EFFECTS OF EARLY WEANING ON FEEDLOT PERFORMANCE OF BULLS AND STEERS

E. K. Schlickau, J. A. Unruh, T. T. Marston, J. Brethour, and M. E. Dikeman

Summary

Crossbred Hereford × Angus calves (n = 103) were used to determine the effects of early weaning on feedlot performance of bulls and steers. Treatments were: 1) early-weaned (117 days of age) bulls, 2) early-weaned steers, 3) normal-weaned (220 days of age) bulls, and 4) normal-weaned steers. Early-weaned calves were placed on a grower ration at an average age of 134 days and on a finishing ration at 182 days of age. Normal-weaned calves were placed on a finishing ration at 242 days of age. Weight, feed intake, and ultrasound measurements were recorded during the feeding period. Three early-weaned cattle were removed due to chronic bloat, and four early-weaned cattle died in the feedlot. The feedlot period was terminated at either 358 or 387 days of age. Early-weaned cattle had greater average daily gains early in the feedlot period, but normal-weaned cattle had greater gains later in the feedlot period. Excluding the initial weight at 117 days of age, early-weaned cattle maintained heavier weights throughout the feeding period. Bulls had greater average daily gains until feedlot entry of normal-weaned calves, but steers had greater average daily gains later in the feedlot period, resulting in similar final weights. For early-maturing British-type cattle, early weaning resulted in heavier final weights, but it may not be the most viable management strategy because of disadvantages in animal health. Overall, there was no growth-performance advantage for leaving males intact, suggesting that the implant regimen used for these steers was sufficient to compensate for the expected loss in performance when bulls are castrated.

Introduction

Some consumers prefer “natural” non-implanted beef with minimal fat. Feeding bulls may provide an opportunity to meet this specification and improve performance compared with that of steers. Increased muscle gain can be obtained through the use of bulls for beef production. Although the use of bulls for meat production was extensively researched in the early 1980s, it has not been evaluated in combination with the practice of early weaning. Early weaning of steers has been shown to improve feed efficiency, accelerate marbling deposition, and decrease age at slaughter. Our objective was to investigate the use of early weaning and bulls on feedlot performance.

Procedures

One hundred three male Hereford × Angus calves born from January 31 to April 6, 2003, were used for this experiment. Calves were blocked by birth date and sire, then randomly assigned to one of four groups: 1) early-weaned bulls, 2) early-weaned steers, 3) normal-weaned bulls, and 4) normal-weaned steers. All calves were injected with Fortress® 7 (Pfizer Animal Health) on May 27 (average age of 86 days); at this time, calves assigned to the steer groups were castrated and implanted with Component® E-C (VetLife).

At an average age of 117 days, calves assigned to early weaning were weaned, weighed, injected with Bovi-Shield® 4 (Pfizer Animal Health), randomly assigned to pens by sex class (two bull pens and two steer pens),
and fed a complete starter ration. At an average age of 134 days, weight was recorded, and calves were shipped to the Agriculture Research Center in Hays, Kansas. The early-weaned calves were fed a grower ration and adjusted to a finishing ration at an average age of 182 days.

The calves designated for normal weaning remained with the cows on native grass near Manhattan, Kansas, with no creep feed throughout the summer. At an average age of 201 days, calves were injected with Bovi-Shield®, 4, One Shot® (Pfizer Animal Health), and Fortress® 7. Calves were weaned, weighed, randomly assigned to pens by sex class (two bull pens and two steer pens), and fed a complete starter ration at an average age of 218 days. At an average age of 242 days, calves were weighed, shipped to Hays, and adjusted to a finishing ration. All calves were then injected with Bovi-Shield® 4, and steers were implanted with Synovex® Choice (Fort Dodge). Steers were re-implanted with Synovex® Choice at an average age of 328 days. Feed intake was recorded daily for each pen.

Three cattle (two early-weaned steers and one early-weaned bull) were removed from the trial due to chronic bloating. Three early-weaned steers and one early-weaned bull died during the early feedlot phase. The cause of death was not determined. Data collected from these seven animals were not included in analysis.

