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Variability in behavior and production among dairy cows fed under differing levels of competition

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ABSTRACT

The objective of this study was to investigate the effects of differing levels of competition for feed access on group-housed dairy cows, and on variations in behavior and productivity between individuals within each group. Eighteen lactating Holstein cows, averaging 77 ± 20 d in milk with a production of 46 ± 7 kg/d at the start of the trial, were divided into subgroups of 3 and fed a total mixed ration 3×/d. Groups were exposed to each of 3 competition levels: high (3 cows:1 feed bin), moderate (3 cows:2 feed bins), and low (3 cows:3 feed bins). Treatments were assigned in random order according to a modified Latin-square design, and each was applied for 10 d. Using an automated feed intake system, feeding behavior data (dry matter intake, feeding time, feeding rate, and meal patterns) were recorded for each cow on d 6 to 10 of each treatment period. Additional behavioral [sorting, rumination, competitive interactions (replacements), lying time] and production (milk yield and components) data were collected. Greater competition resulted in a reduction in feeding time (low = 202.6, moderate = 194.9, high = 183.6 min/d; SE = 8.84), and an increased rate of feed intake (low = 0.16, moderate = 0.18, high = 0.20 kg of dry matter/min; SE = 0.01), especially following fresh feed delivery and milking. Dry matter intake was similar across treatments (average of 29.1 kg/d). Meal length increased under high competition (low = 37.0, moderate = 36.6, high = 47.3 min/meal; SE = 5.05) due to greater non-feeding time within meals, which was approximately twice as long under high competition (low = 10.0, moderate = 10.8, high = 20.3 min/meal; SE = 3.24). Daily lying time (low = 10.2, moderate = 10.2, high = 9.5 h/d; SE = 0.51) and milk protein yield (low = 1.41, mod = 1.42, high = 1.36 kg/d; SE = 0.05) were reduced under high competition. Analysis of individual within-group variability, calculated as the

daily standard deviation of each group, averaged across 5 recording days, revealed greater variability in feeding time, feeding rate, meal length, non-feeding time within meals, milk yield, milk fat composition (%), and milk fat component yield (kg/d) under high competition. These results suggest that at elevated competition levels, cows modify their feeding behavior to consume feed in a shorter period and devote a large portion of their mealtime toward waiting to gain feed access, resulting in reduced daily lying time. Furthermore, meal patterns and milk production vary greatly within groups of cows at high levels of competition for feed access.

Key words: dairy cow, feeding behavior, competition, meal patterns, milk production

INTRODUCTION

Dairy cows experience the greatest motivation to feed following the delivery of fresh feed and, to a lesser extent, upon return from milking (DeVries and von Keyserlingk, 2005; King et al., 2016). However, when space at the feed bunk is limited, particularly at these times of high bunk attendance, individual cows must compete for feed access. Competition for resources such as feed leads to greater social pressure (Nielsen, 1999) and altered feeding behavior, such as reduced feeding time (Huzzey et al., 2006; Proudfoot et al., 2009), increased feeding rate (Olofsson, 1999; Hosseinkhani et al., 2008), and greater idle standing time (Huzzey et al., 2006). Higher frequency of displacement from the feeding area has also been demonstrated under increased competition for feed access, particularly for subordinate cows (Huzzey et al., 2006; Val-Laillet et al., 2008; Proudfoot et al., 2009). These alterations of feeding behavior in competitive environments may lead to abnormal intake and meal patterns, as well as greater stress on the hoof, resulting in health problems such as subacute ruminal acidosis (Shaver, 2002) and increased lameness (Cook et al., 2004). The productivity of individual cows may also be affected by such changes in feeding behavior, because milk production has been correlated with feeding time and DMI (Dado and Allen, 1994; Shabi et al., 2005).

