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Carcass and meat quality characteristics of Brahman cross bulls and steers finished on tropical pastures in Costa Rica

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ABSTRACT

Forty-eight male calves (3/4 Brahman × 1/4 Charolais) were used to determine carcass cutability and meat tenderness of *Longissimus lumborum* (LL), *Gluteus medius* (GM), *Semitendinosus* (ST) and *Psoas major* (PM) steaks from lighter weight carcasses of bulls and steers castrated at 3, 7, or 12 mo of age grown under tropical pasture conditions. Steaks from steers had lower (more tender) LL Warner–Bratzler shear force (WBSF) values than those from bulls. Steaks from steers castrated at 3 mo had lower GM WBSF than those from bulls. For PM steaks, those aged 28 d had lower WBSF than those aged 2 d. Steaks aged 28 d had the lowest LL and GM WBSF and steaks aged 2 d had the highest LL, GM, and ST WBSF. Castration at younger ages is recommended because it provides improvement in LL and GM tenderness over bulls with no differences in carcass traits or subprimal yields.

1. Introduction

In Costa Rica, beef cattle production is based primarily on *Bos indicus* bulls utilizing pasture/forage-based diets in a tropical environment. Finishing cattle on forage-based diets to similar carcass weights and degree of fatness as grain-fed diets can result in similar beef quality characteristics (Muir, Deaker, & Bown, 1998). However, beef production in Costa Rica is challenged with lower quality forages and a challenging tropical environment. Finishing cattle on lower quality pasture diets can have negative consequences on carcass tenderness and organoleptic properties of the meat (Mitchell, Reed, & Rogers, 1991), and grass-finished cattle may have decreased average daily gain, longer finishing periods to reach a target endpoint, reduced dressing percentages, and lower quality grades than cattle fed more energy-dense concentrate diets (Bidner, Schupp, Montgomery, & Carpenter, 1981; Bidner et al., 1986).

It has been generally accepted that intact bulls provided adequate nutrition grow faster and more efficiently and produce carcasses with less fat than castrated steers (Mach, Realini, Furnols, Velarde, & Devant, 2009; Seideman, Cross, Oltjen, & Schanbacher, 1982). In addition, meat from steers is often preferred by consumers over meat from bulls because improved sensory traits, particularly tenderness, have been shown in some trials (Field, 1971; Seideman, Cross, & Crouse, 1989).

Postmortem aging is a technology that enhances beef palatability, and it is among the most popular options for improving tenderness (Dransfield, 1994). This practice is not widely adopted in Costa Rica and has been used by only a few beef retailers. Individual muscles can respond differently in their extent of tenderization improvement after postmortem aging periods because of differences in connective tissue (Rhee, Wheeler, Shackelford, & Koohmaraie, 2004), in the rate and extent of pH decline, in activity of calpains (Ilian et al., 2001), and thus in the extent of proteolytic degradation (Rhee et al., 2004; Taylor, Geesink, Thompson, Koohmaraie, & Goll, 1995).

Beef cattle production in Costa Rica is facing many challenges including improvement of beef quality. Because of this interest, castration has been reintroduced to Costa Rica as production tool. For some niche markets, producers have incorporated late castration (>12 mo of age) to potentially increase the fatness and meat quality of subprimals from steers compared with subprimals from bulls yet take advantage of the believed superior growth rate and efficiency of bulls compared with early castrated steers. Few research trials have been conducted in Costa Rica using antemortem and postmortem technologies to improve beef quality and tenderness. Ardaya and Zapata (1999) found no difference in live animal performance between bulls and late-castration steers. Both Ardaya and Zapata (1999) and Arce and Murillo (2004) found *Longissimus* steaks from steers had lower (more tender) WBSF

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means than those from bulls and Arce and Murillo (2004) found aging improved *Longissimus* tenderness for both sex classes. Therefore, the objectives of this study were to determine 1) the effects of castration and age at time of castration on the carcass composition and beef tenderness, and 2) the effects of different lengths of postmortem aging on the tenderness of four different muscles from cattle produced in a tropical climate.

2. Materials and methods

2.1. Animals

Procedures involving male cattle were reviewed and approved by the Kansas State University Institutional Animal Care and Use Committee (Protocol # 3001) and the administration of the Instituto Tecnologico de Costa Rica (ITCR)—San Carlos. Forty-eight male cattle (3/4 Brahman × 1/4 Charolais) were selected randomly from cattle representing the four treatments of intact bulls and steers castrated at either 3, 7, or 12 mo of age. Cattle were pasture-fed at the ITCR—San Carlos Cattle Unit. One calf from the 7-mo castration treatment died of unknown causes.

At approximately 26 mo of age, cattle were assigned randomly within treatments to one of four harvest groups of 12 cattle consisting of three cattle per treatment. Harvest was conducted weekly during a 4-week period. For each harvest group, individual live weight was recorded on the farm 5 d before transportation to a commercial harvest facility. Cattle were transported 70 km by truck early at night to minimize stress and avoid exposure to high daily temperatures.

2.2. Animal history

Cattle were born and raised in Costa Rica at the ITCR—San Carlos cattle farm. The area is located 85 m above the sea level and has flat topography, annual rainfall of 3400 mm, average daily temperature of 26 °C, and relative humidity of 85%. At birth, male calves from the crossbred herd were assigned randomly to treatments of intact male, castration at 3 mo, castration at 7 mo, and castration at 12 mo for a farm production trial. All steers were surgically castrated by an experienced technician.