At average ages of 269 and 328 days, calves were weighed, and ultrasound (Aloka, Wallingford, Connecticut, and Cattle Performance Enhancement Company cattle software; Oakley, KS) was used to determine marbling score and backfat over the first lumbar vertebrae. Ultrasound measures were then used to project feedlot termination. One randomly selected pen from each treatment was terminated when the steers were projected to have 0.4 inches of backfat. The remaining four pens were terminated when the bulls were projected to have 0.4 inches of backfat. Calves were consolidated and commingled with the other pens for shipment at average ages of either 358 or 387 days.

Results and Discussion

Early-weaned cattle initially had live weights similar to normal-weaned calves (117 days of age; Table 1). At 242 and 328 days of age (Table 1) and at the end of the feeding period (Table 2), early-weaned cattle were heavier than normal-weaned cattle. As a result, early-weaned cattle had greater weight per day of age than did normal-weaned cattle at all times except at 117 days of age.

Early-weaned calves had greater average daily gains from the time of early weaning to feedlot entry of the normal-weaned calves (Table 1). During the first 27 days that normal-weaned calves were in the feedlot (242 to 269 days of age), early-weaned cattle also had greater average daily gains. Early-weaned cattle had lesser average daily gains following this period until the termination of the trial (Table 2).

These results suggest that early-weaned cattle gain more rapidly during the early post-weaning period than do normal-weaned cattle, due to greater nutrient intake; early-weaned cattle continue to have an advantage in gain while normal-weaned cattle are adjusting to the feedlot. During the finishing phase, early-weaned cattle lose their advantage in gain but still have heavier final weights than normal-weaned cattle.

Bulls and steers had similar weights and weight-per-day-of-age at all times measured (Table 1). Compared with steers, bulls had greater average daily gains from early weaning to feedlot entry of normal-weaned cattle, but had lesser gains from 269 days of age until the end of the feeding period (Table 2).
It is well documented that bulls gain faster than steers due to the anabolic effects of testosterone, although this was not true during the feedlot period in our study. It may be that the implant regimen for steers yielded responses similar to the natural testosterone produced by bulls. Also, increased activity (fighting, etc.) may have caused bulls to expend more energy and have lesser gains later in the feedlot period.

Normal-weaned cattle had less dry matter intake but similar gain-to-feed ratios compared with early-weaned cattle during their first 27 days in the feedlot (Table 3). Compared with normal-weaned cattle, early-weaned cattle had similar feed intakes, but less efficient (P<0.05) gain-to-feed ratios during the finishing phase.

Bulls consumed less dry matter, but gained with similar efficiency to steers from feedlot entry of the early-weaned cattle to feedlot entry of the normal-weaned cattle (Table 3). After normal-weaned cattle entered the feedlot (242 days of age), bulls and steers had similar dry matter intakes and gain-to-feed ratios.

In our study, seven early-weaned cattle were removed due to chronic bloat or death. There were no deaths or instances of chronic bloat in the normal-weaned groups. The increased incidence of respiratory disease and death in our study may be partly due to stress at early weaning. The increased incidence of bloat may have been due to high feed intake or fluctuating consumption patterns induced by sub-acute acidosis.

Marbling score and backfat thickness, measured by ultrasound at 267 and 328 days of age, were greater for early-weaned cattle than for normal weaned cattle (Table 1). The greater intramuscular fat of early-weaned cattle can be partly attributed to the greater nutrient intake during the early feedlot period.

Bulls tended to have less ultrasound backfat at 269 days of age and had less ultrasound backfat at 328 days of age than steers did (Table 1). Bulls and steers had similar ultrasound marbling at both times, but this was not consistent with the carcass data (reported in an accompanying article). Bulls may have lost more marbling than steers did when cattle were mixed before slaughter, due to increased mounting and fighting activity.

