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Impact of timing of feed delivery on the behavior and productivity of dairy cows

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ABSTRACT

The objective of this work was to assess the effect of timing of feed delivery on the behavior and productivity of cows milked 3 times per day. Twelve lactating Holstein dairy cows (4 primiparous and 8 multiparous), milked 3 times per day (at 1400, 2100, and 0700 h), were individually assigned and exposed to each of 2 treatments (over 21-d periods) in a replicated crossover design. Treatments were the manipulation of timing of TMR delivery, 2 times per day, in relation to milking time: (1) feeding at milking time (at 1400 and 0700 h), and (2) feeding halfway between milking times (at 1730 and 1030 h). Milk production, feeding, sorting, and rumination behavior were monitored for each animal for the last 7 d of each treatment period. Milk samples were collected for 2 of the last 4 d of each period for milk component analysis. With a feed delivery delay, dry matter intake (DMI) tended to be lower (26.5 vs. 27.2 kg/d). Although no difference was found in feeding time (224.2 min/d), cows fed with a delay consumed their feed more slowly (0.12 vs. 0.13 kg of dry matter/min) in more frequent meals (10.0 vs. 9.1 meals/d), which were smaller in size (2.8 vs. 3.1 kg/meal) and tended to be shorter in duration (26.7 vs. 30.1 min/meal). Cows fed at milking sorted for long particles (102.3%), whereas cows fed with a delay did not sort for or against those particles. Cows sorted for medium particles to a similar extent (102.5%) on each treatment. Cows did not sort for or against short particles on either treatment. Sorting against fine particles was observed, to a similar extent (97.1%), on both treatments. Rumination time (8.9 h/d) and lying time (9.5 h/d) were similar between treatments. Cows without fresh feed at the 1400 h milking tended to stand for less time following that milking (71.0 vs. 94.0 min), whereas cows without fresh feed at the 0700 h milking stood for less time following that milking (66.3 vs. 87.8 min). No difference in this latency to lie down was seen at the 2100 h milking. Milk yield (48.0 kg/d), milk fat content (3.64%), and milk protein content (2.86%) were similar between treatments. Given the tendency for a difference in DMI and no change in yield, efficiency of production was improved with a feed delay (1.93 vs. 1.80 kg of milk/kg of DMI). These data suggest that moving the timing of feed delivery resulted in cows consuming their feed more slowly in smaller, more frequent meals, contributing to an improvement in efficiency of production.

Key words: feed delivery, meal pattern, behavior

INTRODUCTION

Enhancing health and productivity involves the management of cow feeding and lying behavior patterns. Ruminal health is optimized when cows consume smaller meals, slowly and frequently, while minimizing feed sorting (Krause and Oetzel, 2006; DeVries et al., 2008). Udder health may be improved by controlling the duration of time cows spend standing after milking (Barnouin et al., 2004; DeVries et al., 2010; Watters et al., 2014).

Fresh feed delivery has an effect on both meal patterning and latency to lie down after milking. Feed delivery is known to stimulate feeding activity, with frequent delivery of TMR resulting in a more even distribution of feeding activity throughout the day (DeVries et al., 2003a, 2005; DeVries and von Keyserlingk, 2005). Furthermore, cows will remain standing longer after milking when feed is delivered close to a milking time (Tyler et al., 1997; DeVries et al., 2010; Watters et al., 2014).

It is possible that the delivery of feed can be delayed from the time of milking to encourage cows to eat more often, by taking advantage of both feeding stimuli (i.e., feed provision and return from milking). DeVries and von Keyserlingk (2005) demonstrated that with 2 times per day milking and feeding, daily feeding time increased by 12.5% with a 6-h feed delay after milking. In the same study, standing duration after milking was reduced from 65.7 min, when fed at the time of milking, to 45.1 min when fed 6 h after milking. Shortened

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latency to lie down may be associated with a higher risk of acquiring new IMI (DeVries et al., 2010; Watters et al., 2014). It is unknown if lying latencies would be further reduced with a feed delay when cows are milked 3 times per day. Additionally, DeVries and von Keyserlingk (2005) focused on behavioral responses at a group level and did not record DMI or meal patterns for individual cows. It is, thus, unclear how a feed delay after milking affects feeding activity at the individual cow level. As feeding behavior varies greatly for individual cows within a group (Melin et al., 2005), it is important to understand how management practices, such as timing of feed delivery, influence that behavior at a cow level.

