MANIPULATION OF PRE-RIGOR GLYCOLYTIC BEHAVIOURS TO PRODUCE CONSISTENT BEEF TENDERNESS

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Background

One of the most important challenges met by the meat industry today is to provide a product of consistent eating quality in which tenderness is a strong attribute. Beef is generally variable in eating quality, which stems mainly from how the muscles are treated up to the time of rigor. (Koomaraie, 1996). Variance in temperature, pH and their relationship with time *post-mortem* is important in pre-rigor beef. Fluctuations within a carcass in the temperature/pH profile, post slaughter, is a root cause in the inconsistency beef tenderness. Hot boning is defined as the removal of muscles or muscle systems from the carcass prior to chilling (West, 1983) and is beneficial for both industrial and experimental reasons as each muscle can be treated individually according to its own glycolytic behaviours. Hot boning allows for the manipulation of muscles during the critical pre-rigor period, therefore, optimum conditions in terms of pH/temperature profiles can be determined for the production of consistently tender beef.

Objectives

The objective of this study was to alter rigor development via post mortem manipulation for the optimisation of consistently tender beef.

Materials and methods

Hereford cross Friesian heifers (n=8) were captive bolt stunned and exanguinated conventionally at the Meat Industrial Development Unit, National Food Centre, Dublin 15. From each animal both *longissimus dorsi* muscles were hot-boned within 90 minutes post slaughter. Each muscle was divided in 3 so that there was 6 samples per replicate. Each sample was randomly selected and submerged in water baths pre-set at the following temperatures; 0, 5, 10, 15, 20 and 25^{0}C. After eight hours the muscles were placed in a 2^{0}C chill and aged for 14 days post- slaughter. pH profiles were observed by inserting a glass electrode approximately 2 inches in to the muscle Sarcomere length, was determined by diffraction of a laser beam according to the method determined by Cross *et al.* (1980) 2 days *post-mortem*. Steaks were cut (2.5cm thick) at day 2, 7 and 14 *post-mortem* and stored at –20^{0}C for Warner Bratzler Shear Force (WBSF) analysis, which was carried out according to the method described by Shackelford *et al* (1991). Samples were taken at days 2, 7 and 14 to measure proteolytic activity.

Results and discussion

Pre-rigor incubation temperature had an effect on the rate of pH decline (Fig. 1), with higher temperatures giving a faster rate of pH decline. The 0^{0}C samples had the shortest sarcomere length followed by the 5^{0}C samples, whereas 10-25^{0}C samples did not cold shorten (Table 1). These results are reflected in the WBSF results (Fig. 2), where cold shortened muscle (0 and 5ºC) was found to be toughest. Fig. 3 shows the interaction of pH taken at 3 hours post-mortem (pH_3), WBSF at day 14 and temperature. The most tender and least variable beef was found at pH_3 between 5.9 and 6.2. However, this is not the case for cold shortened samples as cold shortened muscles were more variable in tenderness and pH. The absolute rate of tenderisation between day 2 and day 14 (ΔWBSF) was greatest for cold shortened muscles, particularly muscles incubated at 5ºC. Muscles with the highest ΔWBSF were also found to be most variable in tenderness at day 14. Therefore variability may be due to tenderisation of cold shortened muscles. Analysis of protein profiles showed that the appearance of the 30-kDa band was related to the rate of tenderisation, therefore proteolysis might be a root cause of variation in tenderness of cold shortened muscle.

The rate of pH fall is a good indicator of the rate of glycolysis (Bendall 1978) as pH fall is generally due to an increase in lactic acid, a product of anaerobic glycolysis. Therefore the incubation temperature influenced the rate of glycolysis. Cold shortening is a toughening of meat that occurs due to chilling meat below 10^0C before the onset of rigor, when pH reaches 6.2. This explains the results obtained following sarcomere length analysis. Each muscle aged over a 14-day period, irrespective of cold shortening, hence measuring the sarcomere length at day 2 *post-mortem* is a useful tool for predicting tenderness but not toughness as muscles with short sacomeres tenderise over time.

