Growth implants reduced tenderness of steaks from steers and heifers with different genetic potentials for growth and marbling

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ABSTRACT: The objective of this study was to evaluate the effect of growth implants on the carcass characteristics and tenderness of steers and heifers with different genetic potentials for growth, lean meat yield production, and marbling. Two experiments were conducted. Experiment 1 evaluated Angus steers sired by bulls with high EPD for retail product yield or marbling. Implant treatment was imposed randomly within sire groups. Loins (Institutional Meat Purchasing Specifications 180) were collected from each carcass and cut into three 2.54-cm steaks aged for 7, 14 and 21 d to evaluate tenderness. The second experiment evaluated steers and heifers of British and Continental breed descent. Steers and heifers were slaughtered after 120 d on feed. Loin sections were collected, and one 2.54-cm steak aged 7 d was used for tenderness analysis. When implants were used in Angus steers, HCW and LM area increased, whereas internal fat and marbling decreased (P < 0.01). In Angus steers, sire type did not affect shear force values of steaks; however, implant use significantly increased shear force values (P < 0.01). Carcasses from cattle of Continental breed descent were significantly heavier than carcasses of British breed descent with larger LM area, slightly less fat, and a reduced yield grade (P < 0.01). Also, steer carcasses were heavier than heifer carcasses with larger LM (P < 0.05), but no effect of sex on fat depth, internal fat, yield grade or marbling was observed. No significant interactions were seen between growth implant and breed or between growth implant and sex for shear force values. Shear force values were significantly less for steaks from steers and heifers of British decent compared with steers and heifers of Continental descent (P < 0.01). Steaks from implanted steers and heifers had significantly (P < 0.01) greater shear force values than steaks from steers and heifers not implanted. Use of growth implants in growing cattle resulted in significantly heavier carcass weights, larger LM area, and reduced internal fat. However, implant use also reduced the amount of marbling along with contributing to reduced tenderness. Complicating the tenderness issue is the increased shear force values reported for heifers as well as steers of Continental breed descent. Use of implants may contribute to tenderness variability because of different animal responses to implants.

Key words: beef, genetic potential, growth implant, shear force, tenderness

INTRODUCTION

Growth implants are routinely used to improve efficiency of meat production by improving red meat yield. Increased feed efficiency (Herschler et al., 1995; Johnson et al., 1996; Foutz et al., 1997) and increased LM area (Duckett et al., 1999) have been reported with the use of implants. Some researchers have reported a reduction in marbling and fewer carcasses grading Choice (Roebel et al., 2000; Platter et al., 2003). Duckett et al. (1999) reported that implanting reduced marbling score by about one-half a marbling degree compared with nonimplanted controls.

Recent research has shown reduced tenderness with aggressive implant strategies. Roebel et al. (2000) reported steaks from British steers treated with a combination (estradiol benzoate, trenbolone acetate) implant followed by no implant had significantly greater Warner-Bratzler shear values than steaks from steers never implanted. Furthermore, consumer panelists found steaks from implanted steers less tender and juicy than steaks from nonimplanted steers. In another study, Platter et al. (2003) reported the closer the implant strategy was used, the greater the incidence of implanted steers scoring in the Choice or Prime grade, and the greater the incidence of implanted steers scoring less tender and juicy compared with nonimplanted steers.

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applied to slaughter the more likely shear values were to be affected. Additionally, Scheffler et al. (2003) observed a linear increase for Warner-Bratzler shear force values in steaks from heifers that had been implanted with greater cumulative estradiol benzoate potency.

Late maturing, heavily muscled animals already have a larger muscle to bone ratio (Wheeler et al., 1989) indicating greater protein accretion with reduced protein degradation (Koohmaraie et al., 2002) than earlier maturing light muscled animals. This observation is also true when steers are compared with heifers. The use of growth implants in animals with greater growth potential to increase the rate of growth may compound any tenderness problems created by growth implants. The objective of this study was to evaluate the effect of growth implants on the carcass characteristics, tenderness, and protein degradation of steers and heifers with different genetic potentials for growth, lean meat yield production, and marbling.

MATERIALS AND METHODS

All procedures involving live animals were conducted within the guidelines and approval of the Montana State University Agricultural Animal Care and Use Committee.

