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ELECTRICAL STIMULATION AND HOT-PROCESSING INFLUENCES ON LAMB QUALITY, PALATABILITY AND CONSUMER ACCEPTANCE

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INTRODUCTION

Palatability largely determines consumer acceptance after purchase. For red meats, tenderness is the major determinant of palatability, and tenderness is largely dependent upon processing conditions during the early post-mortem period. Electrical stimulation (ES) has been observed to minimize cold shortening and improve tenderness and hot-boning (HB) or pre-rigor excision of the edible portions from unchilled carcasses has been demonstrated to be feasible and to increase processing efficiency and improve functional properties, flavour, juiciness and cooking losses, but to reduce tenderness. However, few studies have attempted to determine if the beneficial effects of ES are capable of preventing or offsetting the detrimental effects of HB on tenderness. The present study was undertaken to evaluate the effects of ES alone and in combination with HB on the quality, palatability and consumer acceptance of lamb cuts.

MATERIALS AND METHODS

A total of 500 lambs (159 rams, 165 ewes and 176 wethers) six to nine months of age and with slaughter weights between 41 and 77kg were utilized. Carcasses were either electrically stimulated (ES), electrically stimulated and hot-boned (ES/HB), or processed conventionally (C) at approximately 45 minutes post-mortem. Genders and slaughter weights were allocated as equally as possible to treatments. ES consisted of the application of 550 volts, 5 amps in 20 pulses of two second duration interspersed with one second resting intervals. HB consisted of the removal of the edible portion immediately after ES and the fabrication of primal cuts, which were then vacuum packaged and chilled for 48 hours at 1°C±2°C. C and ES carcasses were also chilled for 48 hours at 1°C±2°C in the same meat cooler with a relative humidity of 90% and an air speed velocity of 0.5 meters per second.

Both muscle pH and temperature were recorded immediately before and after ES and at three hours post-mortem in both the *longissimus dorsi* (LD) and *semimembranosus* (SM) muscles using methods previously described (Martin *et al.*, 1983). Carcass lean from the left side of each carcass was ground twice through a 3mm plate, prior to being subsampled. Percent transmission and expressible juice were determined using procedures previously outlined (Murray *et al.*, 1989), except 20g subsamples were centrifuged at 37,000xg for 60 minutes, rather than for 15 minutes. Three reflectance measurements were made on the cross-sectional surface of the LD muscle between the twelfth and thirteenth vertebra using a Macbeth Series 1500 colour measuring system (Macbeth, Newbergh, N.Y.).

Wholesale loins from the right sides were weighed, vacuum packaged, frozen at -30°C, and held at this temperature until evaluated (90 to 180 days). All loins were thawed at 4°C for 48 hours and then reweighed to determine thaw-drip losses. A saber thermocouple was inserted into the centre of each loin and they were roasted in an electric convection oven preheated to 177°C, to an internal temperature of 75°C. Each loin was then reweighed to determine total cooking losses and cooking times were recorded. The drip from each loin was weighed to determine cooking-drip losses and evaporative cooking losses were obtained by differences. Degree of doneness was subjectively evaluated (1=rare; 5=well done). Loins were then subsampled as previously described (Jeremiah and Martin, 1982). Subsamples were held in covered glass containers in a circulating water bath (70°C) until evaluated (10 to 15 minutes). Panellists

evaluated subsamples using 8-point descriptive scales for initial and overall tenderness (1=extremely tough; 8=extremely tender), amount of perceptible connective tissue (1=abundant; 8=none), juiciness (1=extremely dry; 8=extremely juicy), and lamb flavour intensity (1=extremely bland; 8=extremely intense); and the presence of any off flavour or odour was noted. Three cores (13mm) were also removed from each loin using a mechanical cork borer after the loin had been refrigerated overnight at 4°C. Each core was sheared three times using the Ottawa Texture Measuring System fitted with a Warner-Bratzler blade and mean shear force value was calculated and recorded.

The shoulders from the right sides were boned, rolled, tied, vacuum packaged, frozen at -30°C and stored at this temperature until subsampled for analysis. Two shoulder roasts were randomly selected from each gender/slaughter weight/treatment subgroup, resulting in 24 roasts being analyzed per treatment. Shoulder roasts were cooked, subsampled and evaluated as previously described (Jeremiah, 1988). Complete flavour and texture profiles were obtained using a highly trained flavour-texture profile panel as previously described (Jeremiah, 1988).

