Effects of Frequency of Feed Delivery on Dairy Cattle Behavior

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Abstract

The objective of this study was to determine the effects of frequency of feed delivery on time budgets of individually stalled dairy cows. The experiment was conducted as a 2 × 2 crossover design using 12 Holstein dairy cows randomly assigned to 1 of 2 treatments (n = 6): ad libitum feeding of a total mixed ration (TMR) delivered either 2 × or 3 × daily in a tie-stall operation. The experiment consisted of two 21-d experimental periods (13 d of adaptation and 8-d data collection periods). During the data collection periods, time-lapse video photography was used to quantify time budgets. Frequency of feed delivery had no effect (P > 0.05) on DMI, milk yield, or time budgets of the dairy cows. These results suggest that as long as feed is available to the cows ad libitum, frequency of feed delivery does not seem to affect time budget.

Key words: feed delivery, feeding behavior, dairy cow

Introduction

Researchers have studied housing comfort and stall design factors that may affect time budgets in dairy cows (Haley et al., 2000, 2001). Time budget is defined as the amount of time individual animals allocate to mutually exclusive activities (e.g., standing or lying down). A well-managed feeding system provides cows with ready access to feed and a comfortable area for resting. Haley et al. (2000) showed that individually housed cows in tie stalls tended to eat the majority of their feed during the day, and peak feeding activity occurred immediately following milking and feeding. Cow comfort, well being, and maximum productivity were enhanced when cows were allowed adequate opportunity to lie down and rest (Haley et al., 2000). Previous studies have shown that cows prevented from lying down had plasma concentrations of growth hormone that were 25% less than cows that were free to rest throughout the day (Munksgaard and Lvendahl, 1993).

Furthermore, stall design and lack of housing comfort can reduce the time spent lying and increase the time cows spend standing idle (Haley et al., 2000, 2001). Research on feeding management in more competitive free-stall settings indicates that frequency of delivery of fresh feed stimulates feed bunk attendance (DeVries et al., 2003) and can affect other aspects of cows’ time budgets apart from feeding such as time spent standing or ruminating while standing vs. lying down (Phillips and Rind, 2001). Although a few studies have indicated little effect of the frequency of delivering fresh feed on overall feed intake or patterns of eating behavior of cows in tie stalls (Nocek and Braund, 1985; Robinson and Sniffen, 1985), there is little information on the effect of frequency of feed delivery on the cows’ time budgets. The objective of this study was to determine the effect of frequency of feed delivery on time budget in dairy cows in a tie-stall operation.

Materials and Methods

Twelve Holstein dairy cows (168 ± 19 d in milk; 1.9 ± 0.5 parity) were used in the study. The cows were housed in a tie-stall barn [1,350-mm × 1,750-mm stalls (width × length, respectively) with suspended dividers and on pasture mat] at the Elora Dairy Research Centre (University of Guelph, Guelph, ON). The barn was naturally ventilated and lit, and lights were turned on at 0500 h each morning and turned off at 1800 h. To facilitate video recording at night, one row of lights in the middle of the barn ceiling was left on. All experimental procedures were carried out with the approval of the University of Guelph Animal Care Committee in accordance with the guidelines of the Canadian Council on Animal Care (1993).

The cows were fed a TMR consisting of 34% corn silage, 22.7% hay-
lages, 4.5% hay, 20% high-moisture corn, and 18.8% protein supplement on a DM basis. The composition of the TMR was 50.5% DM and contained (on a DM basis) 14% CP, 48.9% NDF, 33.4% ADF, 0.9% Ca, 0.4% P, and 1.34 NE (Mcal/kg). The experiment was conducted as a 2 × 2 crossover design replicated over time. The animals were blocked by days in milk and randomly assigned to 1 of 2 treatments (n = 6; 3 pairs per group). The treatments were 1) feed delivered 2× daily at 0700 and 1300 h and 2) feed delivered 3× daily at 0700, 1300, and 1700 h. The total amount of feed offered was kept equal between the 2 treatments. The experiment consisted of 2 21-d experimental periods (13 d of adaptation or adjustment and 8-d data collection periods). During data collection, time-lapse video photography was used to quantify time budgets. The animals were milked 2× daily at 0500 h in the morning and 1500 h in the afternoon. Feed intake and milk yield were monitored throughout the experiment.

During data collection, the pairs of cows from each treatment were randomly selected and continuously video taped. One time-lapse video cassette recorder (Panasonic model AG-6740, Panasonic Canada Inc., Mississauga, ON, Canada) and a video multiplexer (Panasonic MonoQuad-4, Panasonic Canada Inc.) were used to record the output from 3 video cameras (Panasonic color CCTV Super Dynamic II model WV-CP464, Panasonic Canada Inc.). Each camera captured the activities of one pair of cows. Therefore, each videotape recorded the activities of 3 pairs of cows/d. On d 1 and 2 and d 5 and 6 of each data collection period, 1 pair of cows on the 2× treatment and 2 pairs of cows on the 3× treatment were randomly selected and video-taped. On d 3 and 4 and d 7 and 8 of the data collection period, 2 pairs of cows on the 2× treatment and 1 pair of cows on the 3× treatment were videotaped. Upon completion of video recording, an instantaneous scan-sampling technique (Altmann, 1974; Fregonesi et al., 2004) was used at 10-min intervals to estimate time budgets for each activity, which were expressed as a percentage of 24 h.