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Subordinate cows have demonstrated a greater stress response to feeding in the company of higher-ranked neighboring cows (Hetti Arachchige et al., 2014), and a tendency to sacrifice feed quality to avoid feeding in proximity to a more dominant individual (Rioja-Lang et al., 2009). This indicates that feeding conditions can impose great social stress on subordinate cows, which have been observed to deviate from preferred peak feeding times associated with fresh feed delivery when under competitive pressure (Olofsson, 1999). In these situations, individuals may consume a diet that is different from that intended, because feed sorting results in altered feed composition further from feed delivery times (Leonardi and Armentano, 2003). Hosseinkhani et al. (2008) studied the effects of feed bunk competition on feed sorting by close-up prepartum cows and found a tendency for competition to affect the sorting of medium particles: competitively fed cows displayed less sorting of medium particles than non-competitively fed cows shortly after feed delivery. However, those researchers compared only non-competitively and competitively fed cows and did not consider to what extent the degree of competition could affect sorting behavior. In addition, they looked at close-up cows fed a diet with a higher proportion of forage compared with a lactating cow diet; such a diet could be less easily sorted than a lower-forage lactating cow ration (DeVries et al., 2007).

A common factor in most studies of feeding competition is that subordinate cows are particularly affected by increased levels of competition (DeVries et al., 2004; Huzzey et al., 2006; Val-Laillet et al., 2008). Depending on grouping strategy, individual cows in group-housed systems can differ based on their age, parity, stage of lactation, production level, and BW, all of which may influence their relative social position and contribute to their success in competitive interactions. Poor success in gaining feed access in competitive situations can act as a source of physiological stress, with negative consequences for an individual cow's welfare (Huzzey et al., 2012b; Hetti Arachchige et al., 2014). Although these studies have discussed differences between dominant and subordinate cows, they have not investigated how individual variability among all cows in the group may affect respective feed intake, meal patterns, and time allocated to other behaviors (e.g., ruminating and lying down).

The primary objective of this study was to investigate the effect of differing levels of competition for feed access on the behavior and productivity of group-housed dairy cows. The secondary objective was to determine the effect of competition on variability in behavior patterns and productivity between individuals within the group. We hypothesized first that as competition increased, cows would consume their feed faster and

in larger meals, reducing their ability to sort feed and their time spent ruminating and lying down, in turn negatively affecting their milk production. We also hypothesized that individuals within each group would experience more variability in patterns of behavior and productivity when under greater competition for feed access.

MATERIALS AND METHODS

Animals and Housing

Eighteen lactating Holstein dairy cows, including 5 primiparous and 13 multiparous (average parity = 3.4 ± 1.3), were chosen from the research herd at the University of Guelph, Kemptville Campus Dairy Education and Innovation Center. At enrollment in the study, subject animals were 77 ± 20 DIM, with an average milk production of 46 ± 7 kg/d, and a BW of 721 ± 85 kg. The health status of each cow was evaluated before selection and monitored throughout the trial; no cows experienced health concerns that required removal from the study during transition, early lactation, or the study period. Each cow participated in the study for a total of 33 d. Cows were housed in groups of 6, in a freestall pen with 6 automated feed bins (Insentec RIC, Marknesse, the Netherlands) and 6 stalls (arranged in 2 rows, head-to-head) equipped with waterbeds (DCC Waterbeds; Advanced Comfort Technology Inc., Reedsburg, WI) and bedded with wood shavings as needed. Manure was scraped from the stalls to within reach of automatic alley scrapers during milking times. Cows had ad libitum access to water from 2 bowls in the pen. To simulate conventional milking systems, cows were milked 3 times daily at fixed times: 0800, 1400, and 2000 h; at each milking, cows were brought to a holding pen for individual milking by an automatic milking system (Lely Astronaut A3 Next; Lely Industries N.V., Maassluis, the Netherlands). No supplemental feed was supplied by the automated milking system. Once per week, cows were treated with preventative hoof spray (HealMax Spray; Agrochem Farm and Dairy Products, Saratoga Springs, NY). 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 was conducted using 3 groups of 6 individuals. Within each group, cows were assigned to 2 subgroups of 3 individuals (for a total of 6 subgroups) that were balanced for DIM, parity, and production.

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