



Short communication: Effects of frequency of feed delivery and bunk space on the feeding behavior of limit-fed dairy heifers

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ABSTRACT

The objective of this experiment was to determine the interaction between feed bunk space and frequency of feed provision on the feeding behavior patterns and growth of growing dairy heifers fed a limited amount. Sixteen Holstein dairy heifers (183.4 ± 9.1 d of age, mean \pm standard deviation) were divided into 4 groups of 4. The groups were exposed to each of 4 treatments, using a 4×4 Latin square design with a 2×2 factorial arrangement of treatments, over 21-d periods (14-d adaptation period, 7-d data collection periods). The treatments were arranged in 2 feed delivery frequencies (once per day at 1200 h: $1 \times/d$, and twice per day at 1200 and 1400 h: $2 \times/d$) and 2 levels of feed bunk space (adequate feed bunk space: 0.40 m/heifer, and reduced feed bunk space: 0.29 m/heifer). Pen dry matter intake (DMI) was recorded daily, average daily gain (ADG) was recorded weekly, and variability in ADG was calculated from the standard deviation of ADG. Feeding, unrewarded behavior (time at feed bunk without feed present), and competitive behavior were recorded using time-lapse video. Feeding and unrewarded behavior were measured for the last 7 d of each period, whereas competitive behavior was recorded on d 16, 18, and 20 of each period. Lying time was recorded for the last 7 d of each period. A tendency for interaction between feed bunk space and frequency of feed delivery on the feed efficiency of limit-fed dairy heifers was noted. Heifers provided restricted bunk space were reported as being less efficient when fed $2 \times/d$; however, no other interactions were found. Although DMI and variability in ADG were similar between treatments, ADG was higher (1.0 vs. 0.9 kg/d) when heifers were provided with 0.40 m of feed bunk space and tended to be higher when fed $1 \times/d$ compared with that of heifers given restricted bunk space or fed $2 \times/d$. Heifers fed $1 \times/d$ spent more time feeding throughout the day (70.5 vs.

58.9 min/d) than heifers fed $2 \times/d$. Heifers fed at a restricted bunk space or fed $1 \times/d$ were approximately 25% more variable in feeding time than heifers fed $2 \times/d$ or with adequate bunk space. Heifers spent a similar amount of time in unrewarded visits to the feed bunk (28.9 min/d). Although feed bunk space did not affect competition (3.6 displacements/d), heifers fed $1 \times/d$ were displaced twice as frequently than heifers fed $2 \times/d$. Regardless of treatment, heifers spent a similar amount of time lying down and standing without eating. Overall, providing sufficient feed bunk space to allow all limit-fed heifers to feed simultaneously improves feed efficiency and ADG and reduces variability in feeding time. Additionally, although delivering feed $1 \times/d$ resulted in increased competition, it also enabled heifers to gain adequate weight and spend more time feeding each day.

Key words: dairy heifer, feeding behavior, feeding frequency, feed bunk space

Short Communication

Recent interest in limit-feeding strategies has driven an increase in research relating to heifer feeding management. Limit feeding involves providing a nutrient-dense ration—composed of high levels of concentrate, high-quality forages, or a combination—to heifers in a restricted quantity. This feeding strategy has many benefits, including a decrease in fecal excretion (and subsequent nitrogen excretion), reduced feed costs, increased feed efficiency, and effective control of ADG (Hoffman et al., 2007; Lascano et al., 2009; Kitts et al., 2011).

Despite the many demonstrated benefits to limit feeding, several behavioral, health, and welfare concerns are associated with the practice. These include decreased feeding and lying time, and increased unrewarded time at the feed bunk, vocalizations, and inactive standing time (Hoffman et al., 2007; Kitts et al., 2011; A. M. Greter; O. AlZahal, Department of Animal and Poultry Science, University of Guelph, Guelph, ON, Canada; T. F. Duffield; B. W. McBride; T. M. Widowski; and T. J.

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DeVries; unpublished data). Additionally, rations high in fermentable carbohydrates, when rapidly consumed, leave replacement heifers susceptible to subclinical depressions in rumen pH (Quigley et al., 1992; Moody et al., 2007). Researchers have recently attempted to identify why these concerns arise and what factors may help diminish or eliminate them. When offered straw alongside a limit-fed TMR, heifers will begin consuming the straw immediately upon completion of the TMR, suggesting that they are still hungry and continue to be motivated to feed (Greter et al., 2011; Kitts et al., 2011). In a more recent study, we demonstrated that increased frequency of delivery of a limit-fed TMR did not result in a return to more natural feeding patterns, as heifers fed more frequently ($2\times$ or $4\times/d$) spent less time feeding throughout the day (less than 1 h) and more time standing without eating than heifers fed $1\times/d$ (Greter et al., unpublished data). We speculated that this was due to high feeding motivation in these animals. Additionally, in that study, variability in ADG between individuals within a pen was greater when heifers were fed more frequently.

