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Factors influencing tenderness in steaks from Brahman cattle

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Abstract

The objective of this study was to identify a set of explanatory variables for Warner–Bratzler shear force and myofibril fragmentation indices after 7, 14, and 21 d of aging; and sensory tenderness after 14 d of aging of steaks from Brahman cattle. Insoluble collagen was negatively associated ($P < 0.001$) with all tenderness traits across aging periods, and regression coefficients ranged from 5.69 ± 0.49 to 9.12 ± 0.29 N for Warner–Bratzler shear force. The effect of lean color score ($P < 0.05$) in analyses of unadjusted traits was diminished when data were adjusted for contemporary group (calves of the same sex, fed in one pen, and slaughtered the same day). Insoluble collagen may be of special importance and offer a unique opportunity to improve palatability of steaks from purebred Brahman cattle.
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Keywords: Beef; Brahman; Collagen; Tenderness

1. Introduction

There are many advantages of using Brahman crossbred cattle in different parts of the world, but there are some widely known undesirable palatability attributes which reduce the value of cattle with Brahman background. Among the most important of these undesirable attributes is the reputation for inadequate tenderness in the middle meats. Since the report of Crouse, Cundiff, Koch, Koohmaraie, and Seideman (1989), the US beef industry has persistently identified toughness of steaks from Brahman carcasses as a final product problem for consumers. Consequently, lower prices for feeder and fed cattle have been realized for cattle with identifiable Brahman background. It is therefore appropriate to investigate all aspects of tenderness in Brahman cattle for potential improvement. Characterization of tenderness measures in purebred populations is an important initial step in finding a solution to this problem. Genetic control of tenderness measures is low in purebred Brahman (Riley et al., 2003a), but appears to be somewhat higher in crossbred populations (Gregory, Cundiff, & Koch, 1995; O'Connor, Tatum, Wulf, Green, & Smith, 1997). A major palatability difference between *Bos indicus* and *Bos taurus* cattle appears to be the result of calpastatin activity in postmortem muscle (Pringle, Williams, Lamb, Johnson, & West, 1997; Whipple et al., 1990b). Proper management of the carcass may be more important for controlling palatability, especially tenderness (Robinson, Ferguson, Oddy, Perry, & Thompson, 2001). Postmortem intervention strategies such as electrical stimulation or alternate methods of carcass suspension (Koohmaraie, 1996; Thompson, 2002) especially with regard to different muscles (Koohmaraie, Kent, Shackelford, Veiseth, & Wheeler, 2002) may be effective

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for improving tenderness in Brahman carcasses. The objective of the present study was to identify a set of factors that influence different measures of tenderness of longissimus steaks from Brahman carcasses.

2. Materials and methods

2.1. Animals

The original experiment design and animal population was described by Riley et al. (2002). In brief, Brahman sires were progeny tested by mating to Brahman cows in the herd at the Subtropical Agricultural Research Station (STARS) near Brooksville, FL. Initially, four or five sires were used each year from 1994 through 1998 in single-sire breeding herds of approximately 30 cows. In all years but the first, a sire used the previous year was again used. In 1999, the American Brahman Breeders Association requested that the experiment be continued for two additional years in order for the breed to participate in the various aspects of the National Cattlemen's Beef Association Carcass Merit Project. The data for the current study came from calves that were born in 1998 through 2001. Brahman bulls ($n = 12$) were loaned to the station for this project or semen (for $n = 3$ bulls) was provided for artificial insemination of cows.

2.2. Feeding and slaughter procedures

All experimental procedures were evaluated for compliance with all appropriate regulations and approved by the local Institutional Animal Care and Use Committee. Calves were born in spring of each year and immediately after weaning at approximately 7 months of age, both steers (all males were castrated at birth) and heifers went through a brief conditioning period and then were placed in the STARS feed yard and adjusted to a feeding regimen previously described (Riley et al., 2002). When the median back fat (as measured by real time ultrasound) of a pen of cattle was 10 mm, the entire pen was slaughtered under normal commercial procedures in Central Florida. Sires averaged 31.2 progeny with records; these ranged from $n = 12$ (sire was killed by lightning during the breeding season) to $n = 53$.

2.3. Traits evaluated

Hot carcass weight was recorded at slaughter. Approximately 18–24 h after slaughter, carcasses were evaluated by trained University of Florida personnel. Factors affecting USDA yield and quality grades were: 12th rib fat thickness adjusted according to USDA (1990) guidelines and ribeye area. Color, texture, and firmness of the longissimus muscle were subjectively evaluated at the interface of the 12th and 13th ribs on the carcass. Lean color was scored on a scale from 1 to 8 (1 = dark pink; 5 = cherry red; 8 = very dark red). Lean texture and lean firmness were scored on 1–7 scales (1 = very fine, very firm; 7 = extremely coarse, extremely soft). Maturity scores (lean, skeletal, and overall) were evaluated numerically where A = 100 to 199, and B = 200 to 299. Marbling score was evaluated numerically: Devoid = 100 to 199; Traces = 200 to 299; Slight = 300 to 399; Small = 400 to 499; Modest = 500 to 599; Moderate = 600 to 699. Carcass hump height was measured from the most dorsal point of the hump to the dorsal edge of the ligamentum nuchae.

After grading (18–24 h after slaughter), the strip loin from the left side of each carcass was removed and sent to the University of Florida Meats Laboratory, where each was fabricated into steaks. Steaks were assigned to the various analyses in this manner, from posterior to anterior: (1) 24 h calpastatin, (2) and (3) 14 d sensory panel analyses, (4) 14 d Warner–Bratzler shear force, (5) 14 d myofibril fragmentation index, (6) 7 d Warner–Bratzler shear force, (7) 7 d myofibril fragmentation index and sarcomere length, (8) 21 d Warner–Bratzler shear force, (9) 21 d myofibril fragmentation index, (10) 24 h collagen, (11) percentage of raw lipids. Steaks for assay of myofibril fragmentation indices after all aging periods, sarcomere length, and percentage of raw lipids were cut 1.26 cm thick; all others were 2.54 cm thick.

Calpastatin activities (24 h) were determined according to the procedures of Koohmaraie (1990) with slight modifications described by Riley et al. (2003a). Total lipids were obtained on oven-dried steak samples by diethyl ether extraction (Method 985.15 AOAC, 1995), and recorded weights were used to determine percentages. Muscle collagen was estimated by determining hydroxyproline content of 5 g samples of longissimus muscle. Samples for collagen assays were frozen 24 h post slaughter. Samples were homogenized in a food processor and subsequently heated in a water bath (77 °C) for 63 min in 0.25 strength Ringer's solution (Hill, 1966). After centrifugation (12,000 rpm for 20 min at 4 °C with SS 34 rotor), the supernatant and residue fractions were individually hydrolyzed in 6 M HCl for 18 h at 15 psi (121 °C). Hydroxyproline content of each hydroxilate was determined according to Bergman and Loxley (1963). Total and soluble collagen was calculated according to Goll, Hoekstra, and Bray (1964). Sarcomere length of longissimus samples was determined by homogenizing a 5 g sample in 25 ml of a 0.25 M sucrose solution. A drop of the homogenate was placed on a slide and covered with a slip. Ten diffraction patterns were measured for each sample with a helium-neon laser (Model 155, Spectra Physics, I. C., Mt. View, CA) light (0.95 W) transmitted through individual myofibrils. The equation of Cross, West, and Dutson (1980) was used to convert measurements to micrometers.