The activities of the animals were assigned based on predefined options: posture (standing or lying down), location (feed manger, parlor, or exercise yard), and activity (eating, drinking, ruminating, idle, other, or absent). Standing was defined as the animal's body being supported by the 4 legs; lying down as the animal's body resting on the ground; eating as feed in mouth, chewing, or head down in the manger close to the feed; ruminating as regurgitating, chewing, or swallowing of the previously eaten feed; drinking as the muzzle being in the water bowl or the tongue licking water; idle as the animal doing absolutely nothing; other as any activity not mentioned here (e.g., grooming); and absent as the cow being in the milking parlor or exercise area. Time budgets were then calculated as the number of observations monitored for a particular activity per day divided by the total number of observations collected that day.

Feed [total mixed ration (TMR)] samples and orts were collected daily during the last week of each experimental period, stored at −20°C, and composited for subsequent analysis. Pooled TMR and ort samples were analyzed for DM by oven-drying at 60°C for 48 h (method 930.15, AOAC, 1990), for CP by using the macro-Kjeldahl procedure (method 984.13, AOAC, 1990), for ADF (method 973.18c, AOAC, 1990), for NDF (Van Soest et al., 1991), and for minerals (Ca, P, Mg, and K) by inductively coupled plasma spectroscopy (method 945.46, AOAC, 1990). Feed intake and milk yield data were analyzed using PROC GLM of SAS (v. 8.0, SAS Inst., Inc., Cary, NC).

Behavioral observations were analyzed using PROC MIXED of SAS. Time budget data (percentage of 24 h) were logarithm-transformed before analysis. The models evaluated the effects of treatment, period, group, and cow(group). Group effects were tested against the mean square of cow (group). Treatment least squares mean data are expressed as means ± SE. A probability of P < 0.05 was accepted as significant.

Results and Discussion

The time budgets for the 2× and 3× feeding expressed as a percentage of 24 h (time) are presented in Table 1. Time budgets were not affected (P > 0.05) by the frequency of feed delivery. In both treatments, the animals spent about 24% of the time within a 24-h period eating and about 30% of the time ruminating. This is consistent with the findings of Chaplin et al. (2000). Metz (1975) described the eating and ruminating patterns of 7 dry, nonpregnant Dutch cows offered hay wafers for ad libitum intake. The time spent eating in a 24-h period ranged from 17.2 to 27.2% and was not associated with either DMI or the BW of the cows, which is consistent with our findings. Daily rumination times in the Metz (1975) study ranged from 32.2 to 40.2% compared with 30% in the current study. The animals were idle for 29.7 vs. 29.0% (2× vs. 3×; Table 1) of the time. Phillips and Rind (2001) found that more frequent feeding of cows in free-stall housing resulted in reduced milk yield and suggested that feed delivery created a disturbance, as there is competition among cattle fed in groups and some cows might have to wait in the feeding passage before gaining access to the feed bunk. In the current study, there were no (P > 0.05) treatment differences in DMI (20.6 vs. 20.0 kg/d; SE = 0.26; 2× vs. 3×) and milk yield (31.0 vs. 31.0 kg/d; SE = 0.24; 2× vs. 3×), which is consistent with other previous studies (Nocek and Braund, 1985; Robinson and Sniffen, 1985). The animals spent 10.6% of the idle time within a 24-h period in the parlor or in the exercise yard. It is important to recognize that a long wait for milking limits access to feed and might limit DMI.
TABLE 1. Time budgets (percentage of 24 h; n = 6) for cows in a tie-stall operation fed a total mixed ration delivered 2× and 3× daily.

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatment</th>
<th></th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>2×</td>
<td>3×</td>
<td></td>
</tr>
<tr>
<td>Eating</td>
<td>23.3</td>
<td>24.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Ruminating</td>
<td>30.2</td>
<td>29.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Drinking</td>
<td>2.6</td>
<td>3.0</td>
<td>0.6</td>
</tr>
<tr>
<td>Idle(^a)</td>
<td>29.7</td>
<td>29.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Other</td>
<td>3.6</td>
<td>4.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Absent</td>
<td>10.6</td>
<td>10.6</td>
<td>0.2</td>
</tr>
<tr>
<td>Standing(^b)</td>
<td>41.0</td>
<td>42.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Lying down(^b)</td>
<td>48.4</td>
<td>46.9</td>
<td>2.6</td>
</tr>
</tbody>
</table>

\(^{a}\)In the parlor or in the exercise yard.

\(^{b}\)Summation of activities when standing or lying down.

Because there were no treatment differences (P > 0.05) in time budgets, we pooled the results (Figure 1). From the pooled data, the animals spent 42.4% of the time standing and 47.1% of the time lying down. Of the time spent eating, 84% of the time the animals were standing. Of the time spent ruminating, 67% of the time the animals were lying down. Of the time the animals were idle, 80% of the time they were lying down, which may be important to cows for several reasons. Several physiological changes are associated with reduced lying time in cattle; these include a short-term increase in plasma cortisol levels (Ladewig and Smidt, 1989; Fisher et al., 2002) and increased incidence of lameness (Singh et al., 1993; Leonard et al., 1994).

More blood circulates to the udder while the animal is lying down compared with standing (Metcalf et al., 1992).

**Implications**

Changing the feeding frequency from 2× to 3× daily did not alter the behavior patterns of dairy cows in tie stalls nor affected their feed intakes and milk yields. From a nutritionist or producer’s perspective, the most important activities for a dairy cow are eating, drinking, and ruminating (particularly ruminating while lying down). Dairy farmers can use knowledge of animal behavior to improve cow well being and yield.

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