The Influence of End-Point Cooking Temperature on Shear Force Measurements

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Aim

Determine the effect of end point cooking temperature (65 - 80°C) as meat ages over three days at 15°C

Introduction

The way meat is cooked influences its palatability, hence for objective testing and comparisons, we need to standardise the method of cooking. Meat may be cooked from fresh (AMSA,1995) or from the frozen state (Graafhuis *et al.*, 1991; Duckett *et al.*, 1998) or thawed before cooking (Locker and Daines, 1973; Jeremiah *et al.*, 1991; Ferguson *et al.*, 2000). In addition, there are variations in the end-point temperature to which meat is cooked, ranging from 65-80˚C, with significant differences in tenderness between the lowest and highest temperatures (Graafhuis *et al.*, 1991; Bejerholm & Aaslyng, 2004), or meat may be cooked for a defined period of time at a given temperature (Ferguson *et al.*, 2000). As meat ages, the cytoskeletal proteins degrade and the contribution of these compounds diminishes. Actin degradation is another influencing factor and hence end-point temperatures should be kept consistent.

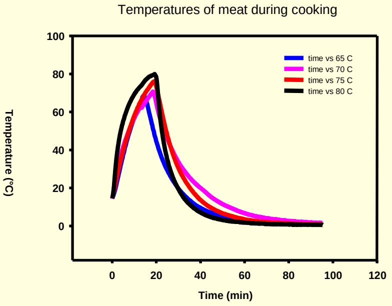

Figure 1. The rise in internal temperatures of 30 mm LL samples during water bath cooking at 85˚C. When the desired end-point temperature, either 65, 70, 75 or 80˚C was reached, samples were removed and placed in ice water.

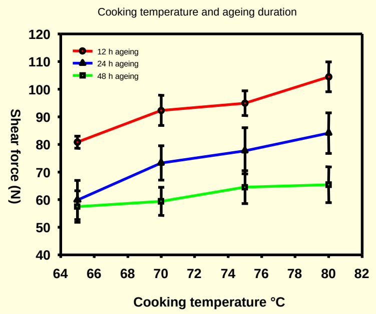

Figure 2. The effect of increases in cooking temperature from 65˚C to 80˚C on the mean shear force at different ageing durations. Means ± se relate to variation between animals

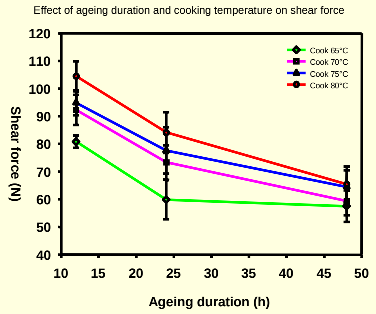

Figure 3. The effect of increases in cooking temperature from 65˚C to 80˚C on the shear force as the meat ages. Means ± se relate to individual animal variation.

Methods

Eight hot boned *m. longissimus lumborum* (LL) from electrically stunned but not electrically stimulated bulls were obtained. The muscles were transported to a laboratory and within 90 min from slaughter were wrapped tightly in polyethylene film to reduce rigor shortening and held at 15˚C to go into *rigor mortis* and then held overnight at 4˚C.

The next day the muscles were placed in a 15˚C room to equilibrate and age at this temperature.

After 12, 24 and 48 hours, samples were taken from each muscle and were cooked in the following manner: From each muscle four, 30 mm thick slices (~250 g) had thermocouples placed into the centre of the muscles. The four samples were placed in weighted plastic bags and placed in an 85˚C water bath.

When the first piece of meat reached 65˚C, it was immediately removed and placed in ice water; this was repeated as the remaining meat samples reached 70, 75 and 80˚C respectively. The cooking procedure was then repeated for each of the eight muscles at each of the ageing times. Every cooked sample was then cut along the muscle fibre axis using scalpel blades to produce at least six subsamples (termed bites) with a 1cm x 1cm cross section. Each bite was sheared using a MIRINZ tenderometer with a wedged shaped tooth and the peak shear force value was obtained (Graafhuis *et al*, 1991). The entire experimental procedure gave shear force values at four cooking temperatures with eight *m. longissimus lumborum* samples aged for 3 different times.

Results and Discussion

It took approximately 13 minutes for the meat to reach 65˚C and 20 minutes for the meat to reach the 80˚C end-point temperature (Fig 1). In order to avoid an overshoot, the samples were removed from the water bath early so that the measured end-point temperature was as close as possible to the nominal value. Most measured end-point temperatures were within ± 1°C of the nominal value.

There was a wide variation in shear force values at all end-point temperatures, as shown by the error bars in Figures 2 and 3.
End-point temperature had the biggest impact on shear force values from meat aged for 12 and 24 hours, with much less impact after 48 hours of ageing (Figure 2). Figure 3 showed significant shear force differences between meat cooked to 65, 75 and 80˚C ($p < 0.01$) after 12 hours of ageing, but no significant differences after 24 and 48 hours of ageing. Analysis of the mean values showed that there was an average increase of 1.6 N per degree for the range 65 to 80˚C at 12 hours ageing, which reduces to 0.7 N per degree for 24 hours ageing and 0.2 N per degree for 48 hours ageing. Hence, at a nominal end-point temperature, a 5°C overshoot will result in mean shear force values that differ by about 8 N for meat aged at 15°C for 12 hours. The differences in N in this instance are greater than the standard deviation of the bites of each meat sample where the range at 12 h ageing is 24 N.

Conclusions

An increase in the mean shear force values of LL was observed for high end-point cooking temperatures with increases for individual readings generally obscured by the variation in shear force measurement. The end-point temperature only had a significant impact at the shortest ageing duration of 12 hours at 15˚C. After longer ageing periods, the end-point temperature had no significant impact on shear force values.

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