Effect of feeding frequency on feedlot steer performance\textsuperscript{1,2,3}

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ABSTRACT

Crossbred yearling steers (n = 270; mean initial BW = 318 kg) were used to determine the effect of feeding frequency on feedlot performance and carcass characteristics. Steers were stratified by BW and randomly assigned to pens. Pens were then randomly assigned to 1 of 3 treatment groups: once-daily feeding (1X), twice-daily feeding (2X), or 3-times-a-day feeding (3X). Steers were fed a standard high-concentrate steam-flaked-corn based finishing ration for 170 d. Steers were housed in pens measuring 6.1 × 18.3 m. Feed was delivered to steers in fence-line (3.7 m in length) concrete bunks (0.31 m per steer). Pen served as the experimental unit, and cattle were slaughtered at a constant days on feed. Average daily gain was similar for steers fed 1X or 2X per day; however, feeding 3 times a day increased ADG, ADFI, and hot carcass weight.

Key words: feeding frequency, feedlot management, performance, steer

INTRODUCTION

In most large feedlot operations, cattle are fed more than once a day. Feeding multiple times during the day is believed to keep feed fresh, reduce digestive upsets, and improve performance because feed trucks may entice cattle to the bunk and stimulate cattle to eat (Schwartzkopf-Genswein et al., 2003). Feeding more than once per day has been reported to increase feed intake by 2 to 5% and reduce digestive upsets in feedlot cattle (Anderson, 1990). In addition, multiple feedings may help to maximize an individual animal’s access to feed (Pritchard, 2003). In contrast, cattle fed once daily at consistent morning times had higher ADG and better feed efficiencies than cattle fed once in the afternoon or twice daily (Delehant and Hoffman, 1996). Moreover, ADFI was similar between feeding frequencies (Delehant and Hoffman, 1996; Ruiz and Mowat, 1987). Cattle fed once daily in the morning had higher DP and QG, larger loin-eye areas, and less backfat than did cattle fed twice daily. The discrepancies between studies may be due to one or more of several factors including feedlot location, management strategies, diet composition, and cattle type.

Daily feed intake is favorably related to the health and profitability of feedlot cattle (Loerch, 2000). Cattle are inherently programmed to spend most of their time either eating or ruminating; therefore, altering feeding frequency could influence performance traits (Stricklin and Kautz-Scanavy, 1984). The objective of the present study was to determine the effect of feeding 1, 2, or 3 times per day on overall performance and carcass characteristics of finishing feedlot steers at the Southeast Colorado Research Center, located near Lamar, Colorado.

MATERIALS AND METHODS

Steer Source and Processing

Prior to the initiation of this experiment, all procedures were approved by the Colorado State University Animal Care and Use Committee. Crossbred yearling steers (n = 270; mean initial BW = 318 kg) were used in this experiment. The experiment was conducted during late summer, fall, and early winter in southeast Colorado. Steers were from a previous receiving study at the Southeast Colorado Research Center. Upon ini-
tion of this study (d −1), all steers were weighed, assigned a breed-type code and a previous receiving study treatment code, implanted (200 mg progesterone and 20 mg estradiol; Vet Life, Des Moines, IA), and given an electronic identification tag. Initial data were sorted by weight, and all steers that were ±2 SD from the mean initial BW were removed from the experiment. A sufficient number of the lightest remaining steers were then removed to obtain the 270 steers required for use in this study. To minimize the effects of the previous receiving experiment treatments, previous treatments were balanced across pens in this experiment.

