ENHANCEMENT EFFECTS ON PHYSICAL AND CHEMICAL CHARACTERISTICS OF HOT BONED BEEF

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Background

The meat industry continues to strive to fulfil consumer expectations for consistent, high quality meat products at a reasonable cost to the producer, packer, processor and retailer (ROBBINS *et al.*, 2002). Because of the processing and energy efficiencies of hot-boning, an increasing amount of beef produced in export oriented countries, such as New Zealand and Australia, is processed this way, where the carcasses are usually boned out within 45 min of slaughter, before they go into rigor (FAROUK & SWAN, 1998). However, changes in quality of hot boned meat, mostly associated with tenderness, colour and microbiology, have been mentioned (PISULA & TIBURCY, 1996). Injection technology to improve eating quality was evaluated over 20 years ago in the poultry industry when water and polyphosphates were injected into chicken meat (YOUNG *et al.*, 1987). Enhancement solutions, containing salt and phosphates have been studied extensively in pork to provide consumers with enhanced, more tender, juicy products (BREWER et al., 2002), but have been studied to a lesser extent in beef (BOLES & SHAND, 2001). Brazilian cattle is 80% grass fed Nelore breed (*Bos indicus*) which is considered to have tougher meat than *Bos taurus* (CROUSE *et al.*, 1993).Therefore, the purpose of this study was to evaluate some physical and chemical traits of injected hot boned beef cut.

Objectives

The aim of this work was to evaluate the effect of hot boning and enhancement with brine containing salt and polyphosphates on pH, colour, proximate composition, cook yield and Warner Blatzler shear force of *Triceps brachii* muscles (clod) excised from electrically stimulated beef carcasses.

Methodology

Grass fed Nelore (*Bos indicus*) steers (n=36, average weight=435kg, average age=30-36months) were captive bolt stunned and carcasses were low voltage electrically stimulated (20V(rms) / 60Hz/0.25 amps/ 90s) immediately after bleeding. Carcasses were halved, one side was hot boned approximately 45 min after slaughter and the *Triceps brachii* muscles removed. Hot boned muscles were conditioned 15 hours at 25ºC then at 7ºC until the temperature reached 15ºC, followed by 0ºC until 5ºC at the center of the muscle. The conventionally chilled carcasses were held at 2ºC during 24hours prior to removing the *Triceps brachii* muscles. The beef cuts were randomly assigned to four treatments: Non injected cold boned (CB/NI); Enhanced cold boned (CB/E); non injected hot boned (HB/NI) and enhanced hot boned (HB/E). Enhancement brines contained 2.4% sodium chloride and 1.8% polyphosphates blend (KENA 27- Rhodia Food). The muscles were injected to 120% of the green weight using a twelve needles injector (Lingaard mod 500, 42l/min). Injected and non injected muscles were divided into two roasts, which were vacuum packaged in shrinkable bag (CRYOVAC®) and allowed to equilibrate at 0ºC during 20 hours, followed by cryogenic freezing in liquid nitrogen and held at –20ºC for the analysis. Brining retention (BR) after injection was determined. Samples were analyzed for moisture, fat, protein, ash and chloride contents according to AOAC (1995). The pH measurements were taken in the muscles, after boning (pHAB) and after thawing (pHAT). The cuts were weighed after thawing during 24 hours at 4ºC to determined thawing loss (TL) after six months storage at –18ºC. Cooking losses (CL) were determined after broiling the steaks on preheated electric broiler (SIRMAN mod. PDL) until an internal temperature of 72ºC was reached. Warner Bratzler shear force of 1cm cube 1.27X1.27x2.54 cm core samples sheared perpendicular to the fiber direction in two steaks for each muscle were determined with a TAXT2i Texture analyzer (full scale load 5kg/crosshead speed 200 mm/min) attached to a Warner Bratzler accessory test cell, following the same procedure used for CL. Instrumental color determinations were made on the surface of non injected and injected raw samples, after 30 min of air exposure after thawing, under D_{65} illuminant and a 10º angle, using a Minolta spectrophotometer (model CM508-d) and CIE LAB values (L*, a* and b*) were calculated. Data were analyzed as a 2 X 2 factorial treatment design with boning method (HB, CB) and enhancement (NI,E) as main factors. All treatments were applied to a single cut, so that the cut was considered a replicate (6 cuts were used for each treatment). LSD ($p<0.05$) was used to identify the effects significance ($p<0.05$) and the differences among treatment means.