In our study with early-maturing British-type cattle, early-weaned cattle and bulls gained faster early in the feeding period, whereas normal-weaned cattle and steers gained faster later in the feedlot period. Early-weaned cattle had heavier final weights than normal-weaned cattle had, but bulls and steers had similar final weights. Overall, there was no growth-performance advantage for bulls, suggesting that the implant regimen was sufficient to compensate for the expected loss in performance when bulls are castrated.
Table 1. Effects of Weaning Time and Sex Class on Growth Characteristics of Early-maturing British-type Cattle

<table>
<thead>
<tr>
<th>Item</th>
<th>Weaning Time</th>
<th>Sex Class</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Early&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Normal&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Steers</td>
</tr>
<tr>
<td>No. of cattle</td>
<td>45</td>
<td>51</td>
<td>47</td>
</tr>
<tr>
<td>Weight, lb</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>117 days</td>
<td>356</td>
<td>368</td>
<td>365</td>
</tr>
<tr>
<td>242 days</td>
<td>712&lt;sup&gt;c&lt;/sup&gt;</td>
<td>663&lt;sup&gt;f&lt;/sup&gt;</td>
<td>681</td>
</tr>
<tr>
<td>269 days&lt;sup&gt;c&lt;/sup&gt;</td>
<td>786</td>
<td>729</td>
<td>749</td>
</tr>
<tr>
<td>328 days</td>
<td>1035&lt;sup&gt;e&lt;/sup&gt;</td>
<td>970&lt;sup&gt;f&lt;/sup&gt;</td>
<td>1002</td>
</tr>
<tr>
<td>Weight per day of age, lb</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>117 days</td>
<td>3.11</td>
<td>3.22</td>
<td>3.22</td>
</tr>
<tr>
<td>242 days</td>
<td>2.98&lt;sup&gt;e&lt;/sup&gt;</td>
<td>2.76&lt;sup&gt;f&lt;/sup&gt;</td>
<td>2.84</td>
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<td>269 days</td>
<td>2.91&lt;sup&gt;e&lt;/sup&gt;</td>
<td>2.71&lt;sup&gt;f&lt;/sup&gt;</td>
<td>2.78</td>
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<tr>
<td>328 days</td>
<td>2.95&lt;sup&gt;e&lt;/sup&gt;</td>
<td>2.71&lt;sup&gt;f&lt;/sup&gt;</td>
<td>2.8</td>
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<tr>
<td>Daily gain, lb/day</td>
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<td></td>
<td></td>
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<tr>
<td>117-242 days</td>
<td>2.67&lt;sup&gt;e&lt;/sup&gt;</td>
<td>2.36&lt;sup&gt;f&lt;/sup&gt;</td>
<td>2.43&lt;sup&gt;h&lt;/sup&gt;</td>
</tr>
<tr>
<td>242-269 days</td>
<td>3.64&lt;sup&gt;e&lt;/sup&gt;</td>
<td>1.92&lt;sup&gt;f&lt;/sup&gt;</td>
<td>2.82</td>
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<td>Marbling score&lt;sup&gt;d&lt;/sup&gt;</td>
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<td></td>
<td></td>
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<td>269 days</td>
<td>4.4&lt;sup&gt;e&lt;/sup&gt;</td>
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<td>4.3</td>
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<tr>
<td>328 days</td>
<td>4.9&lt;sup&gt;e&lt;/sup&gt;</td>
<td>4.5&lt;sup&gt;f&lt;/sup&gt;</td>
<td>4.7</td>
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<tr>
<td>Backfat thickness&lt;sup&gt;d&lt;/sup&gt;, inches</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>269 days</td>
<td>0.21&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.12&lt;sup&gt;f&lt;/sup&gt;</td>
<td>0.17</td>
</tr>
<tr>
<td>328 days</td>
<td>0.33&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.25&lt;sup&gt;f&lt;/sup&gt;</td>
<td>0.33&lt;sup&gt;g&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup>Early-weaned calves were weaned at 117 days of age and entered the feedlot at 134 days of age.

<sup>b</sup>Normal-weaned calves were weaned at 220 days of age, entered the feedlot at 242 days of age.

