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Short communication: Associations between feed push-up frequency, feeding and lying behavior, and milk yield and composition of dairy cows

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ABSTRACT

Feeding management factors have great potential to influence activity patterns and feeding behavior of dairy cows, which may have implications for performance. The objectives of this study were to assess the effects of feed push-up frequency on the behavioral patterns of dairy cows, and to determine associations between behavior and milk yield and composition. Lactating Holstein dairy cows (n = 28, parity = 1.9 ± 1.1; mean ± SD) were housed in tiestalls, milked twice per day, and offered ad libitum access to water and a total mixed ration (containing, on a dry matter basis: 25% corn silage, 25% grass/alfalfa haylage, 30% high-moisture corn, and 20% protein/mineral supplement), provided twice per day. Cows were divided into 2 groups of 14 (balanced by days in milk, milk production, and parity) and individually exposed to each of 2 treatments in a crossover design with 21-d periods; treatment 1 had infrequent feed push-up (3×/d), whereas treatment 2 had frequent feed push-up (5×/d). During the last 7 d of each period, dry matter intake and milk production were recorded and lying behavior was monitored using electronic data loggers. During the last 2 d of each period, milk samples were collected for analysis of protein and fat content and feed samples of fresh feed and orts were collected for particle size analysis. The particle size separator had 3 screens (19, 8, and 1.18 mm) and a bottom pan, resulting in 4 fractions (long, medium, short, fine). Sorting was calculated as the actual intake of each particle size fraction expressed as a percentage of the predicted intake of that fraction. Feed push-up frequency had no effect on lying time [11.4 ± 0.37 h/d; mean ± standard error (SE)], milk production (40.2 ± 1.28 kg/d) and composition (milk protein: 3.30 ± 0.048%; milk fat: 3.81 ± 0.077%), or feed sorting. Cows sorted against long particles (78.0 ± 2.2%) and for short (102.6 ± 0.6%) and fine (108.4 ± 0.9%) particles. Milk fat content decreased by 0.1 percentage points for every 10% increase in sorting against long particles and was not associated with lying behavior or other cow-level factors. Milk protein content decreased by 0.03 percentage points for every hour decrease in lying time and by 0.04 percentage points for every 10% increase in sorting against long particles. These results suggest that sorting against long ration particles may negatively affect milk composition. Additionally, we did not find that altering feed push-up frequency affected feed sorting or cow standing and lying patterns.
Key words: feed sorting, lying behavior, milk fat, milk protein

Short Communication

It is well established that behavior of dairy cows is subject to feed management factors, including feed delivery frequency and time of feed delivery (DeVries and von Keyserlingk, 2005; DeVries et al., 2005; King et al., 2016). Feed delivery frequency influences both diurnal patterns of feeding time, with peaks in feeding time corresponding to feed delivery, and the extent of feed sorting (DeVries et al., 2005). As cows sort their TMR, NDF content of the feed remaining in the bunk increases throughout the day, and the extent of this sorting is reduced by increasing frequency of feed delivery beyond once per day (DeVries et al., 2005). Feeding frequency and timing of feed delivery also affect diurnal patterns of lying time, as cows are prompted to stand and feed when fresh feed is delivered (DeVries and von Keyserlingk, 2005).

Whereas timing and frequency of the delivery of fresh feed clearly influence behavior of dairy cows, the influence of feed push-up on behavioral patterns is less clear. Evidence exists that feed manipulation, in general, including delivery of fresh feed and feed push-up, around the time that cows are milked increases latency to lie down after milking compared with feed manipulation hours after milking time (Watters et al., 2013). Deming et al. (2013) also found a positive association between feed push-up frequency and total daily lying duration,

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suggesting that improving feed availability may allow cows to feed more efficiently and spend more time lying down. However, frequency of feed push-up has been found to have little effect on feeding time or on the diurnal pattern of feed alley attendance (DeVries et al., 2003). Further, no research to date has evaluated the effects of feed push-up frequency on feed sorting.

Much interest in understanding the relationship between feeding management and behavior is based on the goal of improving dairy cow health and performance. For example, knowing that feed delivery frequency influences the extent of feed sorting (DeVries et al., 2005; Sova et al., 2013) provides an opportunity to make management changes that may improve the balance of nutrients each cow receives, which may translate into production increases (Sova et al., 2013). Timing of feed delivery not only influences distribution of DMI across the day, along with resultant production efficiency (King et al., 2016), but also the diurnal patterns of standing time, providing an opportunity to manipulate postmilking standing time and reduce risk of IMI (DeVries et al., 2010). The effect of feed push-up on cow behavior and resultant changes in milk composition is, however, unknown.

