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Influence of blade tenderization, moisture enhancement and pancreatin enzyme treatment on the processing characteristics and tenderness of beef *semitendinosus* muscle

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ABSTRACT

The combined effect of blade tenderization (BT), moisture enhancement and enzymatic tenderization on drip loss, cook loss, Warner–Bratzler shear force (WBSF) and sensory characteristics of beef *semitendinosus* (ST) steaks from cattle under 30 months of age was investigated.

Injection with phosphate/chloride solution improved tenderness and juiciness of ST muscles ($P < 0.01$). No additional improvement in tenderness was observed with incorporation of a pancreatin enzyme preparation into the moisture enhancement solution ($P > 0.1$).

Injection of pancreatin alone tended to improve overall tenderness ($P = 0.09$) and did not adversely affect other palatability attributes. Blade tenderization of ST muscles improved tenderness, as indicated by lower WBSF and increased sensory tenderness scores than for control samples, without decreasing flavour and juiciness.

The results suggest that moisture enhancement and blade tenderization can be effectively utilized to reduce the variability in and improve both tenderness and palatability of ST muscles. Pancreatin was not particularly effective at the 0.02% level used.

1. Introduction

Tenderness is an important driver of beef consumer satisfaction and as such has been extensively investigated (Beef Information Centre, 2002; Boleman et al., 1997; Neely et al., 1998). Many reports indicated a high level of unacceptably tough retail cuts originating from the round, especially when cooked as steaks (Brooks et al., 2000; Morgan et al., 1991; Rhee, Wheeler, Shackelford, & Koohmaraie, 2004; Von Seggern, Calkins, Johnson, Brickler, & Gwartney, 2005).

While intervention strategies can be effective for tenderness enhancement in muscles such as the *longissimus*, the *semitendinosus* (ST) is resistant to tenderization due to a high elastin content (Bendall, 1967; Nguyen & Zarkadas, 1989) and as a consequence is retailed as a relatively low value steak (Beef Information Centre, 2002; Brooks et al., 2000). Conventional methods for tenderization such as modified chilling (Janz et al., 2004; Van Moeseke, De Smet, Claeys, & Demeyer, 2001), extended ageing (Janz et al., 2004), altered carcass suspension (Aalhus, Larsen, Dubeski, & Jeremiah, 2000; Hostetler, Link, Landmann, & Fitzhugh, 1972) and prerigor skeletal separations (Shanks, Wulf, Reuter, & Maddock, 2002) are not sufficient to guarantee tenderness of the eye of round. Calcium chloride injection (DeYonge-Freeman, Pringle, Reynolds, & Williams, 2000) was also ineffective at tenderizing the ST muscle from mature cows.

Moderate improvement of tenderness in ST muscles has been reported with application of blade tenderization (Seideman, Smith, Carpenter, and Marshall (1977). Jeremiah, Gibson, and Cunningham (1999) demonstrated a reduction in overall toughness with blade tenderization, however, 32% of samples were still rated tough. Kolle, McKenna, and Savell (2004) studied the effect of injection with a salt and phosphate solution, blade tenderization and enzymatic tenderization on beef round muscles and found that *semitendinosus* showed no improvements in tenderness with any of the tenderization strategies. This lack of effect may be linked to a high amount of connective tissue and the uniquely high elastin content in this muscle (Nguyen & Zarkadas, 1989).

Proteolytic enzymes, particularly with sufficient specificity to target elastin, may be a viable option for ST enhancement. Enzymatic tenderization of meat has been used for many years, most commonly using enzymes of plant origin such as papain, bromelain, and ficin. However, many tenderizing enzymes lack substrate specificity and without careful control over application and action,

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overtenderization may result causing an undesirable mushy, pasty texture (Ashie, Sorensen, & Nielsen, 2002; Stefanek, Scanga, Belk, & Smith, 2002) and off-flavours (McKeith, Brewer, & Bruggen, 1994).

In a preliminary study the use of porcine pancreatin, an elastase-containing food-grade enzyme cocktail designed for cheese making that had not previously been applied to meat was studied (Janz, Pietrasik, Aalhus, & Shand, 2005). Results showed that ST tenderness could be improved with the use of injection treatments particularly where enzyme and a salt/phosphate moisture enhancement solution are combined. However, the ST muscle responded to neither salt/phosphate moisture enhancement at 105% and 110% over green weight nor pancreatin treatment at 0.01% level, applied alone.

Most previous studies utilized a single post harvest intervention method that did not allow an examination of potential synergistic effects of the simultaneous use of two or more methods. Since the physical disruption caused by blade tenderization may compliment the effects of injection, further studies were warranted.

Hence the objective of the current study was to investigate the effect of salt/phosphate moisture enhancement and pancreatin enzyme treatment in combination with blade tenderization (BT) on the cooking properties and palatability of beef ST muscles.

2. Materials and methods

Sixteen paired beef *semitendinosus* muscles (ST) from Canada Grade A carcasses were obtained from the Agriculture and Agri-Food Canada Lacombe Research Centre (Lacombe, AB, Canada) abattoir. All muscles were removed from carcasses at 48 h postmortem following conventional carcass chilling (0–2 °C), then vacuum packaged, aged to 7 d postmortem at 3 °C, then boxed and frozen in a blast-freezer, and stored at −30 °C until processed. An elastase-containing food-grade enzyme cocktail designed for cheese making (liquid porcine pancreatin; RENCO New Zealand, Eltham, NZ; distributed by Danlac, Airdrie, AB) was chosen for injection.

