EVALUATION OF THE EFFECT OF DIFFERENT COOKING TREATMENTS ON THE TENDERNESS AND COOK LOSS OF INJECTED BOVINE FOREQUARTER MUSCLES

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Introduction
Recently, numerous studies have shown that injecting bovine muscles with brine enhances tenderness (Molina *et al.*, 2005; Lennon *et al.*, 2006). Cooking has a major influence on the tenderness of meat. However, there is little information available on the effect of different cooking regimes on the eating quality of injected bovine muscles. Collagen shrinks during cooking. However, with extended heating in the presence of moisture, collagen is solubilised and therefore meat becomes more tender (Sims and Bailey, 1992). The aim of this study is to investigate the effects of extended cooking regimes on the tenderness and cooking losses of brine injected forequarter bovine muscles.

Materials and Methods
Forequarter muscles were excised from O grade steer carcasses at 48 hours (h) *post-mortem*, namely, *pectoralis profundus* (PP), *infraspinatus* (IF), *supraspinatus* (SP) and *triceps brachi caput longum* (TB). PP, TB and IF muscles were cut into 400g pieces. SP was not sectioned. Individual muscles/muscle sections were selected randomly from each muscle group and assigned to one of the treatments below, such that a total of twelve representatives of each muscle were used for each treatment. Each muscle/muscle section was injected with brine at an injection rate of 10% to give a residual 0.5% NaCl content. The muscles or sections of muscles were equilibrated at 1°C overnight and then vacuum packed in cook-in shrink bags before cooking. Five cooking regimes were evaluated for IF, SP and TB as follows: (a) Cooking to an internal core temperature (ICT) of 72°C using an oven temperature of 80°C (72°C); (b) Cooking to an ICT of 72°C using a delta (Δ) 10 cook procedure such that a constant differential of 10°C is maintained between the product core temperature and oven temperature (Δ72C°); (c) Cooking to an ICT of 69°C and holding for 4h (69°C+4h); (d) Cooking to an ICT of 69°C using a delta 10 cooking procedure and holding for 4h (Δ69°C+4h); (e) Cooking to an ICT of 69°C and holding for 12h (69°C+12h)
Sections of PP were (a) Cooked to an internal core temperature of 69°C using a delta 10 cooking procedure and held for 4, 6, 8, 10 and 12h (Δ69°C+4, 6, 8, 10, 12h) or (b) Cooked to an ICT of 69°C and held for 12h (69°C+12h). Warner Bratzler shear force (WBSF) values were determined on 1.27 cm diameter cores (n=6), cut parallel to muscle fibre orientation, on a texture analyser (Stable Micro Systems, UK). Cook loss was determined by expressing the weight loss during cooking as a percentage of the before cooking weight. Sensory analysis was performed using an 8-member in-house trained panel.

Results and Discussion
PP was the toughest of the four muscles investigated as indicated by WBSF values (Tables 1 and 2), which may be attributed to its high collagen content (Torrescano *et al.*, 2003). Slow Δ 10 cooking did not significantly enhance the tenderness of brine injected SP compared with conventional cooking when meat was cooked to an end point cooking temperature (EPCT) of 72°C or to an ICT of 69°C and held at 69°C for 4h as indicated by WBSF values and sensory scores. In contrast, Δ 10 cooking significantly reduced the WBSF values of brine injected IF and TB heated to 69°C or 72°C compared with conventional cooking. While the sensory tenderness ratings followed the same trend, the differences were not significant. For brine injected IF, TB and SP, Δ 10 cooking did not significantly affect % cook loss and overall there was no significant difference in the % cook losses when meat was cooked to an EPCT of 72°C or to an ICT of 69°C and held at 69°C for 4h. For brine-injected IF and TB, increasing the holding time at 69°C from 4 to 12h significantly increased % cook loss, while no significant effect was observed for brine injected SP. Increasing the cooking time at 69°C from 4 to 12h significantly increased the tenderness scores and decreased the WBSF values of brine injected IF, TB and SP.

Table 1: Mean ± SD Warner Bratzler shear force values (WBSF) (N), sensory analysis tenderness scores (Tend) and cook loss (%CL) for IF, SP and TB muscles.