Study 1: Marbling and Retail Product Animals

Steers (n = 64; 32 implant, 32 no implant) sired by bulls with high EPD for retail product yield (low yield grades) and steers (n = 64; 32 implant, 32 no implant) sired by bulls with high EPD for marbling were assigned to an implant protocol (implanted or not implanted) on entry into the feedlot in 2 consecutive years. Sire selection was based on the EPD for retail product yield and marbling. The EPD for these characteristics were from the top 10% of the breed, and all other EPD for production traits such as birth weight, yearling BW, and milk production were maintained close to the breed average. High retail product sires had marbling EPD near the breed average, whereas high marbling sires had retail product EPD near the breed average. Sires were the same for both years and had to have accuracies for the EPD of at least 50%. Ralgro (Schering-Plough, Kenilworth, NJ) was administered for 60 d on all steers at weaning, and one single implant was administered upon entry into the feedlot (120 d). Animals designated as no implant did not receive an implant upon entry into the feedlot. Implants were a combination implant containing estradiol benzoate (14 mg) and trenbolone acetate (100 mg; Synovex Choice, Fort Dodge Animal Health, Overland Park, KS). Steers were fed in a commercial feedlot on a high energy barley-based ration and slaughtered following normal industry procedures. Trained university personnel collected carcass data including HCW, fat thickness, LM area, internal fat percentage, and marbling scores. Loins (Institutional Meat Purchasing Specifications 180) were collected from each carcass. Loins were transported (4°C) to Montana State University and cut into four 2.54-cm steaks. Steaks were aged for 7, 14, or 21 d at 4°C and then frozen at –20°C until cooked for tenderness analysis.

Study 2: Breed Type

Steers and heifers sired by British (n = 34, 18 heifers, 16 steers; 17 implant, 17 no implant) or Continental (n = 41; 18 heifers, 23 steers; 20 implant, 21 no implant) sires were randomly assigned to implant treatments. No calf implants such as Ralgro (Schering-Plough) were used for either treatment. One implant was administered on entry into the feedlot. Implants used were a combination implant containing estradiol benzoate (24 mg), trenbolone acetate (120 mg), and tylosin tartrate (29 mg; VetLife, West Des Moines, IA). Steers and heifers were fed a high energy barley-based ration for 120 d, then shipped to a commercial processing facility (8 h with 12 h of rest) and slaughtered following normal industry procedures. After 24 h at 4°C, carcass data were collected by experienced university personnel, including carcass weight, fat thickness, LM area, internal fat percentage, and marbling scores. Loin sections (7.62 cm) were removed from each carcass starting at the 13th rib and moving toward the round. One 2.54-cm steak was cut from each loin section for tenderness analysis.

Shear Force Analysis

Steaks were thawed at 4°C for 24 h. Each steak was weighed before and after cooking to determine cooking loss. Eight to 10 samples (1.27 × 1.27 × 2.54 cm) for shear force evaluation were removed from each steak parallel to the fiber direction. Samples were sheared once perpendicular to the fiber direction with a TMS 30 Food Texturemeter (Food Technology Corp., Rockville, MD) fitted with a Warner-Bratzler shear attachment. The average of the samples sheared was used for statistical analysis.

Statistics

Individual animals were used as the experimental unit in both studies. In study 1 steers sired by bulls selected for marbling or high retail product yield were randomly assigned to 2 implant strategies, implanted upon entry into the feedlot or no implant in the feedlot. Carcass data and shear force values were collected. The second study randomly assigned steers and heifers sired by British breed bulls or Continental bulls to 2 different implant strategies, single implant upon entry into the feedlot or no implant for the life of the animal. Carcass and shear force data were collected. The GLM proce-
dure of SAS was used to analyze carcass and tenderness data. In study 1 sire type, year, and implant strategy were used as independent variables. Individual sires were tested but had no effect so were dropped from the model. In study 2 breed type, sex, and implant strategy were used as the independent variables. Planned comparisons between implant strategy (implant vs. no implant) and genetic classifications (high retail product vs. high marbling or Continental vs. British) or implant strategy and sex were used to determine mean differences.

## RESULTS AND DISCUSSION

### Carcass Characteristics

No significant sire type \times implant interaction was observed for any of the carcass data when evaluating Angus steers. Year had no effect on HCW, fat depth, internal fat, yield grade, or marbling. The LM area was, however, smaller in yr 1 than in yr 2 (Table 1). Growth implants used in Angus steers classified by sire EPD for marbling and retail product yield significantly ($P < 0.05$) affected carcass characteristics (Table 1). When implants were used in Angus steers, HCW and LM area increased ($P < 0.01$), whereas internal fat was reduced ($P < 0.01$). Fat depth and yield grade were not significantly affected ($P \geq 0.09$). Additionally, marbling score was significantly reduced ($P < 0.01$) with the use of implants (Table 1). Even though groups were finished to an ultrasound endpoint of low Choice, steers that did not receive an implant had greater marbling scores (Table 1). Carcasses from steers that had been implanted graded Low Choice, whereas the average marbling score for carcasses from nonimplanted steers graded Average Choice, which means the nonimplanted group would be eligible for premiums given for the upper two-thirds of Choice.