**Pen and Treatment Allotment**

The study steers were ranked by BW and assigned a random number using the random number function in Microsoft Excel 2007 (Microsoft Inc., Seattle, WA). The lightest 135 steers were randomly assigned within each successive set of 5 steers based on the random number assigned to each steer, with each successive random number being assigned to replicates 1 through 5 in succession. This process was repeated until all 135 light steers were assigned to a replicate. Next, the heaviest 135 steers were randomly assigned to additional replicates that were numbered 6 through 10 using the same process as was used for replicates 1 through 5. Steers were next sorted by replicate and breed type and randomly assigned within replicate and breed type to 1 of 3 treatment groups: once-daily feeding (1X), twice-daily feeding (2X), or 3-times-a-day feeding (3X). Each successive set of 3 steers was assigned to treatment based on successive random numbers to the 1X, 2X, and 3X treatments, respectively. On study d 0, steers were returned through the chute, weighed, tagged with a visual tag, and sorted into 1 of 30 pens each housing 9 steers.

Steers on all treatments were fed a common finishing diet of steam-flaked corn grain, a roughage source, soybean meal, and a urea/limestone-based vitamin and mineral supplement (Table 1). Diets were formulated to meet or exceed all nutrient requirements for finishing steers (NRC, 1996). Various roughages were used throughout the study reflecting roughage availability at the Southeast Colorado Research Center. Feed calls were determined at 0630 h daily before the morning feeding. Bunk scores were developed based on ease of implementation and sensitivity. Bunk scores were as follows: n, a bunk that was devoid of all feed particles at the end of the work day or during the night (night slick); 0, a bunk devoid of all feed particles at morning (slick); 1/2, a bunk that contained trace to 2.26 kg of feed as fed (crumbs) at morning; 1, a bunk that contained 2.27 to 9.05 kg of feed as fed at morning; 2, a bunk that contained 9.06 to 18.80 kg of feed as fed at morning; and 3, a bunk that contained more than 18.80 kg of feed as fed at morning (feed looked virtually untouched by cattle).

A 0.23-kg-per-steer increase feed call occurred every other day for bunks with a score of n (night slick bunks), and a 0.23-kg-per-steer increase feed call occurred every third morning for cattle with a score of 0 (morning slick). Cattle with a bunk score of 1, 2, or 3 were cut by 0.91, 1.82, or 2.27 kg, respectively, the day of the score. Bunks with scores of 1 or 2 were scooped on d 3. Bunks with a score of 3 were scooped on d 1. A feed sample was collected and analyzed. The first day that cattle had a slick bunk after a feed cut, the cattle received half of the total kilograms cut back and were then bumped normally.

Steers on the 1X treatment were fed 100% of their ration starting at 0800 h; 2X steers were fed 60% of their total ration starting at 0730 h and the remaining 40% of their ration at 1300 h; and 3X steers were fed 34% of their ration starting at 0700 h, 33% of their ration at 1000 h, and the remaining 33% of their ration at 1400 h. Weigh backs were collected, weighed, and recorded throughout the study as feed became spoiled or on weigh days.

Steers were housed in pens measuring 6.1 × 18.3 m with a single continuous-flow automatic water fountain shared between every 2 pens. Feed was delivered to steers in fence-line (3.7 m in length) concrete bunks (0.31 m per steer) that had a 3.7-m-wide and 6.1-m-long concrete apron adjacent to the bunk to provide a solid area for steers to stand while eating. Steers were weighed individually on d −1, 0, 47, and 169. Steers were pen weighed on d 83 and 126.

Steers were slaughtered after 170 d on feed. On the shipping date, steers were transported approximately 274 km to a commercial abattoir for slaughter. Trained personnel matched ear tag with carcass identification tag on the day of slaughter. United States Department of Agriculture carcass grade data were obtained from the slaughter plant carcass data sheets.

