



Effect of frequency of feed delivery on the behavior and productivity of lactating dairy cows

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ABSTRACT

The objective of this study was to determine the effect of feed delivery frequency on the behavioral patterns and productivity of lactating dairy cows. Twelve freestall-housed, lactating Holstein dairy cows, including 6 primiparous (PP) and 6 multiparous (MP), milked 3×/d (at 1400, 2200, and 0600h), were exposed to each of 3 treatments (over 21-d periods) in a replicated Latin square design. Treatments included feed delivery frequency of (1) 1×/d (at 1400 h), (2) 2×/d (at 1400 and 2200 h), and (3) 3×/d (at 1400, 2200, and 0600 h). Milk production as well as feeding, lying, and rumination behaviors were electronically monitored for each animal for the last 7 d of each treatment period. Milk samples were collected for the last 3 d of each period for milk component analysis. Dry matter intake (DMI) varied with feed delivery frequency, with greatest DMI observed in cows fed 3×/d (27.8 kg/d) compared with those fed 2×/d (27.0 kg/d) or 1×/d (27.4 kg/d). Treatment had no effect on milk yield (41.3 kg/d) or efficiency of production (1.54 kg of milk/kg of DMI). Cows that did not receive delivery of feed following the 2200 h milking (treatment 1) and 0600 h milking (treatments 1 and 2) had lower DMI during the first hour after milking than those that received feed at all milkings (treatment 3). Total feeding time and meal frequency, size, and duration did not vary by treatment, but PP cows consumed smaller meals at a slower rate, resulting in lower DMI compared with MP cows. Primiparous cows consumed 50.1% and 26.1% less dry matter than MP cows during the first meal following the first and second milkings, respectively. Lying time did not vary by treatment, but PP cows spent more time lying (10.3 vs. 8.3 h/d) than MP cows. Under 3×/d milking schedules, greater feed delivery frequency resulted in greater DMI as a function of increased DMI

following the return from milking and the delivery of feed.

Key words: dairy cow, feed delivery frequency, behavior

INTRODUCTION

The delivery of fresh feed and the act of returning from milking stimulate feeding activity in lactating dairy cattle group-housed and group-fed indoors (DeVries et al., 2003a). Because the delivery of fresh feed has been demonstrated to be a stronger stimulus to initiate feeding activity than is the return from milking (DeVries and von Keyserlingk, 2005), increased frequency of feed delivery has the potential to influence feeding behavior, health, and productivity. Cows fed more frequently consume feed more evenly after each feed delivery and throughout the day (DeVries et al., 2005; Mäntysaari et al., 2006) and, therefore, exhibit more desirable feeding patterns to support rumen health. Such desirable feeding patterns are conducive to more consistent rumen pH (French and Kennelly, 1990), which may contribute to the improved milk fat (Rottman et al., 2011), fiber digestibility (Dhiman et al., 2002), and production efficiency (Mäntysaari et al., 2006) observed when cows are fed more frequently than 1×/d. In contrast, 1×/d feed delivery frequency results in a significant peak in feeding activity in the immediate period following feed delivery (DeVries et al., 2005), known as slug feeding, which predisposes cows to SARA (Shaver, 2002) due to large diurnal fluctuations in ruminal pH (Shabi et al., 1999).

Some reports indicate that cows fed more frequently spend more time feeding and show no difference in DMI (DeVries et al., 2005), whereas others have shown no difference in feeding time but lower DMI for cows delivered feed more frequently compared with 1×/d feed delivery (Phillips and Rind, 2001; Mäntysaari et al., 2006). From this latter research (Phillips and Rind, 2001; Mäntysaari et al., 2006), it was concluded that the disturbances caused by increased feed delivery frequency may have detrimental effects on behavior patterns

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and thus productivity of dairy cattle. Previous research has demonstrated no effect of feed delivery frequency on daily lying time of cows milked 2×/d (DeVries et al., 2005). It is possible that for cows milked 3×/d, the time required for an extra milking in conjunction with greater feed delivery frequency may alter the amount of time devoted to behavioral activities such as lying, feeding, and rumination, all of which are critical for milk production, maintenance of energy balance, efficient digestion, cow health, and welfare.