One of the essential management aspects associated with limit feeding is the amount of feeding space needed for heifers to feed simultaneously. When limit-fed heifers lack adequate space, the level of competition at the feed bunk increases, time spent feeding decreases, and variability in growth between heifers increases (Keys et al., 1978; Longenbach et al., 1999). Alternatively, providing more than adequate space (0.68 vs. 0.34 m/heifer) has been shown to have no benefit on the behavior of limit-fed heifers (Greter et al., 2011). Zanton and Heinrichs (2008) recently suggested that, when feed bunk space is insufficient for limit-fed heifers to feed simultaneously, producers should consider feeding $2\times/d$ at close intervals (i.e., 2 h apart). The untested hypothesis of these researchers was that this provides more opportunity for larger, dominant animals to feed at will after the first feed delivery and the more timid animals to feed after the second feed delivery. Unfortunately, given that limit-fed heifers consume their feed so quickly and are still motivated to feed following complete consumption of the TMR present in the bunk (Kitts et al., 2011), it could be hypothesized that the dominant heifers may return and dominate the feed bunk after the second feed delivery as well. Therefore, the objective of this experiment was to determine the interaction between feed bunk space and frequency of feed provision on the feeding behavior patterns and growth of growing dairy heifers fed a limited amount. We hypothesized that delivering a limit-fed ration twice daily ($2\times/d$) in 2 equal amounts (2 h apart) to heifers with restricted feed bunk space would result in less time feeding due to increased competition at the feed bunk compared with

heifers given adequate feed bunk space and fed once per day ($1\times/d$).

Sixteen dairy heifers were used in this study; 8 heifers were owned by the University of Guelph, Kemptville Campus, and the remaining 8 were acquired, on loan, from a local commercial dairy operation. Upon arrival, all heifers were given a broad-spectrum antibiotic (Draxxin, tulathromycin, Pfizer Animal Health, Kirkland, Quebec, Canada) to prevent potential sickness due to transport and mixing stresses (Stanton et al., 2010) and were given a 14-d adaptation period to acclimate to groups and their environment. Heifers were 183.4 ± 9.1 d of age (mean \pm SD) and weighed 223.3 ± 20.5 kg at the beginning of the study. Heifers weighed 312.6 ± 29.1 kg at the end of the study. Heifers were housed in pens of 4 balanced for age and weight. Pens were located in a naturally ventilated barn at the University of Guelph, Kemptville Campus (Kemptville, Ontario, Canada), and were managed according to the guidelines set by the Canadian Council on Animal Care (2009). Use of heifers was approved by the University of Guelph's Animal Care Committee (AUP#09R022), and the study was conducted between March and June 2011. Pens consisted of an indoor, sand-bedded pack area (3.6 m \times 10.9 m; width \times depth) and an outdoor concrete run (3.6 m \times 16.4 m). Sand bedding was cleaned out and replenished once weekly throughout the experiment. Feed bunks were located along the front of each indoor pack area and varied in length depending on treatment. Water was available ad libitum to the heifers through a water bowl in each pen and heifers were given ad libitum access to trace mineral salt blocks (Windsor TM Stock Salt, The Canadian Salt Company Limited, Pointe-Claire, Quebec, Canada).

Prior to the start of the study, all heifers had previously been fed a TMR. Upon arrival, heifers were fed a high-concentrate TMR (Table 1) that was formulated, and fed at a restricted level (2.0% of BW), to meet the nutrient requirements for a nonbred Holstein heifer growing at 0.9 kg/d (NRC, 2001). Over the 14-d adaptation period, heifers were fed straw (initially offered at 8.0 kg/pen as-fed) alongside the TMR. This long forage was provided to stimulate rumination, chewing, and resultant buffering (Beauchemin et al., 2008) to help transition the rumen to the high-concentrate TMR. The transition was done over 8 d; the amount of straw offered per pen was gradually reduced by 1.0 kg/d until heifers were provided only with the high concentrate, limit-fed TMR.

Following the adaptation period, groups of heifers were exposed to each of 4 treatments, in 21-d periods, using a 4×4 Latin square design with a 2×2 factorial arrangement of treatments. The treatments included arrangement of 2 feed delivery frequencies ($1\times/d$ at

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