**Statistical Analysis**

Statistical analysis of data was performed using mixed-model procedures as described by SAS (release 9.1, SAS Inst. Inc., Cary, NC). The model included the fixed effects of treatment, time, treatment × time interactions where appropriate, and initial weight as a covariate to account for the light and heavy weight blocks. The covariate was initially included within the

<table>
<thead>
<tr>
<th>Table 1. Basal diet composition (% DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ingredient</strong></td>
</tr>
<tr>
<td>Steam-flaked corn</td>
</tr>
<tr>
<td>Roughage source</td>
</tr>
<tr>
<td>Soybean meal</td>
</tr>
<tr>
<td>Yellow grease</td>
</tr>
<tr>
<td>Condensed corn distillers solubles</td>
</tr>
<tr>
<td>Supplement</td>
</tr>
</tbody>
</table>

1Roughage sources used included alfalfa hay, wheat silage, sorghum silage, and corn silage based on the forage availability throughout the study. Type of forage affected other ingredient amounts to balance CP and NE₃. |
model to ensure that the a priori randomization of the cattle truly worked to ensure that all treatment groups were of equivalent initial BW. The covariate was removed when found to be nonsignificant. Random effects were pen within treatment. Treatment and treatment × period interactions were considered to be significant if $P < 0.05$. Linear and quadratic contrasts were used to determine overall treatment effects. All frequency data were analyzed using chi-squared analysis, and within-class variances were compared using $F$-tests.

### RESULTS

#### Performance

The effects of feeding frequency on feedlot performance are shown in Table 2. Initial BW were similar ($P > 0.99$) across treatments. However, linear effects of feeding frequency on final BW were significant ($P < 0.05$). Final BW averaged 593, 593, and 604 kg for the 1X, 2X, and 3X treatments, respectively. Average daily gain ($P < 0.03$) and ADFI ($P < 0.04$) increased linearly as feeding frequency increased and averaged 1.63, 1.64, and 1.71 kg ADG and 9.24, 9.27, and 9.67 kg ADFI for the 1X, 2X, and 3X treatments, respectively. Gain-to-feed ratio was similar across all treatments and averaged 0.18.

#### Carcass Characteristics

The effects of feeding frequency on hot carcass weight and DP are shown in Table 3. Hot carcass weight for the steers increased (linear, $P < 0.01$; quadratic, $P < 0.05$) with increased feeding frequency, indicating that hot carcass weight was greater for steers fed 3X (370 kg) as compared with steers fed 1X (362 kg) or 2X (360 kg). Dressing percentages were similar ($P > 0.05$) among treatments and averaged 61.1%. No differences in YG or QG were detected among treatments (Table 3). A greater percentage of condemned livers ($P < 0.03$) were observed in cattle fed 3X and declined as feeding frequency decreased (Table 3).

### DISCUSSION

#### Feedlot Performance

Individual feedlot operations should examine the effect of feeding frequency on cattle performance and overall profitability. By determining what effect the number of feed deliveries per day has on intake, feedlot managers can determine how many times per day feedlot cattle should be fed to achieve optimum profitability by keeping labor, equipment, and feed costs at a minimum. Multiple feedings may improve labor and equipment utilization in large feedlots if multiple truck loads and several employees are needed to distribute feed to all cattle. Conversely, feedlots where multiple loads and several employees are not required to distribute adequate feed for an entire day, reducing the number of feedings may reduce labor, equipment maintenance, and repair costs.

Several early studies were conducted to determine the effects of feeding frequency on rumen factors. Gibson (1981) reported improved performance results due to increased feeding frequency in a meta-analysis of data obtained from 15 published reports. The meta-analysis analyzed data for cattle, and all experiments ran for a fixed time period. The study investigated ADG and ADFI based on the number of meals per day (1 to 24). According to the distribution of responses, the mean ADG ($P < 0.01$) was positively correlated with increased feeding frequency. Improved feed efficiency was also noted. It was concluded that the increased response of ADG to increased feeding frequency is most likely observed 1) in young animals, 2) in animals on diets that give low ADG if fed on 1 or 2 meals a day, 3) in animals fed diets with a high concentrate content, or 4) where increased feeding frequency increased ADFI. In an earlier experiment, Putnam et al. (1961) used 8 Angus heifer calves to determine if feeding more frequently than twice daily had an effect on rumen volatile acids, protozoal population, and BW.

