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# EATING QUALITY OF COMMERCIALLY PROCESSED HOT BONED MUTTON

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## Introduction

The application of hot boning of sheep carcases for the retail market is not extensive (Waylan & Kastner, 2004), and there is limited literature available on the eating quality of hot boned sheep meat. Hot boning is the removal of muscle from the carcass prior to the completion of rigor mortis in most muscles (Devine et al. 2004). Economic benefits for using hot boning include; increased yield, energy savings, chiller space, labour and time (McPhail, 1995). The use of hot boning can however have major constraints. These include increased risk of shortening in muscles (Devine et al. 2004) which can be minimized by the use of electrical stimulation. Electrical stimulation will accelerate the onset of rigor mortis and reduce cold-induced shortening (Hwang et al., 2003). Shortening is a major contributor to the toughness of meat Tornberg, (1996), and tender meat is one of the most important requirements for consumers (Thompson, 2002). Another constraint of hot boning is the increased risk of bacterial growth Spooncer, (1993), however bacterial growth can be controlled by a combination of drying and cooling of the carcass (Spooncer, 1993).

## Objectives

To examine the eating quality of hot boned mutton processed under commercial conditions with the use of high voltage stimulation.

## Methodology

### *Animals*

The 60 sheep used in the experiment were sourced from three different farms with an equal sample size (n = 20). The animals were of various ages, breed, sex and had been on various quality pastures prior to slaughter. The animals were slaughtered over two days; day one, group 1 (n = 20) and on day two, groups 2 (n =20) and 3 (n = 20).

*Stimulation Treatments*

The following electrical inputs were used; an immobiliser (40V, current 1.0-1.5 amps) for 40sec which is applied immediately after stunning, spinal discharge (500-585V, 50Hz) for 3-4sec, which is applied approximately one minute after death and High voltage stimulation (1130V peak, 14Hz the rms V is 800V) for 100sec which is applied approximately 20 minutes after death. These electrical inputs are used routinely by the abattoir

*Measurements and sampling*

Carcases were trimmed according to the specifications of AUS-MEAT (Anon, 1992). Hot carcase weights were recorded and the GR measured (total tissue depth over the 12th rib, 110 mm from the midline) using a GR knife. Further background information was also collected on each group including where they were sourced from and their transport time.

Carcase pH and temperature measurements were taken at approximately 40 and 120 minutes after death. The pH and temperature measurements were taken in the left portion of the m. longissimus thoracis et lumborum (loin) muscle. The muscle pH was measured using a glass combination pH probe (potassium chloride) Ionode intermediate junction pH electrode, (TPS Pty Ltd., Brisbane, Queensland) attached to a data recording pH meter (TPS WP-80). While muscle temperature was measured using a stainless steel cylindrical probe attached to the same meter. The pH meter was calibrated before use, with two buffers pH 4 and 6.8 at room temperature.

The carcases were hot boned under the normal commercial procedures of the abattoir. During this process both loins were completely removed. The right side loin was removed with a knife and the caudal portion of the loin was retained for shear force testing and other samples were retained for measurement of sarcomere length and iodoacetate (to determine final pH prior to freezing). Samples for shear testing were prepared into 65-gram blocks and then were frozen (-20°C) at (1230-1600 hours) on the day of prepartion and subsequently tested for peak shear force as described by Thompson et al. (2005). Sarcomere length was tested using laser diffraction as described by Bouton et al. (1973). A 1 gram sample of loin muscle was also taken for determination of pH after the sample had been boxed and frozen, using an iodoacetate method adapted from that described by Dransfield et al. (1992). Frozen muscle samples were homogenized using an Ultra Turrax at 19,000 rpm in 6 ml of cold buffer. The buffer contained 5-mM iodoacetate and 150 mM of KCl adjusted to pH 7 with KOH at 4-5°C. Samples were homogenized for 2 bursts of 15 s with breaks of 30-s on ice. The suspensions were then incubated in a water bath at 20°C and the pH measured using a meter (TPS, WP-80, PTS Pty Ltd) with a polypropylene spear-type gel electrode (Ionode IJ 44) which was calibrated at 20°C.

*Consumer testing*

The opposing loin was removed and samples were prepared on site for consumer testing. The subcutaneous fat, connective tissue and the epimysium were removed. Each sample cut was individually packed and then kept frozen (-22  C) until testing. Before testing, the steaks were micro waved to raise the temperature to approximately -4 C and 5 slices of 15mm thickness prepared. These slices (steaks) were re-stored at -22 C until thawing at ambient temperature for cooking. Sample preparation for consumer testing has been outlined by Thompson et al. (2005). Each consumer was asked to assess each steak for tenderness, juiciness, liking of flavour and overall liking on a continuous 100 point scale from 0-100. The ten tastings for each muscle sample were averaged to give the final eating quality scores for the muscle. In addition each person was asked to give an overall rating score for each sample as, either, awful (1 star), unsatisfactory (2 star), good every day (3 star), better than every day (4 star) or premium (5 star). The testing regime has been described previously and sample preparation for consumer testing has been outlined by Thompson et al. (2005).