Calves were weaned at 7 mo of age and placed on pasture at the ITCR—San Carlos Cattle Unit. All animals were fed as a group in a single pasture paddock and rotated to another paddock every 21 d. Pasture grasses consisted of Ratana (*Ischaemum indicum*), Toledo (*Brachiaria brizantha*), and Tanner (*Brachiaria radicans*). A mineral supplement (Multivex, Dos Pinos, Alajuela, Costa Rica) was available ad libitum and a Citrocom energy supplement (Dos Pinos, Alajuela, Costa Rica) with 86.5% dry matter, 11,925 kJ DE/kg DM, and 5.5% crude protein was group fed at 1 kg/hd/d.

2.3. Harvest data

Cattle were off pasture for approximately 10 h before being individually weighed and harvested early in the morning at a federally-inspected commercial harvest facility approved for export. Carcasses were electrically stimulated for 19 s during exsanguination using a Jarvis model BV 80 low voltage beef stimulator (Jarvis Products Corporation, Middletown CT). As a part of standard plant procedures, fat in the flank and cod regions was removed on the harvest floor and not included in the hot carcass weight. Carcasses were chilled immediately after harvest at −3 to 2 °C.

2.4. Subprimal fabrication

At approximately 28 h postmortem, the tail was removed before the left side was weighed and ribbed between the 12th and 13th ribs. Twelfth-rib fat thickness and ribeye area were measured before fabrication into boneless subprimals in a commercial fabrication facility. Whole-muscle subprimals from the forequarter consisted of the ribeye (*Longissimus thoracis*), ribeye cap (*Spinalis dorsi*), back rib fingers (Intercostal muscles), outside skirt (Diaphragm), chuck tender (*Supraspinatus*), top blade (*Infraspinatus*), underblade (*Serratus ventralis*), clod (*Triceps brachii*), top chuck (*Splenis*, *Complexus*, etc.), hump (*Rhomboideus*), brisket flat (*Deep pectoral*), and foreshank were trimmed practically free (<0.13 cm) of subprimal external fat. The closely trimmed (<0.13 cm) whole-muscle subprimals from the hindquarter consisted of the strip loin (*Longissimus lumborum* and *Gluteus medius* anterior the pelvic bone), tenderloin (*Psoas major* and *minor*), center-cut top sirloin butt (*Gluteus medius*), top sirloin cap (anterior *Biceps femoris*), tri-tip (*Tensor faciae latae*), flank (*Rectus abdominis*), inside skirt (*Transverse abdominis*), knuckle (*Vastus intermedius*, *Vastus lateralis*, *Vastus medialis*, and *Rectus femoris*), top (inside) round (*Adductor*, *Semimembranosus*, *Sartorious*, *Gracilis*, and *Pectinius*), bottom (outside) round (*Biceps femoris*), eye of round (*Semitendinosus*), and hindshank. All subprimals, bone and fat trim, and remaining lean trim were weighed for each left side. The strip loin, center-cut top sirloin butt, eye of round, and tenderloin from both sides of each animal were collected and vacuum-packaged for shipping.

2.5. Steak fabrication

Following fabrication, the strip loin, center-cut top sirloin butt, eye of round, and tenderloin subprimals from both sides of each carcass were transported in a refrigerated truck to the ITCR Meat Sensory Laboratory. Subprimals were stored in a cooler with an average temperature of 1.2 °C until they were fabricated into 2.54-cm-thick steaks. *Longissimus lumborum* (LL), *Gluteus medius* (GM), *Semitendinosus* (ST), and *Psoas major* (PM) steaks were cut perpendicular to the long axis and from the center portion of each subprimal. Duplicate LL, GM, and ST steaks from each animal were assigned randomly to aging periods of 2, 7, 14, and 28 d for Warner–Bratzler shear force (WBSF) determination, and an aging period of 14 d for sensory panel determination. For the GM, a single steak from each animal was assigned randomly to each of the WBSF aging periods and for sensory panel.

All steaks were individually vacuum-packaged in a Multivac A200/15 (Multivac, Kansas City, MO) and returned to the cooler until their assigned aging period was reached. The WBSF analyses for LL and ST steaks were performed on fresh, never frozen steaks; however, due to cooking limitations, PM and GM steaks were frozen at the end of their aging periods in a freezer with an average temperature of −13.5 °C and remained frozen until analysis. At 14 d postmortem, sensory panel steaks were removed from the cooler and frozen. Frozen steaks were thawed for 24 h at 4 °C in a McCall refrigerator (Kolpak Industries Inc., Parsons, TN) before analysis.

2.6. Warner–Bratzler shear force

Steaks for WBSF were cooked according to an established protocol consistent with AMSA (1995) guidelines in a Vulcan dual-air-flow convection oven (Vulcan-Hart Co., Louisville, KY) pre-heated at 163 °C. Temperature was monitored by 30-gauge, type T thermocouples inserted into the geometric center of the steak and attached to a Barnant temperature recorder (692-0000 Benchtop, Barrington, IL). When each steak reached an internal temperature of 50 °C, it was turned over and cooked to a final temperature of 71 °C. Steaks were stored overnight at 4 °C in a McCall refrigerator (Kolpak Industries Inc., Parsons, TN), before eight 1.27-cm-diameter cores were taken parallel to the muscle fiber orientation. Cores were sheared perpendicular to the muscle fiber orientation as recommended by AMSA (1995) using a Dillon Quantrol testing machine (Dillon/Quality Plus Inc., Kansas City, MO) with a Warner–Bratzler shear force V-shaped blade attachment (G-H Manufacturing CO., Manhattan, KS).