As expected, breed type and sex had a significant ($P < 0.05$) effect on carcass characteristics, especially HCW and LM area. Carcasses from cattle of Continental sires were significantly ($P < 0.01$) heavier than those of British breed sires with a larger LM area ($P < 0.01$) along with slightly less fat ($P < 0.01$) and a reduced yield grade ($P < 0.01$). Also, steer carcasses were heavier ($P < 0.01$) than heifer carcasses with a larger LM, but there was no effect of sex on the fat depth, internal fat, yield grade, or marbling.

When growth implants were administered to steers and heifers, there was a significant ($P < 0.05$) effect on carcass characteristics, especially HCW and LM area. Carcasses from cattle of Continental sires were significantly ($P < 0.01$) heavier than those of British breed sires with a larger LM area ($P < 0.01$) along with slightly less fat ($P < 0.01$) and a reduced yield grade ($P < 0.01$). Also, steer carcasses were heavier ($P < 0.01$) than heifer carcasses with a larger LM, but there was no effect of sex on the fat depth, internal fat, yield grade, or marbling.

Many researchers have reported similar results to those reported here. Herschler et al. (1995) found increased HCW and decreased fat thickness and KPH with the use of different dose rates of trenbolone acetate and estradiol benzoate implants. Furthermore, these researchers reported the use of a 40/140 (estra-
Shear force values in this study for Angus steers. Agreeing with this information is Bruns et al. (2005) who reported that implanting Angus and Angus × Limousin cross steers with a combination implant significantly increased HCW, dressing percentage, and LM area, as well as reduced marbling score, and decreased the number of carcasses grading in the premium categories of Average Choice and above. In contrast, another study comparing combined use of trenbolone acetate and estradiol implants found no difference in HCW or USDA quality grade but did find a significant increase in LM area (Johnson et al., 1996). Differences reported by different researchers could be explained by differences in the genetic predisposition of the implanted animals to deposit intramuscular fat. Angus steers that had been selected on EPD for marbling had a significantly greater degree of marbling than did Angus steers selected for retail product yield (Table 1). Use of implants reduced the amount of marbling in steers from both sire types (no significant interaction between sire type and implant use). Therefore, when animals that are genetically more likely to deposit marbling are implanted, there would be less of an impact on the number grading Choice than would be seen in animals that were less likely to grade Choice due to genetic predisposition or short-term feeding.

Shear Force Values

There was a significant difference ($P < 0.01$) for shear force between the years (Table 1) in study one. Angus steers slaughtered the first year had greater shear force values than did steaks in the second year. There was no significant interaction between years and implant use or sire type. Differences between the data collected in different years could be attributed to animal variation, along with other environmental factors that were outside the control of the study. Sire type had no effect on the shear force values of steaks from Angus steer carcasses. Implant use did significantly increase shear force values (Table 1). Addition of an implant increased shear force values by 5.8 N, which translates into approximately 0.5 kilogram of shear force. No interaction was observed between sire type (high retail product, high marbling) and use of implant on shear force values. Aging of steaks for 14 or 21 d after slaughter significantly reduced the shear force value of steaks compared with 7 d of aging, but there was no significant decrease in shear force between 14 and 21 d (Figure 1). This suggests that improvements associated with aging happened up to 14 d of aging with no significant improvement after that time. Schneider et al. (2007) disagreed with these data, reporting greater Warner Bratzler shear force values with aggressive implant treatments, but 28 d of aging was needed in most treatments for there to be no differences between the implanted and nonimplanted treatments.

Shear force values were significantly less ($P < 0.05$) for steaks from steers and heifers of sired by British bulls when compared with steers and heifers sired by Continental bulls (Table 2). This information along with increased HCW and LM area of Continental cattle would suggest that increased growth rate might have some impact on tenderness. However, shear force values were significantly less ($P < 0.05$) for steaks from steers than steaks from heifers (Table 2). Hawkins et al. (2004) reported similar Warner-Bratzler shear values of steaks from steers and heifers with heifers having a slightly decreased numeric value. Choat et al. (2006), however, reported greater shear force values for steaks from intact heifers when compared with steaks from steers or spayed heifers. The increased shear force values in heifers could be attributed to greater cumulative estradiol concentrations as reported by Scheffler et al. (2003).

