Meta Science 95 (2013) 36–41

Contents lists available at SciVerse ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci

Alternative pre-rigor foreshank positioning can improve beef shoulder muscle tenderness

A.L. Grayson, T.E. Lawrence *

Beef Carcass Research Center, Department of Agricultural Sciences, West Texas A&M University, Canyon, 79016, United States

ARTICLE INFO

Article history:
Received 13 August 2012
Received in revised form 12 February 2013
Accepted 3 April 2013

Keywords:
Beef
Shoulder
Sarcomere
Tenderness

ABSTRACT

Thirty beef carcasses were harvested and the foreshank of each side was independently positioned (cranial, natural, parallel, or caudal) 1 h post-mortem to determine the effect of foreshank angle at rigor mortis on the sarcomere length and tenderness of six beef shoulder muscles. The *infraspinatus* (IS), *pectoralis profundus* (PP), *serratus ventralis* (SV), *supraspinatus* (SS), *teres major* (TM) and *triceps brachii* (TB) were excised 48 h post-mortem for Warner–Bratzler shear force (WBSF) and sarcomere length evaluations. All muscles except the SS had altered ($P < 0.05$) sarcomere lengths between positions; the cranial position resulted in the longest sarcomeres for the SV and TB muscles whilst the natural position had longer sarcomeres for the PP and TM muscles. The SV from the cranial position had lower ($P < 0.05$) shear than the caudal position and TB from the natural position had lower ($P < 0.05$) shear than the parallel or caudal positions. Sarcomere length was moderately correlated ($r = -0.63$; $P < 0.01$) to shear force.

1. Introduction

Historically, tenderness of meat has been determined to be a large component of overall consumer satisfaction in regards to beef (Boleman et al., 1997; Shackelford et al., 2001; Voges et al., 2007) and consumers are willing to pay a premium for meat that is more tender (Fuez, Umberger, Calkins, & Sitz, 2004). With an increase in tenderness of muscles from the chuck, value can be added, resulting in the development of lower cost and more desirable steak cuts (Von Seggern, Calkins, Johnson, Brickler, & Gwartney, 2005).

Herring, Cassens, Suess, Brungardt, and Briskey (1967), and Rhee, Wheeler, Shackelford, and Koohmaraie (2004) conducted research that discovered differences in sarcomere lengths for various muscles; longer sarcomere lengths were associated with lower shear force values (r values of −0.80 to −0.90). Pre-rigor positioning resulting in the lengthening of sarcomeres is one method by which an increase in tenderness could be achieved. Hostetler, Link, Landmann, and Fitzhugh (1972) discovered that when carcasses were suspended via the *obturator foramen*, an increase in tenderness resulted due to the stretching of sarcomeres in the *longissimus dorsi*, *semimembranosus*, *semitendinosus*, *biceps femoris*, and *gluteus medius* muscles. In addition, Stouffer, Buege, and Gillis (1971) patented a method of pre-rigor tenderization for the loin and leg in which mechanical tension was added to the carcass to stretch the sarcomeres. Recently, Castañon and Lawrence (2010) conducted research in which the foreshank position was altered pre-rigor but reported detrimental effects from caudal positioning. Research on cranial foreshank positioning does not appear in the literature; therefore, the objective of this research was to determine the effects of four angles of pre-rigor foreshank positioning on beef shoulder muscle sarcomere length and WBSF values.

2. Materials and methods

2.1. Cattle harvest and treatment application

Thirty English × Continental crossbred steers approximately 18 to 24 months of age were harvested on one of four days according to the standards set by the United States Department of Agriculture (USDA) Food Safety and Inspection Service (FSIS) at the West Texas A&M University Meat Lab (Est. #7124). After hot carcass weight measurement and final inspection and approval by the USDA inspector (approximately 1 h post-mortem), a stainless steel S-hook was used to independently position the foreshank of each carcass side; the hook was either secured in the flank area or the neck area of the carcass depending upon the treatment that was assigned to the carcass side. Foreshank positions (Fig. 1) were as follows: **cranial**, perpendicular to the floor; **natural** position; **parallel** to the floor; **caudal**, greater than 30° to the floor. Two of the four treatments were randomly allocated to each half of 30 carcasses in an incomplete block design (Table 1). In this manner, each treatment was replicated 15 times amongst the 60 carcass sides. Carcasses were then chilled at 2 °C for 2 days.

* Corresponding author at: WT Box 60998, United States. Tel.: +1 806 651 2560; fax: +1 806 651 2938.
E-mail address: tlawrence@wtamu.edu (T.E. Lawrence).

