THE EFFECT OF HOT BONING AND ELEVATED BRINE TEMPERATURE ON THE PROCESSING AND SENSORY PROPERTIES OF CURED BEEF PREPARED FROM SILVERSIDE AND FOREQUARTER MUSCLES

D. Keenan*[1], J. Hayes[1], T. Kenny[1] and J.P. Kerry[2]

[1]Teagasc, Ashtown Food Research Centre, Ashtown, Dublin 15, Ireland. [2]Department of Food and Nutritional Sciences, Food Technology and Nutrition, University College Cork – National University of Ireland, Cork, Ireland.
Email: derek.keenan@teagasc.ie

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Introduction
Hot boning has not been adopted by meat plants in Ireland, despite offering significant savings in space, energy, labour, materials and supplies as well as improvements in functional properties of the product. Concern has centred on issues, such as re-training of staff, hygiene regimes (as meat is handled while warm) and resultant added costs.). The main concern is the possible loss of tenderness associated with hot boning. Conventionally boned muscles are held in a stretched state by the carcass but unrestrained, hot-boned muscles are more susceptible to contraction and toughening in the absence of this skeletal support at low chilling temperatures (Locker, 1960). Therefore, processing directly after hot boning may offset some of its effects. The rate of curing is controlled by a number of temperature-dependant diffusion processes and chemical reactions. By letting the process take place at a higher temperature than the normal 0-5°C, curing could be accelerated (Pearson and Gillett, 1996). This would be a significant advantage, in particular, for dry cured products as the cure ingredients are rubbed into the meat by hand and therefore require a prolonged time period for cure distribution and aging (Ranken, 2000). The rate of migration of cure ingredients will be examined by determining salt and nitrite distribution in samples at different time intervals.

Materials and Methods
Two muscles, the M. *biceps femoris* (silverside) and M. *pectoralis profundus* (brisket in forequarter), were tested in accordance with a randomised experimental design. Beef cuts were hot-boned within 1.5 hours post mortem. Cold boned carcasses were chilled at 0-2° C before excision at 24 hours post mortem. Brine solutions at normal (1-4 °C) and elevated (12-16 °C) temperatures, were employed, resulting in a total of 4 treatments per muscle. The boneless cuts were pumped to 115% of their green weight with brine and tumbled for 2 hours at 10 r.p.m. Tumbled muscles were enclosed in elastic netting, vacuum packed and steam cooked to a core temperature of 72 °C. Cooked samples were analysed for moisture, fat and protein content (Bostian *et al.*, 1985; Sweeney and Rexford, 1987). Cook loss and yield were calculated. Texture Profile Analysis (TPA), Warner-Bratzler Shear Force (WBSF) and Kramer Shear Force (KSF) measurements were made using Instron 4464 and 5543 models. Mohr's method was used to determine salt content. Nitrite was determined by a purple azo dye colourimetric titration (Ruzicka and Hansen, 1981) using a Foss FIAstar™ 5000 flow-rate injection analyser (Foss Tecator AB, Sweden). An 8- member trained panel was employed to evaluate sensory quality of samples (AMSA, 1995). The effects on storage life of the combined hot boning and warm brine treatments were assessed by storing MA-packed samples for up to 21 days at 4°C in a chill display cabinet. Results were analysed using a two-way analysis of variance (ANOVA).

Results and Discussion
Hot-boned silverside beef had lower ($P \leq 0.001$) salt content than the control beef after tumbling but not after cooking. Table 1 showed that cooked silverside samples exhibited lower nitrite levels ($P \leq 0.05$) than raw meat after tumbling. This expected reduction is a result of nitrite being broken down to nitric oxide, which is fundamental to the formation of the stable cured colour pigment (Ranken, 2000). Cook losses and total yields were not affected ($P \geq 0.05$) by boning method or brine temperature for both silverside and forequarter samples. West (1983) surmised that advantages of moisture retention in hot-boned products may be maintained in the early stages of processing but are often offset in later processing e.g. cooking. Tenderness of silverside was not affected ($P \geq 0.05$) by boning method and only slightly affected ($P \leq 0.05$) by the higher brine temperature, with samples from the latter being rated tougher on day 21. In the case of the forequarter (brisket) beef, the higher brine temperature resulted in higher toughness rating on all days of the shelf-life study, with the effect being more marked ($P \leq 0.001$) on day 14 than day 21 ($P \leq 0.05$). Juiciness was rated as less in samples from the higher brine temperature on day 7 and day 21 ($P \leq 0.05$) for the silverside and on day 7 ($P \leq 0.001$) for the forequarter. Although tenderness was indicated to be higher for hot-boned silverside beef in terms of TPA hardness ($P \leq 0.05$), KSF values ($P \leq 0.01$) and WBSF values ($P \leq 0.001$) than conventional boning, however, this was not supported by sensory analysis data or literature evidence (Jerimiah *et al.* 1985, Bowles-Axe *et al.*, 1983). Hot-boned silverside beef was darker ($P \leq 0.05$) than cold-boned. This agrees with sensory data and the work of authors such as Rees *et al.* (2002b) and Claus *et al.* (1981) who found that hot boning produces a darker coloured meat, attributed to higher pH, increased water holding capacity and a more densely-packed myofibrillar protein matrix.

Combinations of hot boning and higher brine temperatures led to expected higher bacterial numbers. The retail shelf-life of products (estimated as time to reach 10^7 cfu /g) was maintained up until day 21 under retail display conditions (2-4° C) in MA packaging for both silverside and forequarter beef (Table 2).

Table 1: Effect of brine diffusion on nitrite and % salt in cured silverside and forequarter beef.

Treatment	Nitrite		% Salt	
	BF	PP	BF	PP
After tumbling	56.5^a	67.2^a	2.1^a	2.5^a
After cooking	20.5^b	14.8^b	1.7^b	2.6^a

$^{a-b}$ Means in the same column with different letters are different ($P \leq 0.05$).

Table 2: Effect of shelf-life on microbiology of cured silverside and forequarter beef.

Treatment	Hot-boned		Cold-boned	
	(0 - 4° C)	(12 - 16° C)	(0 - 4° C)	(12 - 16° C)
BF				
TVC D.14	1.9×10^5	1.1×10^6	5.6×10^4	1.4×10^7
TVC D.21	4.7×10^6	1.4×10^6	2.9×10^5	4.1×10^6
PP				
TVC D.14	5.0×10^5	2.1×10^5	3.7×10^4	2.0×10^5
TVC D.21	3.7×10^6	7.0×10^5	1.2×10^5	7.7×10^5

Conclusions

Hot boning did not give the expected increase in yield in the cured products. Although processing directly after boning appeared to prevent the adverse effects of hot boning, such as cold shortening- related toughness, sensory data did not support the instrumental measurements in the silverside product. PP products did not exhibit additional toughness as a result of hot boning. While the use of higher brine temperatures did not compromise retail shelf-life guidelines for bacterial counts, it had detrimental effects on juiciness and tenderness as perceived by taste panellists especially in the product from brisket. Incorporation of additional functional ingredients such as may be required to reduce the apparent loss of moisture of the meat as well as novel heating system in the hope of producing a more rapid curing system.

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