<sup>c</sup>Weaning time x sex class interaction (P<0.05) in which normal-weaned steers (709 lb) were lighter (P<0.05) than normal-weaned bulls (749 lb), early-weaned bulls (782 lb), and early-weaned steers (790 lb).

<sup>d</sup>Obtained by ultrasound; 4.0=SI00, 5.0=Sm00.

<sup>e</sup>Within a row and weaning time, means having different superscript letters differ (P<0.05).

<sup>fg</sup>Within a row and sex class, means having different superscript letters differ (P<0.05).
Table 2. Effects of Weaning Time, Sex Class, and Feedlot Group on Final Feedlot Performance of Early-maturing British-type Cattle

<table>
<thead>
<tr>
<th>Item</th>
<th>Weaning Time</th>
<th>Sex Class</th>
<th>Feedlot Group&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Early&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Normal&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Steers</td>
</tr>
<tr>
<td>No. of cattle</td>
<td>45</td>
<td>50</td>
<td>45</td>
</tr>
<tr>
<td>Weight, lb</td>
<td>1117&lt;sup&gt;e&lt;/sup&gt;</td>
<td>1077&lt;sup&gt;f&lt;/sup&gt;</td>
<td>1109</td>
</tr>
<tr>
<td>Weight per day of age, lb</td>
<td>3.00&lt;sup&gt;e&lt;/sup&gt;</td>
<td>2.87&lt;sup&gt;f&lt;/sup&gt;</td>
<td>2.95</td>
</tr>
<tr>
<td>Daily gain&lt;sup&gt;d&lt;/sup&gt;, lb/day</td>
<td>3.22&lt;sup&gt;f&lt;/sup&gt;</td>
<td>3.51&lt;sup&gt;e&lt;/sup&gt;</td>
<td>3.53&lt;sup&gt;g&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup>Cattle were fed to average ages of either 358 or 387 days of age.
<sup>b</sup>Early-weaned calves were weaned at 117 days of age and entered the feedlot at 134 days of age.
<sup>c</sup>Normal-weaned calves were weaned at 220 days of age and entered the feedlot at 242 days of age.
<sup>d</sup>Average daily gain from 269 days of age to end of feedlot period.
<sup>e</sup>Within a row and weaning time, means having different superscript letters differ (P<0.05).
<sup>f</sup>Within a row and sex class, means having different superscript letters differ (P<0.05).
<sup>g</sup>Within a row and feedlot group, means having different superscript letters differ (P<0.05).

Table 3. Effects of Weaning Time and Sex Class on Pen Average Daily Gain, Dry Matter Intake, and Gain-to-Feed Ratio of Early-maturing British-type Cattle

<table>
<thead>
<tr>
<th>Item</th>
<th>Weaning Time</th>
<th>Sex Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Early&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Normal&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>134 to 242 days of age&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>No. of pens</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Dry matter intake, lb/day</td>
<td>20.0&lt;sup&gt;d&lt;/sup&gt;</td>
<td>16.6&lt;sup&gt;e&lt;/sup&gt;</td>
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<tr>
<td>Gain:feed</td>
<td>0.123</td>
<td>0.104</td>
</tr>
<tr>
<td>242 to 269 days of age</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Dry matter intake, lb/day</td>
<td>22.00</td>
<td>21.60</td>
</tr>
<tr>
<td>Gain:feed</td>
<td>0.140&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.165&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup>Early-weaned calves were weaned at 117 days of age, and entered the feedlot at 134 days of age.
<sup>b</sup>Normal-weaned calves were weaned at 220 days of age, and entered the feedlot at 242 days of age.
<sup>c</sup>Early-weaned pens only.
<sup>d</sup>Within a row and weaning time, means having different superscript letters differ (P<0.05).
<sup>e</sup>Within a row and sex class, means having different superscript letters differ (P<0.05).
EFFECTS OF EARLY WEANING ON CARCASS AND RIBEYE STEAK CHARACTERISTICS OF BULLS AND STEERS