Thus, the objective of this study was to determine the effect of feed delivery frequency on the behavior and productivity of lactating dairy cows milked 3×/d. We hypothesized that under a 3×/d milking schedule, an increased frequency of feed delivery would result in increased feeding activity, particularly after fresh feed delivery. We further hypothesized that greater frequency of feed delivery would result in a more uniform distribution of feeding activity throughout the day, thus providing the required plane of nutrition for the increased milk production demand of 3×/d milking schedules. We also hypothesized that more frequent delivery of feed would result in greater time spent feeding, thus potentially reducing the amount of time devoted to other critical behavioral activities (lying and ruminating) throughout the day.

MATERIALS AND METHODS

Animals and Housing

Twelve lactating Holstein dairy cows, including 6 primiparous (PP) and 6 multiparous (MP; parity = 2.5 ± 0.8 ; mean $\pm$ SD), were used in this study. The animals were 79.1 ± 32.4 DIM and producing 39.6 ± 5.0 kg/d of milk at the beginning of the trial. Cows were housed 6 at a time in a freestall research pen located at the University of Guelph, Kemptville Campus Dairy Education and Innovation Centre (Kemptville, ON, Canada). Cows had access to 6 freestalls with waterbeds (DCC Waterbeds, Advanced Comfort Technology Inc., Reedsburg, WI). Waterbeds were topped with wood shavings, and bedding was replaced as needed. Manure was manually scraped to within reach of the alley scrapers 3× daily at 0600, 1400, and 2200 h. Cows were milked 3×/d (at 0600, 1400, and 2200 h) using a robotic milking system (Lely A3 Next, Lely Industries N.V., Maassluis, the Netherlands). At the specified milking times, cows were moved from the research pen into a small holding area adjacent to the robotic milker, from where they were milked individually and sequentially. Cows did not receive any supplemental feed from the robotic milking system while being milked. Cow BW was automatically recorded at each milking by

the robotic milking system; BW averaged 557 ± 53 kg for PP cows and 660 ± 54 kg for MP cows across the study. The experiment was conducted from May 16 to September 26, 2012. The average environmental temperature during the data collection period was $18.8 \pm 4.4^\circ\text{C}$. Use of cows and experimental procedures were approved by the University of Guelph's Animal Care Committee. Cows were managed according to the guidelines set forth by the Canadian Council on Animal Care (CCAC, 2009).

Experimental Design

The number of animals required per treatment was determined through sample size and power analysis (Morris, 1999) to detect a 10% level of observed difference for the primary outcome variables, including behavior, DMI, sorting, and milk production and composition. Cows were divided into 2 groups of 6, which were balanced according to DIM, milk production, and average parity. Within each group of 6, cows were randomly exposed to each of 3 treatments using a replicated 3×3 Latin square design (with groups replicated over time), with 21-d treatment periods. The treatments were the delivery of feed: (1) 1×/d (at 1400 h), (2) 2×/d (at 1400 and 2200 h), and (3) 3×/d (at 1400, 2200, and 0600 h). Cows received 14 d of adaptation to each treatment followed by 7 d of data collection.

Feeding Procedure

Cows were individually assigned to one roughage intake feed bin (Insentec RIC, Marknesse, the Netherlands) to measure individual feed intake and feeding behavior, as validated by Chapinal et al. (2007). Cows received 3 d of training before the start of the experimental period to learn to access their own unique feed bin. Cows were fed a base TMR formulated to meet the nutrient requirements of a cow producing 40 kg of milk according to the NRC (2001) nutrient recommendations for high-producing lactating dairy cows. The TMR consisted of 24.1% grass/legume silage, 28.3% corn silage, 23.4% high-moisture corn, 14.3% protein concentrate, and 9.9% robotic pellet supplement on a DM basis (Table 1).

The TMR (without the robotic pellet supplement) was mixed once daily in a TMR mixer wagon (Jaylor 4425, Jaylor Fabricating, Orton, ON, Canada) and delivered via conveyor into a motorized feed cart (WIC RTM-55, WIC Inc., Wickham, QC, Canada) between 1100 and 1200 h. The robotic pellet supplement was included at a rate of 0.05 kg of pellet to 1 kg of TMR based on the diet formulation for 40 kg/d milk production for the milking herd. The robotic pellet supplement

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