2.1. Preparation of beef steaks

All processing was carried out in a refrigerated pilot plant (<7 °C) at the University of Saskatchewan. Prior to processing and after thawing for approximately 72 h at 3 °C, all muscles were trimmed of visible, external fat and connective tissue, and cut transversely into two 1.0 ± 0.1 kg sections, designated distal and proximal.

Three water-based injection solutions were prepared: an enzyme treatment (ENZ), a moisture enhanced treatment (ME), and a combined moisture enhanced with enzyme treatment (ME + ENZ). The enzyme treatment was formulated to give 0.02% liquid porcine pancreatin in the final injected product. Brines for moisture enhancement were formulated to give 0.5% sodium chloride and 0.25% sodium tripolyphosphate (Curafos STP, Rhodia Food Ingredients, Cranbury, NJ) in injected meat. The combined ME + ENZ treatment was formulated to give 0.02% liquid porcine pancreatin, 0.5% sodium chloride and 0.25% tripolyphosphate.

The roasts designated for ENZ treatment were injected to a target weight gain of 5% of the original mass, while the roasts designated for ME and ME + ENZ treatments were injected to achieve 15% extension. All treatments were allocated to muscle locations such that each location/injection treatment combination was present and replicated. Meat injection was completed using a Reiser Fomaco multi-needle injector (Model FGM 20/40, Fomaco Reiser Ltd., Burlington, ON). The roasts were weighed before and after injection to determine the percent brine pick up (i.e., injected weight/raw weight × 100). Those muscles that did not reach their target weight were further injected with the marinade using a hand injector to compensate for any deviation from the target weight.

Injected muscles and non-injected controls (C) were then divided transversely through the centre into approximately equal halves. Then half of the roasts from control and treatment groups were blade tenderized by one pass through a Jaccard®, Model H# B4590 meat tenderizer (Jaccard®, Orchard Park, NY, USA).

All muscle samples were vacuum packaged and stored at 4 °C. At approximately 48 h post-injection, samples were removed from packaging and weighed to determine the drip loss ({weight before 48 h storage-weight at 48 h/weight before 48 h storage} × 100). Two 2.54 cm thick steaks were obtained by cutting perpendicular to the muscle fiber orientation. The steaks were vacuum packaged, frozen in a blast-freezer and stored at −30 °C until evaluation.

2.2. Warner–Bratzler shear force (WBSF)

Steaks were thawed in a cooler at 4 °C for 24 h and cooked using an electric grill (Garland ED-30B electric grill; Condon Barr Food Equipment Ltd, Edmonton, AB). Steaks were placed on the grill preheated to 210 °C, cooked until the internal temperature reached 35 °C, turned over and cooked to 71 °C. The temperature of the steaks was monitored using copper-constantan thermocouples attached to a scanner (Model 692–8000, Barnant Co., Barrington, IL, USA) and a computer, which recorded the change in temperature at 30 s intervals. Cooking yield ({cooked weight/weight before cooking} × 100) was recorded for each steak. Cooking time for each steak to reach 71 °C internal temperature was also calculated and expressed in min/100 g of sample.

After cooking, steaks were allowed to cool to room temperature for approximately 2 h. The shear force of 7–9 core samples (1.27 × 1.27 × 2.54 cm) cut parallel to the fibre direction from each cooked steak was determined. Samples were sheared perpendicular to the fibre direction using a TMS-90 texture system (Food Technology Corp., Rockville, MD, USA) fitted with a Warner–Bratzler shear attachment and with crosshead speed set to 200 mm/min.

Force–deformation curves from the Warner–Bratzler shear device were used to determine WBSF myofibrillar component (SF-M) and WBSF connective tissue component (SF-C). The initial yield (height of the first peak) corresponded to SF-M and the final yield (height of the second peak) corresponded to SF-C, both of which were measured from the shear curves as suggested by Møller (1981) with slight modifications. Namely, SF-M force was measured on the shear deformation curve as a peak value occurring within the first half of the distance the shear blade cut through the meat sample; whereas SF-C was measured as a peak value within the last 3 mm before the shear blade had completed cutting through the meat sample. Maximum peak force recorded during the test was reported as Warner–Bratzler shear force.

2.3. Sensory properties

Steaks were thawed in a cooler at 4 °C for 24 h, and cooked as previously described for Warner–Bratzler shear force determinations. Type-T copper-constantan spear point thermocouple temperature probes (AllTemp Sensors Inc., Edmonton, AB) were inserted horizontally to the mid-point along the long axis of the steak and temperature was monitored using a Hewlett Packard HP34970A Data Logger (Hewlett Packard Co., Boise ID). After cooling for 10 min, cooking losses were determined by weight difference. Each steak was cut into 1.3 cm cubes, avoiding connective tissue and large areas of fat. Eight cubes from each sample were randomly assigned to an eight-member trained taste panel. Samples were placed in glass jars in a circulating water bath