E. K. Schlickau, J. A. Unruh, M. E. Dikeman, T. T. Marston, and J. Brethour

Summary

Crossbred Hereford × Angus calves (n = 103) were used to determine the effect of early weaning on carcass and ribeye (longissimus muscle) characteristics of bulls and steers. Treatments were: 1) early-weaned (117 days of age) bulls, 2) early-weaned steers, 3) normal-weaned (220 days of age) bulls, and 4) normal-weaned steers. Cattle were harvested at 360 and 389 days of age. At 36 hours postmortem, carcass quality and cutability were measured. Ribeye steaks were aged 14 days and scored for color, Warner-Bratzler shear force, and sensory panel evaluations. Carcasses from early-weaned cattle had greater dressing percentages, heavier weights, greater fat thicknesses, and higher numerical USDA Yield Grades (lower cutability). They also had more marbling and greater USDA quality grades, but had similar longissimus color, shear force, and sensory panel scores, compared with those of normal-weaned cattle. Bulls had greater dressing percentages, but had similar carcass weights to steers. Bull carcasses had less fat thickness and greater ribeye areas, resulting in lower numerical USDA Yield Grades (higher cutability) than steers had. They also had less marbling, darker color, and lower USDA quality grades than steers did. Longissimus muscles from bulls were darker, had greater shear forces, and had lower sensory panel tenderness scores than those from steers. For early-maturing British-type cattle, early weaning is a viable management strategy to produce heavier, higher-quality carcasses than those of normal-weaned cattle. Carcasses from early-weaned cattle are fatter and have lower cutability. For a non-implant “natural” market, bulls could be an alternative for producing high-cutability carcasses. Steaks may be less tender, however, and pre-harvest management must be optimized to reduce dark-cutting carcasses.

Introduction

Some consumers prefer “natural” non-implanted beef with minimal fat. Feeding bulls may provide an opportunity to meet this specification and improve performance compared with that of steers. Increased muscle gain can be obtained through the use of bulls for beef production. Although the use of bulls for meat production was extensively researched in the early 1980s, it has not been evaluated in combination with the practice of early weaning. Early weaning of steers has been shown to increase marbling and may improve tenderness. Our objective was to investigate the use of early weaning and bulls on carcass composition and ribeye characteristics.

Procedures

One-hundred three male Hereford × Angus calves born from January 31 to April 6, 2003, were used in this experiment. Calves were blocked by birth date and sire, then randomly assigned to one of four treatment groups: 1) early-weaned (117 days of age) bulls, 2) early-weaned steers, 3) normal-weaned (220 days of age) bulls, and 4) normal-weaned steers.

Management and performance data are reported in the companion article. At average ages of 269 and 328 days, calves were weighed, and ultrasound (Aloka, Wallingford,
CT, and Cattle Performance Enhancement Company cattle software; Oakley, KS) was used to determine backfat over the first lumbar vertebra. Ultrasound measures were used to project harvest date. One pen from each treatment was randomly chosen for harvest when the steers were projected to have 0.4 inches of backfat. The remaining four pens were harvested when the bulls were projected to have 0.4 inches of backfat.

Three days before harvest, four pens (one from each treatment) were assigned to the first harvest group and commingled for shipment. At 360 days of age, the first group was slaughtered at a federally inspected, commercial processing facility, and carcass data were collected. Five days before the next harvest date, the remaining four pens were commingled for shipment, and they were slaughtered at 389 days of age.

Carcass cutability and quality characteristics were evaluated at 36 hours postmortem. Boneless rib sections (11-12 rib) were collected, transported to Kansas State University, and aged under refrigeration in vacuum-packaged bags for 2 weeks. After aging, rib sections were faced, and three 1-inch thick ribeye (longissimus muscle) steaks were obtained, starting from the posterior end, for Warner-Bratzler shear force, trained sensory panel, and pH evaluations, respectively. Instrumental and visual color at 14 days postmortem was collected on the first steak, which was later used for measuring Warner-Bratzler shear force.

