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# HOT-BONING, ELEVATED TEMPERATURE CONDITIONING AND VACUUM PACKAGE AGING INFLUENCES ON LAMB COOKING LOSSES AND PALATABILITY

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## INTRODUCTION

Considerable interest has developed in increasing efficiency within the meat industry. Accelerated processing systems, including removal of the edible portion from unchilled carcasses (hot-boning, HB), have been demonstrated to be feasible and to markedly improve processing efficiency. Although functional properties, flavour, juiciness and cooking losses have been observed to improve with HB, tenderness has been observed to decrease, constituting a major obstacle to implementation of the technology. However, the beneficial effects of post-mortem aging on tenderness have been extensively documented and elevated temperature conditioning (ETC) has been observed to partially offset the detrimental effects of HB on tenderness. The present study was undertaken to examine the effects of ETC and vacuum packaged, post-mortem aging (VPA) alone or in combination on the cooking properties and palatability attributes.

## MATERIALS AND METHODS

Sixty-four wether lambs, 12 to 15 months of age and with slaughter weights between 59 and 77kg were utilized. All racks were excised at approximately 45 minutes post-mortem and randomly allocated to processing treatments and aging times. Samples were HB at approximately 45 minutes post-mortem and then ETC for 0, 2, 4 or 6 hours at 32°C. Following ETC samples were then VPA for 6, 13, 27 or 41 days at 1°C±2°C. All racks were then frozen at -30°C in still air and stored at -30°C until evaluated (90 to 180 days).

Upon removal from the freezer all racks were weighed, thawed at 4°C for 48 hours, and reweighed to determine thaw-drip losses. A saber thermocouple was inserted into the centre of each rack and they were roasted in an electric convection oven preheated to 177°C to an internal temperature of 75°C. Upon removal from the oven each rack was reweighed to determine total cooking losses, subjectively evaluated for degree of doneness (1=rare; 5=well done) and cooking times were recorded. Six cubes (1.9x1.9x1.9cm) were then removed from each rack taking care to avoid large pieces of fat and connective tissue and randomly assigned to an experienced, six-member taste panel screened and trained according to AMSA guidelines (1978) by placing them in covered glass containers in a 70°C circulating water bath. Subsamples were held in the water bath until evaluated (10 to 15 minutes).

Panel sessions were conducted in well ventilated, temperature controlled, partitioned booths, under 1076 lux of incandescent and fluorescent white light; and room temperature distilled water and unsalted soda crackers were provided to remove residual flavours between samples. Panellists evaluated subsamples using eight-point descriptive scales for initial and overall tenderness (8=extremely tender; 1=extremely tough), amount of perceptible connective tissue (8=no perceptible connective tissue; 1=abundant perceptible connective tissue), juiciness (8=extremely juicy; 1=extremely dry), and flavour intensity (8=extremely intense lamb flavour; 1=extremely bland lamb flavour). The presence of any off-flavour was also noted.

Data were analyzed using the GLM procedure of SAS (1985) which provides an analysis of variance and a mean separation based upon the Student t-test. Initially a model was used which included slaughter weight, treatment and storage time as main effects and all two-way interactions. The only significant interaction ($P<0.05$) was a two-way weight/storage time interaction for flavour intensity. Further examination revealed this interaction effect was not of

practical importance. Therefore, a reduced model was employed, which included slaughter weight, treatment and storage time as main effects and the two-way interaction of treatment with storage time. There were no significant ($P<0.05$) treatment/storage time two-way interactions. Therefore, the main effects of treatment and storage time were evaluated separately. Linear regression was utilized to detect significant trends with conditioning and storage time (Puri and Mullen, 1980).