0309-1740/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.meatsci.2013.04.010

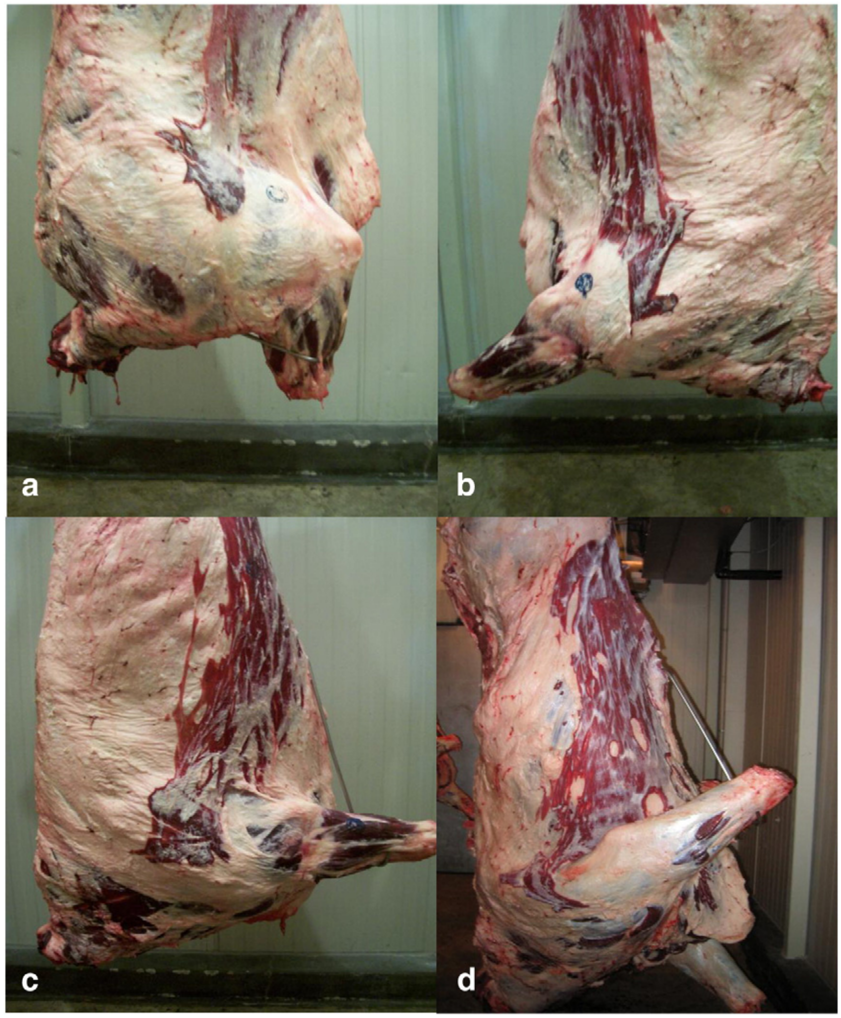

Fig. 1. Carcass foreshank positions applied pre-rigor (a — foreshank positioned cranially perpendicular to the floor; b — natural position; c — foreshank positioned parallel to floor; d — foreshank positioned caudally >30°).

2.2. Carcass evaluation

At 2 d post-mortem, the carcasses were evaluated for USDA quality (marbling, skeletal and lean maturity) and yield (12th rib subcutaneous fat depth, longissimus muscle area, percentage kidney-pelvic-heart fat) grade parameters by trained personnel from the WTAMU Beef Carcass Research Center according to the most current beef carcass grading standards (USDA, 1997). Marbling scores were assessed in comparison to official marbling score standards. Fat depth measurement was conducted using an official USDA preliminary yield grade ruler. Longissimus muscle area was measured using an official USDA dot grid pattern.

2.3. Fabrication

After carcass evaluation was completed, shoulder primals were fabricated and samples were collected. Each shoulder was removed with a cut between the 5th and 6th rib of the carcass. The *M. infraspinatus* (IS), *M. pectoralis profundus* (PP), *M. serratus ventralis* (SV), *M. supraspinatus* (SS), *M. teres major* (TM), and *M. triceps brachii* (TB) muscles were excised as whole muscles and denuded. Four, 2.54-cm-thick steaks were cut from the middle section of the muscle, perpendicular to the muscle fibers, and randomly assigned to either Warner Bratzler Shear Force (WBSF) and sarcomere length measurements. For the IS, the large piece of connective tissue was removed from the steaks to prevent consumer misconception of tenderness. Muscle samples were then individually vacuum-packaged and aged an additional 5 d at 2 °C until 7 d postmortem prior to being frozen at −20 °C.

2.4. Warner–Bratzler shear force determinations

Steaks were defrosted at 1 °C for 24 h prior to cooking. Steaks were cooked in a forced-air convection oven (Blodgett, model CTB/R, G.S. Blodgett Co., Burlington, VT) set at 177 °C until an internal endpoint temperature of 71 °C was reached. The internal temperature of the steak was monitored though a copper-constantan, Type T thermocouple wire (Omega Engineering, Stamford, VT) positioned into the geometric center of the steak, and connected to a temperature monitoring device (Omega Engineering, Stamford, VT). Internal temperature was monitored and steaks were removed from the convection oven at 68.5–69.5 °C in order to achieve an endpoint temperature of 71 °C. Steaks were allowed to cool for 10 min then individually wrapped in cellophane and chilled for 24 h at 1 °C before six 1.27-cm round cores were hand-cored parallel to the muscle fibers randomly throughout the steak (AMSA, 1995). The cores were immediately sheared once using a V-shaped blade on a Warner–Bratzler shear force machine (G-R Manufacturing, Manhattan, KS). The peak shear force value displayed on a Mecmesin BNG-500 Shear Force Gauge (Newton