Conclusions

A pH_3 range of 5.9 to 6.2 produces consistently tender beef where the sarcomere lengths are long (above 1.5µm). Cold shortened muscle tenderises, the absolute rate of tenderisation between day 2 and day 14 was greatest at 5ºC where most variability in tenderisation exists. Proteolysis of cold shortened muscles may induce variability.

References

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Table 1. *Mean sarcomere lengths of M.longissimus dorsi at day 2 post-mortem (um)*

Temperature ^{0}C	0^0C	5^0C	10^0C	15^0C	20^0C	25^0C
Sarcomere length (nm)	1.2± 0.4	1.37± 1.15	1.6 ± 2.65	1.6 ± 4.42	1.7± 5.78	1.6 ± 7.4

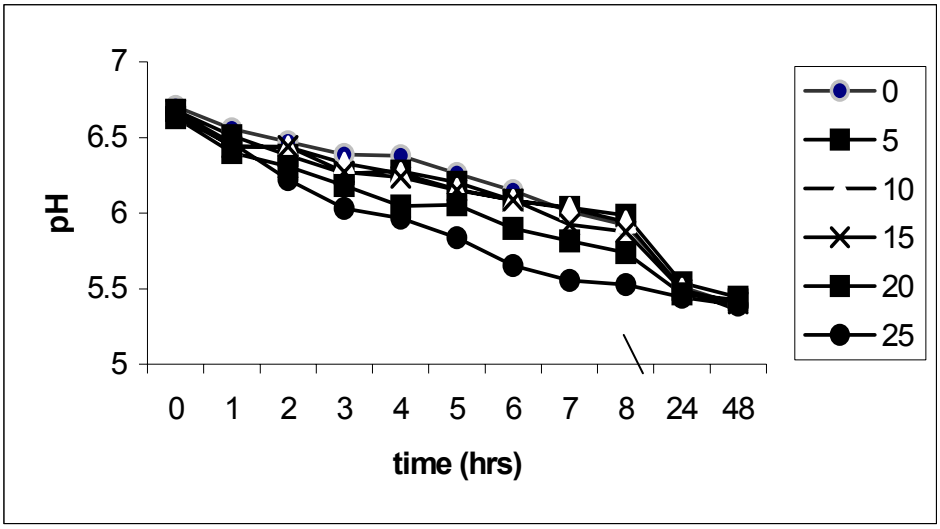

Fig 1; Mean pH decline for M. longissimus dorsi muscles incubated for 8 hours pre-rigor at temperatures from 0 to 25^{0}C.

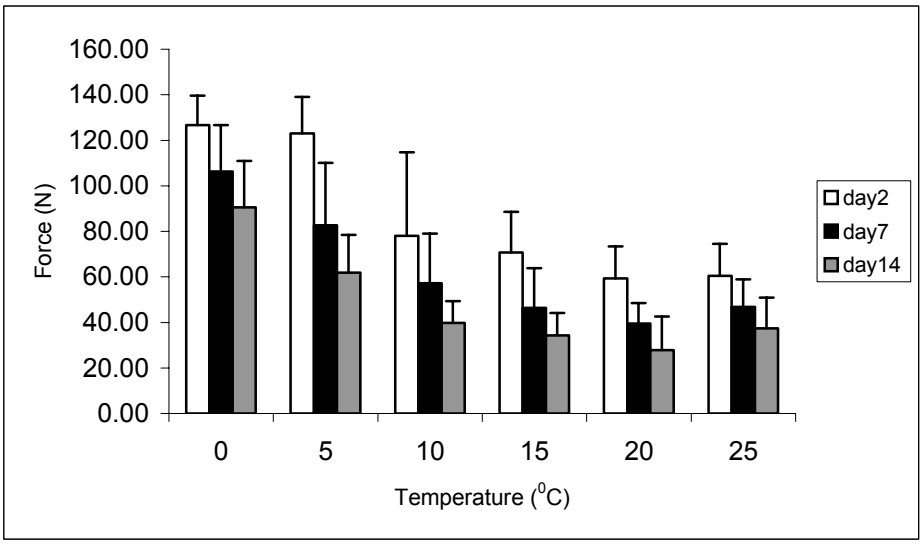

Fig 2; Mean WBSF (N) for M.Longissimus dorsi held for 8 hours at pre-rigor temperatures from 0 to 25°C.