**Results and Discussion**

Early-weaned cattle had greater dressing percentages, heavier hot carcass weights, greater external fat thicknesses, and higher numerical USDA Yield Grades (lower cutability) than normal-weaned cattle had (Table 1). Sex class did not affect hot carcass weight. In a harvest group × sex class interaction, steers harvested at 389 days of age had the greatest fat thicknesses (Table 2); steers harvested at 360 days of age had greater fat thicknesses than did bulls harvested at 360 days of age, with bulls harvested at 389 days of age being intermediate.

Early-weaned cattle had greater marbling scores, resulting in higher average USDA quality grades than those of normal-weaned cattle (Table 1). Weaning time did not affect bone maturity or ribeye color.

Bulls had ribeyes with less marbling and a darker color than ribeyes from steers (Table 1). Bulls and steers exhibited similar bone maturity. In addition, bulls had a larger number of dark-cutting carcasses than steers did. Dark cutting results from the depletion of glycogen before harvest. When commingled before harvest, bulls in this study were more likely to become stressed and have greater energy (glycogen) expenditure than steers were, resulting in a larger percentage of dark-cutting carcasses.

At 14 days postmortem, longissimus muscle instrumental color, visual color, and pH were not affected by weaning time (Table 1). A sex class × harvest group interaction was observed, in which lower visual color scores (brighter and more cherry red) were observed for longissimus muscles from steers harvested at either 360 or 389 days of age than for longissimus muscles from bulls harvested at either 360 or 389 days of age (Table 2). In addition, longissimus muscles from bulls harvested at 389 days of age had lower visual color scores than did longissimus muscles from bulls harvested at 360 days of age. In support of visual color observations, longissimus muscles from bulls had lower L* and b* values, but greater a* values, than did longissimus muscles from steers (Table 1), indicating that bulls had
darker, redder, and less-yellow longissimus muscles.

In a harvest group × sex class interaction, steers harvested at 360 days of age had a lower longissimus muscle pH than did steers harvested at 389 days of age and bulls harvested at either 360 or 389 days of age (Table 2). These data agree with the greater incidence of dark cutters in bulls in the first harvest group, because dark-cutting beef has higher muscle pH and darker color scores than typical beef does.

Weaning time did not affect Warner-Bratzler shear force or sensory panel scores (Table 3). Cooked longissimus muscles from bulls were less tender than were longissimus muscles from steers, as indicated by greater shear force values, as well as lower sensory panel scores for myofibrillar tenderness, connective tissue amount, and overall tenderness. Steaks from bulls and steers had similar (P>0.10) sensory panel scores for juiciness, flavor, and off-flavor intensity.

Sensory panelists found more connective tissue in steaks from bulls than in those from steers. The amount of connective tissue detected by a sensory panel is often associated with connective-tissue maturation and collagen cross-linking. In addition, muscle dehydration due to pre-harvest stress may have contributed to decreased myofibrillar tenderness. The combination of myofibrillar and connective-tissue factors resulted in greater Warner-Bratzler shear force values and lesser overall sensory panel tenderness scores in steaks from bulls than in those from steers.

Except for flavor, sensory attributes and Warner-Bratzler shear forces were not affected by harvest group. Steaks from cattle harvested at 389 days of age had more beef flavor than did those from cattle harvested at 360 days of age. This may be partly attributed to a tendency of the later harvest group to have greater marbling scores.

For early-maturing British-type cattle, early-weaned cattle had heavier carcasses that were higher quality, but were fatter and had lower cutability, than those of normal-weaned cattle. Bulls may be an option for the production of “natural” non-implanted beef that has higher cutability than beef from steers, but steaks from bulls were less tender and had less marbling than did steaks from steers. Pre-harvest management must be optimized to prevent the occurrence of dark-cutting carcasses.
Table 1. Effects of Weaning Time, Sex Class, and Harvest Group on Carcass and Ribeye (Longissimus Muscle) Characteristics of Early-maturing British-type Cattle