### Table 2. Effects of feeding frequency on performance of finishing beef steers

<table>
<thead>
<tr>
<th>Trait</th>
<th>1X (SEM)</th>
<th>2X (SEM)</th>
<th>3X (SEM)</th>
<th>Treatment $P &lt;$</th>
<th>Contrast $P &lt;$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial BW, kg</td>
<td>317 (7.05)</td>
<td>319 (7.05)</td>
<td>318 (7.05)</td>
<td>0.99</td>
<td>0.92</td>
</tr>
<tr>
<td>Final BW, kg</td>
<td>593 (3.49)</td>
<td>593 (3.49)</td>
<td>604 (3.49)</td>
<td>0.05</td>
<td>0.03</td>
</tr>
<tr>
<td>ADG, kg/d</td>
<td>1.63 (0.02)</td>
<td>1.64 (0.03)</td>
<td>1.71 (0.02)</td>
<td>0.03</td>
<td>0.02</td>
</tr>
<tr>
<td>ADFI, kg</td>
<td>9.24 (0.13)</td>
<td>9.27 (0.13)</td>
<td>9.67 (0.13)</td>
<td>0.04</td>
<td>0.02</td>
</tr>
<tr>
<td>FE, kg/kg</td>
<td>0.18 (0.01)</td>
<td>0.18 (0.01)</td>
<td>0.16 (0.01)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

1X = fed once daily; 2X = fed twice daily; and 3X = fed 3 times daily.

2 A covariate of initial BW was used in SAS analysis (SAS Inst. Inc., Cary, NC).

3 Final weights were shrunk by 4% to represent a standard industry shrink.

4 FE = feed efficiency (ADG/ADFI).
gains. Calves were fed either 2 times per day or 10 times per day. There was no difference in VFA profiles or protozoal counts; however, BW gains increased ($P < 0.05$) with increased feeding frequency.

In a study conducted by Goonewardene et al. (1995), 120 steers weighing 285 kg were used to determine if feeding 1, 2, or 3 times per day affected cattle performance. No differences in ADG or feed efficiency ($P > 0.05$) were reported. Similar results were reported in a study designed to determine if 1 afternoon feeding versus 2-times-per-day feeding affected animal performance. No differences in ADG or feed efficiency ($P > 0.05$) were found (Stanton et al., 1991). In addition, a study conducted at the Clayton Livestock Research Center of New Mexico State University using 3 groups of steers revealed no performance improvements based on feeding frequency (Lofgreen et al., 1981). Group 1 cattle were received off of dry native grass, group 2 was received from wheat pasture, and group 3 was received from a growing program in the feedlot. Within each group, cattle were randomly assigned to either once- or twice-daily feeding. No differences were found for ADG, feed intake, or feed efficiencies.

### Carcass Characteristics

In contrast to the findings of the present study, Delehant and Hoffman (1996) reported that cattle fed once daily in the morning had higher DP than did cattle fed once daily in the afternoon or twice daily (60.17% vs. 59.88% vs. 58.92%). These increases could be attributed to the higher gains and feed efficiencies that were shown to exist in the cattle fed once daily in the morning. Another possible reason for the contradicting results could be the variation in climate (southeast Colorado vs. Iowa) or time of year of the trial (late summer to fall vs. late fall to winter). However, Delehant and Hoffman (1996) conducted a second experiment with similar same treatments and found DP to be higher (61.78% vs. 60.58% vs. 59.18%) with the twice-daily feeding as compared with the cattle fed once daily in the morning or afternoon regardless of the fact that the once-daily morning cattle had the greatest ADG. In addition, similar to the current experiment, no treatment differences in QG and YG existed. A study using 320 yearling steers to determine the performance and carcass characteristics of cattle fed once versus twice daily reported similar results to those found in this study; no differences in QG or YG were found across feeding frequencies (Hanke et al., 1981).

