of dairy cows can be strategically manipulated to improve milk production efficiency. Many studies (e.g., Bar-Peled et al., 1995; Hale et al., 2003; Dahl et al., 2004) have demonstrated that a short period of frequent milking (3 or more times daily) during early lactation stimulated a persistent increase in milk production for the remainder of lactation. Furthermore, as little as 14 d of increased MF during the first 3 wk postpartum generated a long-lasting increase in milk production in a half-udder experiment (Wall and McFadden, 2007). These results indicate that a short-term increase in postpartum MF could be used by dairy producers to improve whole-lactation yields.

Although the majority of research has been conducted using high-yielding cows fed TMR (Bar-Peled et al., 1995; Hale et al., 2003; Dahl et al., 2004), 3-times-daily (**3×**) milking during early lactation may also result in a sustained increase in milk production in cows grazing pasture, provided nutrition is not limiting (Phillips et al., 1980). Kolver and Muller (1998) identified DMI as the major factor limiting milk production in grazing cows; however, the prudent use of concentrate supplements (Roche et al., 2006, 2013) might facilitate the increase in DMI needed to capitalize on this putative benefit of short-term 3× milking.

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Conversely, decreasing MF to once daily (**1×**) during early lactation is of interest to dairy producers seeking to capture labor and lifestyle benefits (Stelwagen et al., 2013); this is particularly true in pasture-based systems, where seasonal calving causes a rapid influx of fresh cows, putting pressure on feed resources, staff, and cow management processes. The disadvantage of milking cows 1× is that it decreases milk production (Davis et al., 1999; Rémond and Pomiès, 2005; Stelwagen et al., 2013), although evidence exists of a consequent improvement in energy balance (McNamara et al., 2008; Loiselle et al., 2009; Schlamberger et al., 2010). Furthermore, 1× milking for a short period (6 wk or less) after calving reduces subsequent milk production in housed dairy cows (Rémond et al., 1999; McNamara et al., 2008; Schlamberger et al., 2010), consistent with the positive association between increased MF and production (Wall and McFadden, 2008; 2012). The duration of 1× milking that minimizes the negative carryover effect on milk production is not clear. Loiselle et al. (2009) reported that milking 1× for 1 wk postpartum caused a long-term reduction in milk yield, but in other studies (Rémond et al., 1999; Rémond et al., 2002) no significant carryover loss occurred following 3 wk of 1× milking. Characterization of this duration effect is required to develop strategies that maximize the benefits of 1× milking (e.g., improved energy balance and labor productivity), while minimizing the loss of milk production and revenue.

This study tested the hypothesis that temporarily decreasing the postpartum MF of grazing dairy cows would decrease immediate and subsequent milk production but improve energy status, whereas increasing MF would have the opposite effect. Furthermore, it was hypothesized that these effects would depend upon the duration of altered postpartum MF. Therefore, the immediate and long-term effects of altered MF (1× or 3× milking) for 3 or 6 wk postpartum on milk production, plasma hormones and metabolites, BCS, BW, and fertility were determined in grazing cows supplemented with concentrates.

MATERIALS AND METHODS

This study was conducted at the DairyNZ Lye Farm (Hamilton, New Zealand; 37°46′S, 175°18′S) from June 2009 to May 2010. All procedures had prior approval (RAEC 11812) of the Ruakura Animal Ethics Committee (Hamilton, New Zealand).

Experimental Design and Treatments

One hundred fifty multiparous Holstein-Friesian (n = 106) and Holstein-Friesian × Jersey crossbred (n = 44) cows were randomly assigned to 1 of 5 treatments at calving (mean ± SD; July 15, 2009 ± 10.6 d). Treatments were milked twice daily (**2×**) for the entire lactation (control; n = 30 cows), milked 1× for either 3 or 6 wk immediately postpartum and 2× thereafter (n = 30 cows each), or milked 3× for either 3 or 6 wk immediately postpartum and 2× thereafter (n = 28 and 32 cows, respectively). Daily milking times were 0700 h for 1× milking (24-h interval), 0700 and 1500 h for 2× milking (16/8-h interval), and 0700, 1500, and 2200 h for 3× milking (9/8/7-h interval). All cows were milked 2× after wk 6 postpartum and were individually dried-off when milk yields dropped below 5 kg milk/d for 2 consecutive wk, with a final dry-off date of May 14, 2010.

Grazing Management and Supplementary Feeding

All cows were offered a generous allowance of perennial ryegrass/white clover pasture (~30 to 45 kg DM/cow per day to ground level) throughout the study. From 2 wk before their predicted calving date, cows were also offered 2 kg of DM/cow per day of a pelleted maize/barley/molasses-based concentrate in one feed at 0900 h. Following calving, cows were individually offered 4 kg of DM/d of the same concentrate during the a.m. milking until November 1, 2009 (i.e., ~109 DIM), and 2 kg of DM/d thereafter, until November 24, 2009.

Cows milked 1×, 2×, or 3× were grazed in the same paddock (defined grazing area) and separated by double-stranded electric fences so that they could be drafted independently to the farm dairy for milking. Cows in 1× or 3× milking treatments were moved into the 2× milking herd after completing their 3- or 6-wk period of decreased or increased postpartum MF, respectively, and grazed together for the remainder of the experiment.

Cows were rotationally grazed and had access to a fresh allocation of pasture daily as described by Roche et al. (2002). Briefly, cows had access to 50 paddocks of 1 ha/paddock and these paddocks were grazed in a rotational order. As a result, cows only returned to the same grazing area when a minimum of 2 leaves had regrown on the majority (>66%) of perennial ryegrass (*Lolium perenne* L.) tillers.

Pre- and postgrazing pasture mass was estimated on 3 d each week from June to November 2009 (i.e., from 1 mo before the planned start of calving to mid lactation) and 1 d each week thereafter, using a Rising Plate Meter installed with an electronic counter (Farmworks Ltd., Palmerston North, New Zealand) calibrated as described by Roche et al. (2005). Briefly, pasture samples (n = 15–20) were cut to ground level within rectangular quadrats (0.125 m^2) placed randomly within pasture

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