<table>
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<tr>
<th>Item</th>
<th>Weaning Time</th>
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<th>Harvest Group&lt;sup&gt;a&lt;/sup&gt;</th>
<th>SEM</th>
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<tbody>
<tr>
<td></td>
<td>Early&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Normal&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Steers</td>
<td>Bulls</td>
</tr>
<tr>
<td>No. of cattle</td>
<td>45</td>
<td>51</td>
<td>47</td>
<td>49</td>
</tr>
<tr>
<td>Dressing percentage</td>
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<td>60.1&lt;sup&gt;k&lt;/sup&gt;</td>
<td>60.5&lt;sup&gt;m&lt;/sup&gt;</td>
<td>61.3&lt;sup&gt;l&lt;/sup&gt;</td>
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<tr>
<td>Hot carcass weight, lb</td>
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<td>688&lt;sup&gt;k&lt;/sup&gt;</td>
<td>672</td>
<td>666</td>
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<tr>
<td>Fat thickness, inches&lt;sup&gt;d&lt;/sup&gt;</td>
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<td>0.41&lt;sup&gt;k&lt;/sup&gt;</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Ribeye area, inches&lt;sup&gt;e&lt;/sup&gt;</td>
<td>11.90</td>
<td>12.10</td>
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<tr>
<td>USDA Yield Grade</td>
<td>3.22&lt;sup&gt;j&lt;/sup&gt;</td>
<td>2.70&lt;sup&gt;k&lt;/sup&gt;</td>
<td>3.24</td>
<td>2.68&lt;sup&gt;m&lt;/sup&gt;</td>
</tr>
<tr>
<td>Bone maturity&lt;sup&gt;e&lt;/sup&gt;</td>
<td>160</td>
<td>163</td>
<td>161</td>
<td>162</td>
</tr>
<tr>
<td>Marbling score&lt;sup&gt;f&lt;/sup&gt;</td>
<td>399&lt;sup&gt;j&lt;/sup&gt;</td>
<td>350&lt;sup&gt;k&lt;/sup&gt;</td>
<td>387&lt;sup&gt;l&lt;/sup&gt;</td>
<td>363&lt;sup&gt;m&lt;/sup&gt;</td>
</tr>
<tr>
<td>Visual color (36 hours)&lt;sup&gt;g&lt;/sup&gt;</td>
<td>4.20</td>
<td>4.50</td>
<td>3.5&lt;sup&gt;m&lt;/sup&gt;</td>
<td>5.2&lt;sup&gt;l&lt;/sup&gt;</td>
</tr>
<tr>
<td>USDA quality grade&lt;sup&gt;h&lt;/sup&gt;</td>
<td>4.2&lt;sup&gt;j&lt;/sup&gt;</td>
<td>3.6&lt;sup&gt;k&lt;/sup&gt;</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>No. of dark cutters</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Instrumental color&lt;sup&gt;i&lt;/sup&gt;</td>
<td>L*</td>
<td>42.50</td>
<td>43.00</td>
<td>44.2&lt;sup&gt;l&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>a*</td>
<td>27.40</td>
<td>28.10</td>
<td>26.7&lt;sup&gt;m&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>b*</td>
<td>18.30</td>
<td>18.90</td>
<td>19.9&lt;sup&gt;l&lt;/sup&gt;</td>
</tr>
<tr>
<td>Visual color&lt;sup&gt;di&lt;/sup&gt;</td>
<td>5.60</td>
<td>5.60</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>pH&lt;sup&gt;di&lt;/sup&gt;</td>
<td>5.80</td>
<td>5.70</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<sup>a</sup>One pen from each treatment combination was randomly selected for harvest at 360 or 389 days of age.

<sup>b</sup>Early-weaned calves were weaned at 117 days of age and entered the feedlot at 134 days of age.

<sup>c</sup>Normal-weaned calves were weaned at 220 days of age and entered the feedlot at 242 days of age.

<sup>d</sup>Sex class x harvest group interaction (P<0.05, Table 2).