Thus, the objectives of our study were to assess the effects of feed push-up frequency on the behavioral patterns of lactating dairy cows housed in a tiestall system and to determine associations between behavior and milk yield and composition. We hypothesized that increasing feed push-up frequency would reduce the extent of feed sorting and increase standing time, and that changes in behavior would be associated with milk yield and composition.

Lactating Holstein dairy cows (n = 28; parity = 1.9 ± 1.1; DIM = 67.9 ± 54.1; mean ± SD) were individually housed in tiestalls at the University of Guelph, Kemptville Campus Dairy Research and Innovation Center (Kemptville, Ontario, Canada), and managed according to the guidelines set by the Canadian Council on Animal Care (2009). Each cow had ad libitum access to water (via her own water bowl) and feed (via a feed bunk containing dividers separating her feed from adjacent cows' feed). Cows were milked in their stalls twice daily at 0500 and 1600 h and were provided a TMR (50% DM and containing, on a DM basis, 25% corn silage, 25% grass/alfalfa haylage, 30% high-moisture corn, and 20% protein/mineral supplement; particle size distribution was 8.0 ± 1.72% long particles, 53.5 ± 8.34% medium particles, 29.1 ± 7.19% short particles, and 9.4 ± 2.73% fine particles; mean ± SD) twice daily at 1000 and 1500 h. The amount fed to each cow was adjusted daily to target approximately 10% orts on an as-fed basis. Actual orts were 9.2 ± 0.90% and did not differ between treatments ($P = 0.90$). Cows were given a 2-h exercise period (0800 to 1000 h) each day in an outside dry lot pen. In the outside pen cows had access to water, but not feed, and had a packed dirt and concrete surface on which they could stand or lie down on if they chose.

Cows were divided into 2 groups of 14 (balanced by DIM, milk production, and parity) and individually exposed to each of 2 treatments in a crossover design with 21-d periods; treatment 1 had infrequent feed push-up (3×/d, at 0600, 1400, and 1800 h), whereas treatment 2 had frequent feed push-up (5×/d, at 0600, 1200, 1400, 1600, and 1800 h). During the last 7 d of each period, TMR intake, lying behavior, and milk production were recorded. Dry matter intake was assessed from fresh feed and orts samples; 1 fresh sample was taken daily at time of feed delivery and orts samples were taken from each animal just before morning feed delivery during the last 7 d of each treatment period. Duplicate samples of fresh feed and orts were taken for assessing feed-sorting behavior during the last 2 d of each treatment period. Samples taken for DM analysis were oven-dried at 55°C for 48 h. Lying behavior was recorded using electronic data loggers (IceQube, IceRobotics, Edinburgh, Scotland, UK), as previously validated by Elischer et al. (2013), attached to the rear right leg of each cow. Milk production was recorded at each milking using Tru-Test milk meters (Surge, Mississauga, ON, Canada).

During the last 2 d of each period, milk composition and feed-sorting behavior were monitored. Milk samples were collected from each cow from both morning and evening milking and sent to the DHI testing laboratory (CanWest DHI, Guelph, Ontario, Canada) for analysis for milk protein and fat percentage using a near-infrared analyzer (Foss System 4000, Foss Electric, Hillerød, Denmark). Feed samples taken for analysis of sorting behavior were separated using the 3-screen (19, 8, and 1.18 mm) Penn State Particle Separator (**PSPS**; Kononoff et al., 2003). This device separates the particles into 4 fractions: long particles (>19 mm), medium particles (<19 mm, >8 mm), short particles (<8 mm, >1.18 mm), and fine particles (<1.18 mm). Sorting activity for each fraction of the PSPS was calculated as the actual intake of each fraction expressed as a percentage of the predicted intake of that fraction (Leonardi and Armentano, 2003). The predicted intake of an individual fraction was calculated as the product of the DMI of the total diet multiplied by the DM percentage of that fraction in the fed TMR. Values equal to 100% indicate no sorting, <100% indicate selective refusals (sorting against), and >100% indicate preferential consumption (sorting for).

Data for daily DMI, feed sorting, and milk yield and composition were summarized for each cow by treat-