## RESULTS AND DISCUSSION

Treatment produced no significant effects ($P>0.05$) (Table 1), but storage time significantly ($P<0.05$) influenced all traits, except juiciness (Table 2). Significant ($P<0.05$) trends with increasing conditioning time were not observed in any of the traits. Roasts stored for 27 and 41 days sustained higher ($P<0.05$) total cooking losses than roasts stored for six and 13 days. In addition, roasts stored for 41 days were more tender initially ($P<0.05$) than roasts stored for six and 13 days and roasts stored for 13 days were more tender initially than those stored for six days ($P<0.05$). Roasts stored for six days were also significantly less tender ($P<0.05$) overall than roasts stored for longer periods. It is also of interest that roasts stored for 41 days were more intense in flavour than roasts stored for shorter periods ($P<0.05$); and roasts stored for 27 and 41 days were perceived to contain less connective tissue than roasts stored for six days ($P<0.05$). Significant positive trends with increasing storage time were observed for percent total cooking losses ($R^2=0.94$, $P<0.05$), flavour intensity ($R^2=0.90$, $P<0.05$) and amount of perceptible connective tissue ($R^2=0.92$, $P<0.01$). However, a significant negative trend with increasing storage time was detected for juiciness ($R^2=0.88$, $P<0.05$). Such results indicate vacuum packaged aging is effective in improving initial and overall tenderness and reducing the amount of perceptible connective tissue. However, it increased total cooking losses, reduced juiciness and made flavour more intense.

The fact that racks contain fewer muscles, less connective tissue and more fat than shoulder roasts aids in explaining why treatment effects were not observed from either hot-boning alone or in combination with elevated temperature conditioning in the present study; while detrimental effects from hot-boning on tenderness were observed in shoulder roasts, and were partially offset by elevated temperature conditioning (six hours at 32°C) (Jeremiah *et al.*, 1993).

## CONCLUSIONS

It is apparent from the present data that wholesale racks can be hot-boned early in the post-mortem period (45 minutes) without adversely affecting cooking properties or palatability attributes. Elevated temperature conditioning of hot-boned racks failed to alter either cooking properties or palatability attributes but vacuum packaged, post-mortem aging improved initial and overall tenderness and reduced the amount of perceptible connective tissue, while increasing cooking losses and intensifying lamb flavour.

## REFERENCES

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Table 1. Least squares means and standard errors for treatment effects on cooking and laboratory panel data.

| Trait | Treatment[1] 1 Mean(SE) | 2 Mean(SE) | 3 Mean(SE) | 4 Mean(SE) |
|---|---|---|---|---|
| % total cooking losses | 33.82 (1.18) | 34.73 (1.11) | 31.27 (1.03) | 34.73 (1.38) |
| Initial tenderness | 5.00 (0.27) | 5.58 (0.25) | 5.27 (0.23) | 4.75 (0.31) |
| Overall tenderness | 5.23 (0.30) | 5.61 (0.28) | 5.41 (0.26) | 4.77 (0.34) |
| Juiciness | 5.15 (0.26) | 4.22 (0.25) | 4.96 (0.23) | 4.73 (0.31) |
| Flavour intensity | 5.31 (0.22) | 5.35 (0.20) | 5.41 (0.21) | 5.36 (0.21) |
| Amount of perceptible connective tissue | 7.17 (0.31) | 7.57 (0.30) | 7.20 (0.27) | 6.81 (0.37) |

[1] Treatment: 1=Hot-boned, unconditioned.
2=Hot-boned, conditioned 2h at 32°C.
3=Hot-boned, conditioned 4h at 32°C.
4=Hot-boned, conditioned 6h at 32°C.

Table 2. Least squares means and standard errors for treatment effects on cooking and laboratory panel data.

| Trait | Storage time (days) 6 Mean(SE) | 13 Mean(SE) | 27 Mean(SE) | 41 Mean(SE) |
|---|---|---|---|---|
| % total cooking losses | 31.03[b] (1.03) | 31.42[b] (1.04) | 34.80[a] (1.01) | 37.29[a] (1.57) |
| Initial tenderness | 4.25[c] (0.23) | 4.98[b] (0.24) | 5.38[ab] (0.23) | 5.99[a] (0.36) |
| Overall tenderness | 4.34[b] (0.25) | 5.12[a] (0.26) | 5.53[a] (0.25) | 6.03[a] (0.39) |
| Juiciness | 5.09 (0.23) | 4.80 (0.23) | 4.88 (0.22) | 4.29 (0.35) |
| Flavour intensity | 5.02[b] (0.21) | 4.87[b] (0.21) | 5.01[b] (0.20) | 6.55[a] (0.21) |
| Amount of perceptible connective tissue | 6.44[b] (0.27) | 7.11[ab] (0.28) | 7.35[a] (0.27) | 7.85[a] (0.42) |

[a,b,c] Means in the same row without a superscript or bearing a common superscript do not differ significantly ($P>0.05$).