<sup>e</sup>100=A-00, 200=B-00.

<sup>f</sup>Slight00=300, Small00=400.

<sup>g</sup>Scale of 1-8: 1=bleached red, 4=cherry red, 8=dark red.

<sup>h</sup>5=Choice-, 4=Select+, 3=Select-.

<sup>i</sup>Ribeye measurements at 14 days postmortem.

<sup>j</sup>Within a row and weaning time, means having different superscript letters differ (P<0.05).

<sup>k</sup>Within a row and sex class, means having different superscript letters differ (P<0.05).

<sup>l</sup>Within a row and harvest group, means having different superscript letters differ (P<0.05).
Table 2. Harvest Group x Sex Class Interaction Means for Carcass Traits and Ribeye Longissimus Muscle) Characteristics of Early-maturing British-type Cattle

<table>
<thead>
<tr>
<th>Item</th>
<th>360 Days of Age</th>
<th>389 Days of Age</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of cattle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steers</td>
<td>Bulls</td>
<td></td>
</tr>
<tr>
<td>Fat thickness, inches</td>
<td>0.48d</td>
<td>0.38e</td>
<td>0.61c</td>
</tr>
<tr>
<td>USDA quality grade&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.0d</td>
<td>3.8d</td>
<td>4.4c</td>
</tr>
<tr>
<td>Visual color&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.1c</td>
<td>6.2c</td>
<td>5.2c</td>
</tr>
<tr>
<td>pH, 14 days postmortem</td>
<td>5.6d</td>
<td>5.9c</td>
<td>5.8c</td>
</tr>
</tbody>
</table>

<sup>a</sup>S=Choice-, 4=Select+, 3=Select-.  
<sup>b</sup>Ribeye color scores of 1 to 8 at 14 days postmortem: 1=bleached red, 4=cherry red, 8=very dark red.  
<sup>cde</sup>Within a row means having different superscript letters differ (P<0.05).

Table 3. Effects of Weaning Time, Sex Class, and Harvest Group on Ribeye (Longissimus Muscle) Sensory Panel Scores and Warner-Bratzler Shear Force Values of Early-maturing British-type Cattle

<table>
<thead>
<tr>
<th>Item</th>
<th>Weaning Time</th>
<th>Sex Class</th>
<th>Harvest Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Early</td>
<td>Normal</td>
<td>Steers</td>
</tr>
<tr>
<td>No. of cattle</td>
<td>45</td>
<td>50</td>
<td>47</td>
</tr>
<tr>
<td>Sensory panel&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myofibrillar tenderness</td>
<td>5.6</td>
<td>5.6</td>
<td>5.9b</td>
</tr>
<tr>
<td>Connective tissue amount</td>
<td>6.8</td>
<td>6.8</td>
<td>7.0b</td>
</tr>
<tr>
<td>Overall tenderness</td>
<td>5.7</td>
<td>5.7</td>
<td>6.0b</td>
</tr>
<tr>
<td>Juiciness</td>
<td>5.7</td>
<td>5.7</td>
<td>5.7</td>
</tr>
<tr>
<td>Flavor</td>
<td>5.8</td>
<td>5.8</td>
<td>5.8</td>
</tr>
<tr>
<td>Off flavor</td>
<td>7.7</td>
<td>7.6</td>
<td>7.6</td>
</tr>
<tr>
<td>Shear force, lb</td>
<td>11.7</td>
<td>11.7</td>
<td>10.1c</td>
</tr>
</tbody>
</table>

<sup>a</sup>Sensory panels evaluated steaks on an eight-point scale; (myofibrillar and overall tenderness: 1=extremely tough to 8=extremely tender; connective tissue: 1=abundant to 8=none; juiciness: 1=extremely dry to 8=extremely juicy; flavor: 1=extremely bland to 8=extremely intense; off flavor: 1=abundant to 8=none).

<sup>b</sup>Within a row and sex class, means having different superscript letters differ (P<0.05).

<sup>d</sup>Within a row and harvest group, means having different superscript letters differ (P<0.05).