



Mitigation of variability between competitively fed dairy cows through increased feed delivery frequency

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ABSTRACT

The objective of this study was to determine whether increased frequency of total mixed ration (TMR) delivery could mitigate the effects of feed bunk competition on the behavior and productivity of individual lactating dairy cows within a group. We hypothesized that, for competitively fed cows, a greater frequency of TMR delivery would improve access to feed, and reduce individual variability in behavior, meal patterns, and production between cows. Sixteen lactating Holstein dairy cows (first lactation = 4, second lactation = 5, ≥ third lactation = 7) averaging 72 ± 35 d in milk and producing 42 ± 6 kg of milk/d at the start of the trial, were categorized as either young (\leq second lactation) or mature (\geq third lactation) and paired to maximize difference in parity. Pairs were housed 4 at a time and competitively fed a TMR at a ratio of 2 cows:1 feed bin. Cow pairs were exposed, in a crossover design, to each of 2 feed delivery frequency treatments: low (2×/d) and high (6×/d) frequency. Treatments were applied for 10 d, with dry matter intake (DMI), feeding behavior (feeding time, feeding rate, and meal patterns), and replacement frequency for each cow recorded using an automated feed intake system on d 6 to 10 of each period. Rumination time, feed sorting, lying behavior, and productivity were also measured for this period. Variability in behavior within pairs of cows was determined by averaging the absolute difference within each pair over the recording period to provide 1 value per pair. Frequency of TMR delivery did not affect feeding time, feeding rate, DMI, replacement frequency, feed sorting, or productivity. At the high delivery frequency, there was a tendency for rumination time to increase [low = 519.3; high = 544.3 min/d; standard error of the difference (SED) = 11.32], and to be more variable within pairs (low = 38.0, high = 50.0 min/d; SED = 5.57). Cows also had longer lying bouts at the high delivery frequency (low = 53.0; high = 55.5 min/bout;

SED = 1.00). No differences in daily meal patterns were found between treatments; however, the average first meal following each feeding indicated that cows under the high delivery frequency spent less time, consuming smaller meals during peak feeding periods. Comparing the young and mature individuals within each treatment pair revealed that feeding rate (young = 0.16; mature = 0.19 kg/min; SED = 0.014) and DMI (young = 25.6; mature = 28.6 kg of DM/d; SED = 1.36) were lower for the young cows on both treatments. Meal frequency was greater in young cows (young = 9.0; mature = 7.5 meals/d; SED = 0.71) and meal size was greater in mature cows (young = 3.2; mature = 4.2 kg of DM/meal; SED = 0.32) across treatments. These results suggest that for cows fed at a high level of competition, increasing TMR delivery frequency from 2 to 6×/d led to consumption of shorter, smaller meals during peak periods of feed consumption. However, under these conditions, the relative parity of competitively fed cows had a greater effect on feeding behavior, meal patterns, and production than did the frequency of feed delivery. **Key words:** competition, behavior, feed frequency, meal pattern

INTRODUCTION

Feeding a TMR 1 to 2 times daily is common practice on many farms, yet because the delivery of fresh feed has been shown to have the greatest influence in stimulating feeding activity in dairy cattle (DeVries and von Keyserlingk, 2005; King et al., 2016b), there has been a great deal of research into the effects of greater frequency of TMR delivery. Studies of feed delivery frequency have commonly investigated increases up to 2×/d (Kudrna, 2003; Greter et al., 2013), 3×/d (Hart et al., 2014), 4×/d (Phillips and Rind, 2001; DeVries et al., 2005), 5×/d (Mäntysaari et al., 2006), and 12×/d (French and Kennelly, 1990) over the baseline of 1 to 2×/d. Greater and more evenly distributed feeding activity throughout the day (Phillips and Rind, 2001; DeVries et al., 2005) as well as decreased sorting of feed (DeVries et al., 2005) have both been demonstrated with increased frequency of TMR delivery. The provision of

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fresh feed throughout the day is a contributing factor to a healthy rumen environment (Nocek and Braund, 1985); thus, more consistent availability of TMR could aid in the prevention of SARA (Shaver, 2002; Krause and Oetzel, 2006) and promote greater milk production efficiency (Mäntysaari et al., 2006) and improved milk fat production (Gibson, 1984).