*Statistical Analysis*

Carcase and meat quality traits were analysed using a residual maximum likelihood (REML) procedure (Genstat 7.1, 2004), which contained a fixed effect for lot to estimate the means and standard errors of the differences. For loin pH immediately post-stimulation muscle temperature was used as a covariate and weight was used as a covariate for GR. Linear regression was used to derive the relationship between overall liking and overall rating score and tenderness and overall rating score.

## Results & Discussion

Initial loin pH was not different between lots, however the pH of the loins (LL) before being boxed and frozen was significantly different ($P < 0.05$; Table 1). Lot 2 had a higher average loin pH 5.88 compared to Lot 1 and 3(Table 1). Sarcomere length was significantly different ($P < 0.05$; Table 1) with lot 2 having the greatest sarcomere length. Irrespective of Lot all samples (n = 59) had a shear force above 50 N

A relationship was derived between overall liking and the overall rating score, where; Overall liking score = -6.01 + 20.45 (Overall rating score) R2 = 0.76, r.s.d. = 3.9. In addition a relationship was also derived between tenderness and overall rating score, where tenderness score = -22.66 + 24.18 (tenderness) R2 = 0.64, r.s.d. = 6.1. Predicted overall liking and tenderness scores at each rating score were derived and these relationships are shown in Fig 1. where it is determined that to achieve a rating score of 3 (good every day) then the overall liking score must be 55 and tenderness score must 50 for this product. Of the samples tested 86.5 % had an overall liking score less than 55 and 84.7% had a tenderness score less than 50

## Conclusions

The results show that the initial loin pH was not significantly different between lots however the pH LL prior to boxing and freezing was significantly different between lots with on average one third of the animals sampled having a loin pH greater 5.8. This higher pH can increase the risk of bacterial problems and reduced length of storage life in the product (Jeremiah et al., 1997). Lot 2 had a significantly higher SL compared to lot 1 and 3 however shortening occurred in all three lots. Hwang et al. (2004) determined that short SL is one factor that causes meat toughness and this was supported in the present study by the shear force and eating quality results. Shorthose et al. (1996) reported the threshold for shear force was 50N, however, these results all exceed this threshold indicating that the sampled product was unacceptable and would be extremely tough for consumers. This was consistent with the eating quality results which showed that an overall liking score of 55 and above was needed to achieve an overall rating of "good every day" and a tenderness score of 50 and above. From this it was determined that a large proportion of the hot boned sheep meat had a overall liking score below 55 and a tenderness score below 50, indicating a critically low compliance rate with consumers. It is concluded that the eating quality of hot boned mutton processed under the conditions of this study needs a significant improvement before it would be acceptable as a table meat. Research into other processing techniques that can be used to enhance this type of product is required, but consumer testing of product must be used to quantify improvements with the aim of achieving higher consumer compliance.

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## Tables and Figures

Table 1. Predicted means (av. s.e.d.) of initial pH (post-stimulation), pH LL prior to boxing and freezing, sacromere length(µm), shear force (Newtons), cooking loss (%) and sensory traits for animals according to groups

| | | **Lot** | | ***av. s.e.d.*** |
|---|---|---|---|---|
| Traits | 1 | 2 | 3 | |
| Initial pH* | 5.92a | 5.98a | 5.95a | *0.145* |
| pH LL (b/f box) | 5.67a | 5.88b | 5.60a | *0.070* |
| Sacromere length (µm) | 1.66a | 1.73b | 1.65a | *0.028* |
| Shear force (N) | 77.2a | 83.2a | 86.2a | *4.99* |
| Cooking loss (%) | 19.9a | 21.0a | 19.9a | *0.92* |
| Tenderness | 36.4a | 43.1b | 37.9ab | *3.17* |
| Juiciness | 35.0a | 49.5b | 44.1b | *2.96* |
| Flavour | 48.6a | 53.0b | 52.2ab | *2.19* |
| Overall liking | 43.1a | 49.5b | 46.2ab | *2.44* |

Means followed by a different letter in a row (a, b) are significantly different ($P < 0.05$). *Adjusted to a muscle temperature of 29.3 °C.

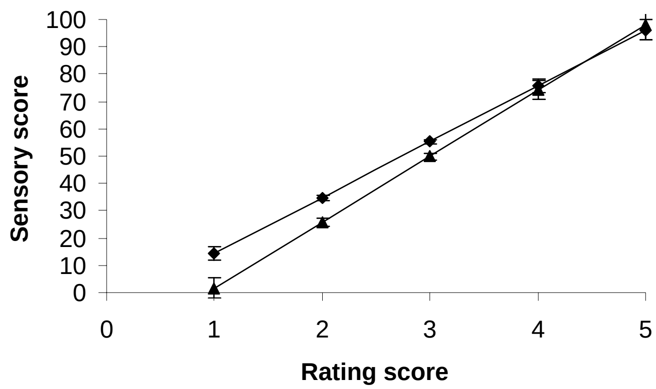


**Figure 1. Relationship between tenderness (▲) and overall liking scores (♦) and rating score where 5 is best.**