	M	Δ69°C+4h	69°C +4h	Δ72°C	72°C	69°C +12h
	IF					
WBSF		26.0 ± 3.0^{a}	31.2 ± 3.0^{b}	25.6 ± 2.4^{a}	32.6 ± 3.6^{b}	16.1 ± 2.0^{c}
Tend		6.5 ± 0.7^{a}	5.8 ± 0.9^{a}	6.4 ± 1.1^{a}	5.3 ± 0.8^{a}	7.4 ± 1.0^{b}
% CL		36.7 ± 1.6^{ac}	34.2 ± 1.6^{c}	37.5 ± 1.8^{a}	$36.1.9^{ac}$	41.7 ± 1.7^{b}
	TB					
WB		26.2 ± 3.0^{a}	34.3 ± 3.8^{b}	27.2 ± 3.2^{a}	33.8 ± 3.9^{b}	17.8 ± 2.1^{c}
Tend		5.8 ± 0.7^{a}	5.1 ± 0.7^{a}	5.6 ± 0.8^{a}	5.3 ± 1.1^{a}	7.3 ± 0.9^{b}
% CL		33.9 ± 1.8^{a}	33.3 ± 1.9^{a}	32.5 ± 1.2^{a}	34.8 ± 1.7^{a}	41.7 ± 1.6^{b}
	SP					
WB		44.2 ± 3.6^{a}	44.3 ± 6.5^{a}	41.7 ± 6.1^{a}	45.7 ± 6.3^{a}	31.4 ± 5.9^{b}
Tend		3.6 ± 0.8^{a}	3.5 ± 0.7^{a}	3.0 ± 1.1^{a}	3.6 ± 0.9^{a}	6.0 ± 0.9^{b}
% CL		37.0 ± 0.9^{a}	39.6 ± 0.7^{b}	39.5 ± 1.3^{b}	38.9 ± 1.6^{b}	40.2 ± 1.8^{b}

[abc] Values with a different superscript across the line denotes significance ($p<0.05$).

When brine injected PP was cooked to 69°C using a Δ 10 heating programme and held at 69°C for 4h, the meat was rated as being unacceptably tough by the sensory panel. Increasing the cooking time to 8h significantly decreased the WBSF values. There was no further significant decrease in WBSF values when the holding time was extended to 10 and 12h. Brine injected PP held at 69°C for 12h was significantly more tender than that held at 69°C for 4h as indicated by the sensory tenderness scores and WBSF values. Increasing the holding time from 4 to 8h did not significantly increase % cook loss of brine injected PP. However the % cook loss at 10 and 12h was greater than that at 4h. When a holding time of 12h was used, there was no significant difference observed in the tenderness or % cook loss of conventionally cooked PP and those cooked using a Δ 10 programme.

Table 2: Mean ± SD Warner Bratzler shear force values (WBSF) (N), sensory analysis tenderness scores (Tend) and cook loss (%CL) values for PP muscles Δ cooked to 69°C and held for 4, 6, 8, 10 and 12h and conventionally cooked to 69°C and held for 12h.

	Δ 69°C+4h	Δ 69°C +6h	Δ 69°C +8h	Δ 69°C +10h	Δ 69°C +12h	69°C +12h
WBSF	50.8 ± 3.3^{a}	47.8 ± 5.1^{ac}	43.2 ± 4.2^{bc}	43.0 ± 3.9^{bc}	37.2 ± 1.9^{b}	35.9 ± 3.1^{b}
Tend	2.8 ± 0.9^{a}	n/d	n/d	n/d	4.9 ± 1.4^{b}	4.5 ± 1.3^{b}
% CL	34.6 ± 2.9^{a}	37.0 ± 2.3^{ab}	35.5 ± 2.0^{ab}	37.6 ± 1.4^{b}	37.2 ± 1.5^{b}	37.6 ± 1.7^{b}

[abc] Values with different superscript across the line denotes significance ($p<0.05$); n/d not determined

Conclusions

Extended cooking times increased tenderness of brine injected IF, TB, PP and SP. However, there was also a significant increase in % cook loss for 3 of the 4 muscles examined. Slow delta cooking programmes decreased the WBSF values of IF and TB but had no significant effect on sensory tenderness scores.

References

Lennon, A.M., Moon, S.S., Ward, P., O'Neill, E.E. and Kenny, T. (2006). Effects of enhancement procedures on whole and reformed beef forequarter muscles. Meat Science, 72, 513-517.

Molina, M.E., Johnson, D.D., West, R.L and Gwartney, B.L. (2005). Enhancing palatability traits in beef chuck muscles. Meat Science, 71, 52-61.

Sims, T.J. and Bailey, A.J. (1992). Structural aspects of cooked meat. In: The chemistry of muscle based foods, Ledward, D.A., Johnston, D.E and Knight, M.K. (Eds.). Royal Society of Chemistry, Thomas Graham House, Science Park, Cambridge, pp 106-127.

Torrescano, G., Sanchez-Escalante, A., Gimenez, B., Roncales, P and Beltran, J.A. (2003). Shear values of raw samples of 14 bovine muscles and their relation to muscle collagen characteristics. Meat Science, 64, 85-91.

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