Researchers have yet to establish how increased feed delivery frequency affects the behavior (such as feeding patterns, rumination activity, and lying time) of dairy cows in a competitive feeding environment. Competition for feed access can lead cows to modify their feeding behavior, including reduced feeding time, and increased rate of feed intake, meal size, and idle standing time (Olofsson, 1999; Huzzey et al., 2006; Hosseinkhani et al., 2008), all of which may elevate the risk of health problems such as lameness and SARA (Cook et al., 2004). Subordinate cows, in particular, have been shown to adjust their feeding times away from peak periods associated with fresh feed delivery, to avoid the social stress and agonistic behavior resulting from competition for feed access (Olofsson, 1999; Rioja-Lang et al., 2009). This, potentially, leads those cows to consume an unbalanced ration of poorer nutritional quality, due to the preferential selection of feed in the bunk throughout the day (Leonardi and Armentano, 2007; Hosseinkhani et al., 2008). DeVries et al. (2005) demonstrated this change in nutrient content of sorted feed throughout the day; further, consumption of such feed may lead to reduced milk components and efficiency of milk production (Miller-Cushon and DeVries, 2017). Lower-parity animals may experience the greatest impact, as their young age and smaller size makes them more likely to be subordinate to other individuals within the herd (Dickson et al., 1970; Wierenga, 1990). More frequent feed delivery may reduce variability between individual cows, as it is those animals that experience shorter feeding times under less frequent feed delivery that are observed to increase their feed consumption activity during peak periods, with more frequent feed deliveries (DeVries et al., 2005).

The primary objective of this study was, thus, to determine whether increased feeding stimuli could mitigate the effects of competition on individual cows within a group. A secondary objective was to examine whether individual cows of different parity would be affected in the same manner. We hypothesized that, in competitive feeding situations, (1) a higher frequency of TMR delivery would allow more individuals the opportunity to access feed during peak periods of feeding activity than at a lower frequency of TMR delivery, and (2) there would be less variability in feeding patterns, behavior, and productivity between individual cows at

a higher TMR delivery frequency than at a lower TMR delivery frequency.

MATERIALS AND METHODS

Animals and Housing

Sixteen lactating Holstein dairy cows, consisting of 4 first-lactation, 5 second-lactation, and 7 third-lactation or greater (parity = 4 ± 0.8) animals, were selected from the University of Guelph, Kemptville Campus Dairy Education and Innovation Center herd. Selected individuals had an average DIM of 72 ± 35 d, daily production of 42 ± 6 kg/d, and BW of 692 ± 73 kg at entry to the study. Before selection, the health status of each cow was evaluated and no cows were included that experienced health concerns during the transition period or early lactation.

Cows were housed in groups of 8 in a freestall pen with a stocking density of 1 stall/cow. Stalls were equipped with waterbeds (DCC Waterbeds; Advanced Comfort Technology Inc., Reedsburg, WI) and bedded with wood shavings as needed; manure was scraped from stalls manually to within range of the alley scrapers at milking times. Two water bowls within the pen provided cows with ad libitum access to water. Cows were milked 3×/d at 0715, 1430, and 2000 h. For milking, cows were brought manually to a holding pen and milked individually and sequentially using an automated milking system (AMS; Lely Astronaut A3 Next; Lely Industries N.V., Maassluis, the Netherlands) to represent conventional milking practices. Cows spent a maximum of 3.5 h/d outside the pen for milking. The cows did not receive supplemental feed from the AMS; TMR (Table 1) was provided through automated feed bins (Insentec RIC; Marknesse, the Netherlands) that monitored the intakes and timing of feed visits for each individual animal, as validated by Chapinal et al. (2007).

Cows were managed according to the standard operating procedures of the research facility. Once weekly, cows' feet were treated with a preventative hoof spray (10% solution of Hoofsure; Provita Eurotech Ltd., Omagh, UK). The use of cows and experimental procedures complied with the guidelines of the Canadian Council on Animal Care (CCAC, 2009) and were approved by the University of Guelph Animal Care Committee (Animal Use Protocol #3245).

Experimental Design

The study took place in July and August 2015 and utilized 8 pairs of cows (16 cows divided into 2 groups

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