No significant interactions were seen between growth implant and breed or between growth implant and sex. Steaks from implanted steers and heifers had significantly ($P < 0.01$) greater shear force values than steaks from steers and heifers not implanted (Table 2). Even though a significant interaction was not found, growth implants administered to Continental steers and heifers did have a much greater numeric increase in shear force values than when implants were administered to steers and heifers sired by British breed bulls (Table 1). Many researchers have reported no effect on tenderness with the use of combination implants. Barham et al. (2003) reported no significant increase in Warner-Bratzler shear force values between steaks from implanted steers when compared with steaks from nonimplanted steers. However, a trained sensory panel rated steaks from implanted treatments to have less initial and sustained tenderness. Consumer panelists on the other hand failed to detect any differences in steak samples related to implant treatment after 7 and 14 days of aging.
d of aging. Furthermore, Hawkins et al. (2004) evaluated different implant strategies on Angus crossbred steers and heifers and concluded that implants had no effect on meat tenderness when calves of a similar genetic background were fed a growing/finishing diet immediately after weaning and slaughtered at a constant fat thickness. Conversely, Foutz et al. (1997) reported that shear force values were significantly greater from steaks from implanted British × Limousin cross steers when compared with steaks from nonimplanted steers. However, no differences were noted in the percentages of tough steaks (shear force values greater than 4.5 kg) produced. Additionally, Platter et al. (2003) reported significant increases in shear force values when aggressive implant strategies were used when compared with no implants. Also, steaks from nonimplanted steers were rated as more desirable for overall eating quality by a consumer panel than steaks from steers implanted 2, 3, 4, or 5 times. Additionally, the number of steaks that had shear force values less than 4.5 kg after 14 d of aging was reduced with the use of implants. Schneider et al. (2007) observed mean 14-d LM Warner Bratzler shear force values increased linearly for steaks from reimplanted heifers as the cumulative, combined dosage of estradiol benzoate plus trenbolone acetate increased. A key concept of using implants effectively is to evaluate the variation in the cattle being implanted. Comparing cattle with genetically different backgrounds resulted in significant changes in meat tenderness (Continental vs. British). It may be very important to reducing variability of meat tenderness to have animals of similar genetic and nutritional background to minimize the impact that implants have on tenderness.

In conclusion, results from this study shows that the use of growth implants in growing cattle result in significantly heavier carcasses weights, larger LM, and reduced internal fat. However, implant use also reduces the amount of marbling along with contributing to reduced tenderness. Complicating the tenderness issue is the increased shear force values reported for heifers as

### Table 2. Effect of breed type, sex, and growth implants on carcass traits and tenderness

<table>
<thead>
<tr>
<th>Item</th>
<th>HCW, kg</th>
<th>LM area, cm²</th>
<th>Fat depth, cm</th>
<th>KPH, %</th>
<th>Yield grade¹</th>
<th>Marbling²</th>
<th>Shear force, N</th>
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<td>320.8</td>
<td>82.6</td>
<td>0.8</td>
<td>1.8</td>
<td>2.2</td>
<td>389</td>
<td>77.5</td>
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<tr>
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<td>75.5</td>
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<td>1.9</td>
<td>2.5</td>
<td>388</td>
<td>65.7</td>
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<td>6.5</td>
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<td></td>
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<tr>
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<td>1.9</td>
<td>2.4</td>
<td>384</td>
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<td>1.0</td>
<td>2.3</td>
<td>381</td>
<td>77.5</td>
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<td>2.0</td>
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<td>0.1</td>
<td>7.0</td>
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</table>

¹Calculated yield grade = 2.5 + (2.5 × adjusted fat thickness, 12th rib, inches) + (0.0038 × HCW, pounds) + (0.2 × percentage KPH) – (0.32 × LM area, square inches).
²200 to 299 = traces; 300 to 399 = slight; 400 to 499 = small; 500 to 599 = modest, 600 to 699 = moderate.
³Breed types were characterized by what the sire was known to be. Continental descent cattle were from Simmental sires whereas British descent cattle were from Angus and Hereford sires. n = 75.
well as steers of Continental breed descent. This sug-
jects that the conflicting results found in tenderness
of steaks reported in the literature are partially due to
sex of the animals along with the genetic background
of the cattle implanted. Variation in the sex, breed, and
implant strategies used in the beef industry contribute
greatly to the variations seen in tenderness of steaks in
the marketplace.

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