Therefore, the objective of this study was to assess the effect of timing of feed delivery on behavior and productivity of cows milked 3 times per day. It was hypothesized that delaying feed delivery from milking time would result in cows consuming more frequent, smaller meals by providing multiple stimuli for feeding across the day. Furthermore, we predicted that the latency to lie down after milking would be reduced when cows did not have fresh feed delivered at the time of milking.

MATERIALS AND METHODS

Animals and Housing

This study observed 12 lactating Holstein dairy cows, including 4 primiparous and 8 multiparous individuals (parity = 3.0 ± 1.3; mean ± SD). Cows were 52 ± 23 DIM and producing 46.6 ± 8.5 kg/d, and weighed 668.2 ± 58.2 kg at enrollment into the study. Cows were housed 6 at a time in a freestall research pen at the University of Guelph, Kemptville Campus Dairy Education and Innovation Center (Kemptville, ON, Canada). The research pen contained 6 freestalls with waterbeds (DCC Waterbeds, Advanced Comfort Technology Inc., Reedsburg, WI), which were bedded with wood shavings; bedding was replaced as needed. Manure was manually scraped from the stalls at 1400, 2100, and 0700 h, such that it was within reach of the alley scrapers. Cows were milked 3 times per day (at 1400, 2100, and 0700 h) using an automatic milking system (**AMS**; 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 AMS. Cows were milked individually and sequentially, receiving no supplemental feed from the AMS and returning to their pen individually following milking. Animal use complied with the Canadian Council on Animal Care guidelines (CCAC, 2009) and was approved by the Animal Care Committee at the University of Guelph.

Experimental Design

Sample size and power analysis were used to calculate the number of animals needed (Morris, 1999) to detect a 14% level of observed difference for the primary outcome variables, including behavior, DMI, and sorting, as well as milk production and composition. Estimates of variation for these variables were based on previously reported values (Leonardi and Armentano, 2003; Hart et al., 2013, 2014). Cows were divided into 2 groups of 6, which were balanced according to parity, DIM, and milk production. Within each group, cows were individually assigned and exposed to each of 2 treatments in a replicated crossover design (with groups replicated over time), with 21-d treatment periods (including 14 d of adaptation to the feeding schedule, before a 7-d data collection period). Treatments were the manipulation of timing of fresh feed delivery, 2 times per day, in relation to milking time: (1) feed delivery at milking time (at 1400 and 0700 h) and (2) feed delivery with delay, halfway between milking times (at 1730 and 1030 h, with a 3.5-h delay from milking time). Within each group, cows were alternately, and individually, assigned to treatments within each period. Thus, across all 12 cows, the order of treatment exposure was balanced. The experiment was conducted between May 19 and August 21, 2014, with an average environmental temperature of 17.9 ± 2.7°C.

Feeding Procedure

Within each group, cows were each assigned to 1 individual feed bin (Insentec RIC, Marknesse, the Netherlands), which measured feed intake and feeding behavior, as validated by Chapinal et al. (2007). Cows trained for 3 d before treatment allocation to access their unique feed bin. Cows were fed a TMR (Table 1) formulated to meet the requirements for 40 kg production according to the NRC (2001) nutrient recommendations for high-producing cows. The TMR (without grain supplement) was prepared once per day in a TMR mixer (Jaylor 4425, Jaylor Fabricating, Orton, ON, Canada) and delivered on a conveyor into a motorized feed cart (Rovibec 530, Ste-Monique Co., Nicolet, QC, Canada) at 1200 h. The appropriate amount of grain supplement was then weighed on a scale (model ES30R, Ohaus Corporation, Pine Brook, NJ) and mixed with the TMR for 4 min in the feed cart. Daily feed allotments were separated into 2 feedings, with the larger feeding (~70%) in the afternoon and the smaller feed-