Results and discussion

The proximate moisture, protein, ash, chloride and soluble collagen contents were significantly affected by enhancement ($p<0.05$), although no significant effect of the boning method was detected ($p>0.05$). A slight increase in moisture was observed in enhanced samples, accompanied by a decrease in total protein. The strong increase in ash and chloride contents was observed is due to brine composition. Soluble collagen amount showed a strong decrease after injection (**Table 1**). The pH measurements after boning showed higher values for hot boned cuts and a strong effect of the boning method on this trait was detected ($p<0.002$). However, after thawing the non injected conditioned muscles, there were no significant differences ($p>0.05$) between HB and CB. A significant effect of enhancement ($p<0.05$) was observed on pH after thawing, but no effect of boning method was detected ($p>0.05$) (**Table 2**). The L*, a* and b* color values after boning the non injected muscles showed significant differences between HB and CB ($p<0.05$), where HB color parameters showed lower values than CB. Only the enhancement showed a significant effect on L*, a* and b* color parameters after thawing ($p< 0.01$, $p<0.01$, $p<0.01$, respectively), which were lower for enhanced samples (**Table 2**). No differences were detected for brine retention among HB and CB muscles ($p>0.05$), suggesting that the boning method probably does not affect the enhancement at 20% level in this muscle. The boning method showed significant effect on TL ($p<0.03$), as well as the enhancement ($p<0.01$). HB muscles showed slightly higher values for TL than CB, whilst enhanced samples had the lowest TL (**Table 3**). The CL was not affected by the boning method ($p>0.05$) nor the enhancement ($p>0.05$) (**Table 3**). If the cooking yield were calculated over the green weight, it could be considered higher for enhanced cuts. Thus, the brine composition was effective in increasing the water retention in raw and cooked samples. The WBS measurements were significantly affected by enhancement ($p<0.01$), but the boning method showed no significant effect ($p>0.05$). Shear force was reduced from 4.35 to 3.34 kgf/cm^2 with enhancement, despite the boning method applied, which corresponds to 23% increase in tenderness.

Finally, the enhancement of HB muscles requires preventing cold shortening, which can be done through chilling at appropriate rates (FAROUK & SWAN, 1998).

Table 1. Proximate composition, soluble intramuscular collagen and chloride contents in non injected and enhanced *Triceps brachii* muscles.

Traits (%)*	NI	E
Moisture	76.82[b]	78.74[a]
Total protein	20.17[a]	17.47[b]
Lipids	1.21[a]	1.24[a]
Ash	0.98[b]	2.17[a]
Collagen	0.89[a]	0.42[b]
Chloride	0.12[b]	0.96[a]

(*)Means within a row with the same letters are not significantly different (p>0.05)

Table 2. Objective color (L*, a* and b* values) measurements and pH means values after boning (AB) and after thawing (AT) of *Triceps brachii* muscles obtained from electrically stimulated carcasses.

Boning[1]	Enhancement[2]	Traits							
		PH		L*		a*		b*	
		AB	AT	AB	AT	AB	AT	AB	AT
CB	NI	5.54[b,B]	5.59[b,B]	33.92[a,A]	29.97[a,B]	17.52[a,A]	16.61[a,A]	5.47[a,A]	4.38[a,A]
	E	-	5.99[a]	-	27.09[a]	-	13.60[a,b]	-	0.17[b]
HB	NI	6.24[a,A]	5.59[b,B]	25.61[b,B]	29.50[a,B]	13.99[b,B]	15.91[a,A]	-2.77[b,B]	3.65[a,A]
	E	-	5.96[a]	-	25.26[b]	-	13.37[b]	-	-0.60[b]

(*)Means within a row with the same capital letters for each trait are not significantly different (p>0.05) and means within a column with the same small letters for each trait are not significantly different (p>0.05) Tukey's test
[1] CB – cold boned; HB – hot boned [2] NI – non injected, E - enhanced

Table 3. Brine retention (BR), thawing losses (TL), cooking losses (CL) and Warner Bratzler shear force (WBS) measurements of hot and cold boned *Triceps brachii* muscles obtained from electrically stimulated carcasses and enhanced with salt and polyphosphates brine.

Traits	CB		HB	
	NI	E	NI	E
Brine retention (%)	0[b]	20.18[a]	0[b]	18.88[a]
Thawing losses (%)	2.0[a,b]	0.6[b]	3.5[a]	1.0[b]
Cooking losses (%)[1]	35.0[a]	32.4[a]	33.5[a]	29.5[a]
WBS (kgf/cm^2)	4.35[a]	3.20[b]	4.35[a]	3.47[b]

(*)Means within a row with different letters are not significantly different (p>0.05) by Tukey's test

Conclusions

Enhancement can be successfully applied to hot boned *Triceps brachii* muscles previously chilled to prevent cold shortening.

Further work will investigate the influences of hot boning and enhancement on sensory attributes, acceptability and purchase intent of clod roasts.

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