Liver abscesses are diet induced and the prevalence and severity of abscesses are negatively related to roughage level in the diet, and liver abscesses are of great economic significance to the beef cattle industry (Nagaraja and Lechtenberg, 2007). Brink et al. (1990) reported increased incidences of liver abscesses at slaughter reduced hot carcass weight ($P < 0.001$) and DP ($P < 0.01$) relative to cattle experiencing no liver abscesses. In addition, in contrast to the findings of this study, a greater incidence in liver abscesses decreased feed intake ($P < 0.10$) and feed efficiency ($P < 0.001$). It is not known why increased liver condemnations were observed for cattle fed 3X in the present study.

Maximizing consistent feed intake is very challenging, and as shown above, results are mixed. Diet formulation, ingredient quality, ingredient variation, ingredient processing, diet conditioners, diet batching time and methods, quantity offered, starting time for feeding, stress management, weather changes, feeding frequency, water management, time of day fed, cattle type, and bunk space have all been addressed as issues associated with intake consistency (Anderson, 1990; Prichard and Bruns, 2003). It is almost impossible to conduct a feed intake study without facing the challenges associated with an applied study of this magnitude. The main focus of this specific research study

### Table 3. Effects of feeding frequency on carcass characteristics and liver abscesses of finishing steers

<table>
<thead>
<tr>
<th>Trait</th>
<th>Treatment 1X</th>
<th>2X</th>
<th>3X</th>
<th>SEM</th>
<th>Treatment P &lt;</th>
<th>Contrast P &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot carcass weight, kg</td>
<td>362.1</td>
<td>360.7</td>
<td>370.9</td>
<td>2.26</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>DP2</td>
<td>61.1</td>
<td>60.8</td>
<td>61.4</td>
<td>0.21</td>
<td>0.18</td>
<td>0.29</td>
</tr>
<tr>
<td>USDA YG</td>
<td>2.92</td>
<td>2.89</td>
<td>2.88</td>
<td>0.10</td>
<td>0.96</td>
<td>0.79</td>
</tr>
<tr>
<td>QQ2</td>
<td>2.81</td>
<td>2.73</td>
<td>2.67</td>
<td>0.07</td>
<td>0.44</td>
<td>0.21</td>
</tr>
<tr>
<td>Noncondemned livers, %</td>
<td>85.54</td>
<td>82.14</td>
<td>69.88</td>
<td>—</td>
<td>0.03</td>
<td>—</td>
</tr>
<tr>
<td>Abscessed livers, %</td>
<td>8.43</td>
<td>3.57</td>
<td>13.25</td>
<td>—</td>
<td>0.08</td>
<td>—</td>
</tr>
</tbody>
</table>

1X = fed once daily; 2X = fed twice daily; and 3X = fed 3 times daily.

2Final weights were shrunk by 4% to represent a standard industry shrink.

3Quality grades were given a numerical code: 1 = Prime, 2 = Choice, 3 = Select, and 4 = Standard.

4Abscessed liver scores include A−, A, and A+ abscesses.
was to examine the best application of feeding frequency at a 1,500-steer feedlot in southeast Colorado. Therefore, discrepancies will exist between literature because of the above confounding restraints of conducting feedlot trials based on the cattle available at the time, the management of the feedyard, and the environmental effects that are uncontrollable.

**IMPLICATIONS**

Results of this study suggest that feeding frequency had an effect on steer performance. Average daily feed intake and ADG were greater for the steers fed 3X compared with those fed 1X or 2X. Increased feeding frequencies may result in higher intakes and gains. However, if managed properly, once-a-day feeding could result in greater profit margins. Once-daily feeding would reduce labor and equipment operation costs as long as multiple loads are not required to deliver adequate feed to all of the cattle. However, at large feedyards, if the same number of total loads and equipment hours are needed to haul feed for the cattle, labor and equipment costs may not necessarily be reduced by once-daily feeding. In addition, because of the discrepancies that exist in the literature, it is important that each individual feedlot evaluate the effect of feeding frequency on total profit and loss to better identify the appropriate feeding frequency system for that operation.

**LITERATURE CITED**