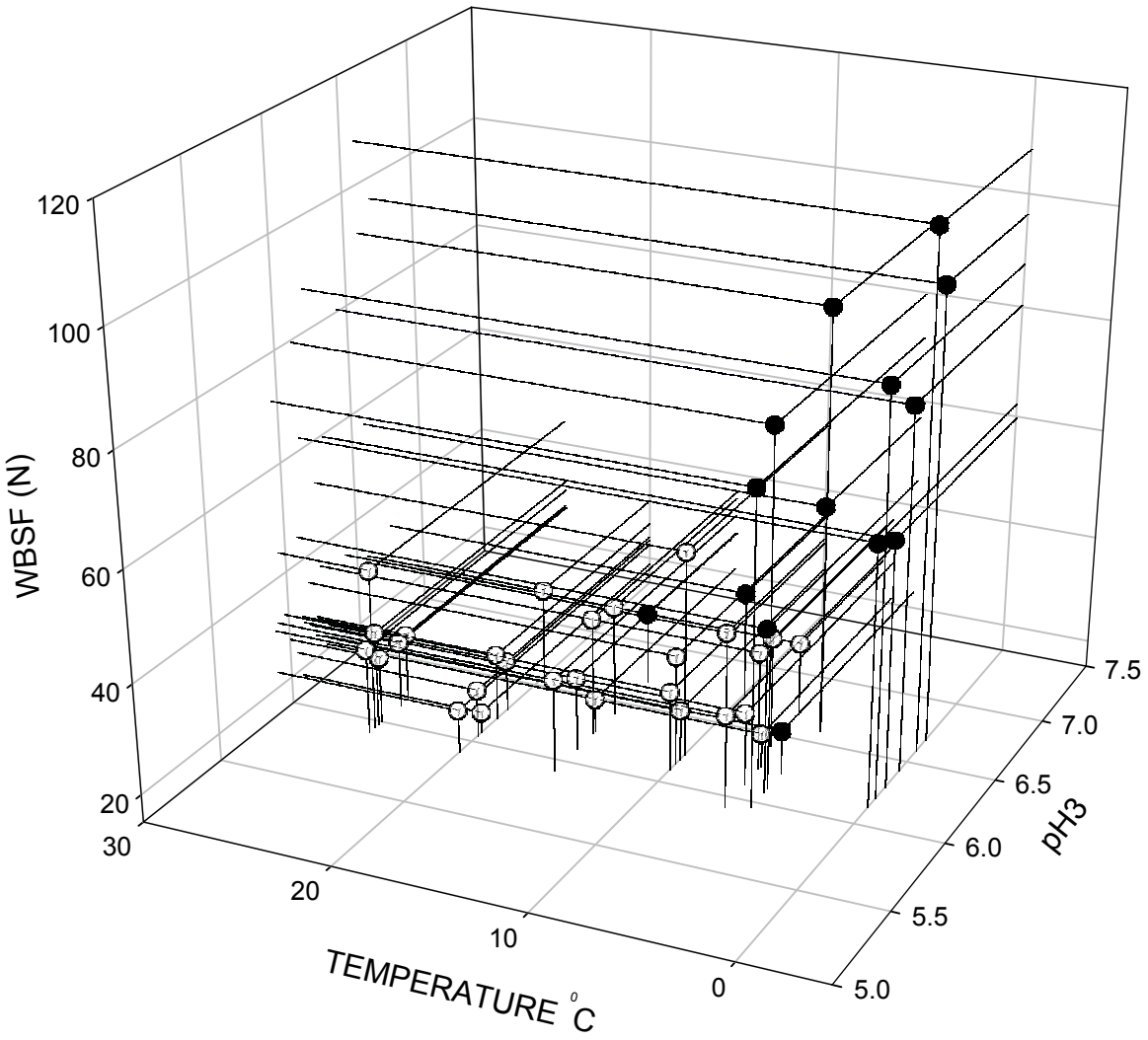

Fig. 3; Interaction between incubation temperature (8 hrs pre-rigor from 0 to 25ºC) and pH_3 and their effect on the tenderness of M.longissimus dorsi