All panel sessions were conducted in well ventilated, temperature controlled, partitioned booths under 1076 lux of incandescent and fluorescent white light. Room temperature, distilled water and unsalted soda crackers were provided to remove flavour residues between sample evaluations.

The legs were boned, rolled, tied, cut into two equal portions, frozen at -30°C and distributed to 500 lamb consuming households. Consumers were instructed to prepare the roasts they received using the methods they normally used for lamb leg roasts, but to record cooking methods and times and the degree of doneness at the point of consumption. Following preparation each household was asked to reach a consensus rating for the acceptability of the flavour, juiciness, tenderness, and overall palatability using a 5-point hedonic scale (1=dislike extremely; 5=like extremely).

Due to lack of meaningful interactive effects of gender and slaughter weight with treatment ($P>0.05$), most data were pooled over weights and genders and analyzed using the GLM procedure of SAS (SAS, 1985) to evaluate treatment effects. Non-parametric data from the flavour and texture panels were analyzed using the Chi-Square test (Puri and Mullen, 1980).

RESULTS AND DISCUSSION

The only significant differences in muscle pH were observed at three hours post-stimulation when conventionally treated carcasses (C) had higher pH values than electrically stimulated (ES) and electrically stimulated/hot-boned (ES/HB) carcasses in both the *longissimus dorsi* (LD) and *semimembranosus* (SM) muscles ($P<0.05$). The pH was also higher in ES/HB LD muscles than in the ES LD muscles ($P<0.05$) and in the ES SM muscles than in the ES/HB SM muscles ($P<0.05$) at this time period. Therefore, both treatments produced a more rapid decline in pH, but no significant time trends were observed ($P>0.05$).

ES/HB carcasses had the lowest SM temperature pre-stimulation and the lowest LD and SM temperatures at three hours post-stimulation ($P<0.05$); and time trends ($P<0.05$) were detected in all muscle/treatment subclasses.

ES/HB samples had lower percent transmission values than their C and ES counterparts and ES samples had higher expressible juice values than their C and ES/HB counterparts ($P<0.05$; Table 1). Significant differences in Hunter colour values were not observed ($P>0.05$).

ES carcasses were the most tender initially and overall and had the lowest shear values and the least perceptible connective tissue, whereas ES/HB carcasses were the least tender initially and overall, and had the highest shear values and the most perceptible connective tissue ($P<0.05$; Table 1). ES/HB loin roasts also required longer cooking times and sustained greater cooking drip and total cooking losses ($P<0.05$).

There were no treatment effects on textural surface properties ($P>0.05$). However, ES/HB samples were the most elastic on partial compression and were the most difficult to compress on the first bite ($P<0.05$). ES/HB samples were also more cohesive during the first bite than C samples ($P<0.05$). In addition, ES/HB samples were the most fibrous and

chewy, required the greatest number of chews, and broke down the most slowly during mastication ($P<0.05$). A higher proportion of ES/HB samples had coarse minus fibres than C samples ($P<0.05$). Lower proportions of ES/HB samples had medium and medium minus fibres than C samples ($P<0.05$). Moreover, ES/HB samples released the least moisture and were the most cohesive and dense during mastication ($P<0.05$). C samples had the least amount of perceptible connective tissue during mastication ($P<0.05$). ES/HB samples also resulted in the most toothpacking and were the least easy to swallow ($P<0.05$). ES/HB samples also generally produced lower proportions of residual particles than C and ES samples ($P<0.05$). These differences combined to give ES/HB samples the lowest texture amplitude ($P<0.05$) and the least appropriate well balanced and well blended texture.

Higher proportions of C samples displayed an inappropriate livery aromatic and aftertaste than ES samples ($P<0.05$). A higher proportion of C and ES/HB samples also displayed an inappropriate metallic aftertaste than ES samples ($P<0.05$). However, a higher proportion of ES samples displayed an inappropriate barnyard aromatic than C samples ($P<0.05$). An appropriate lamb aromatic was most intense in ES samples and least intense in C samples ($P<0.05$), while an inappropriate woolly aromatic was most intense in ES samples ($P<0.05$). The appropriate sweet taste was most intense in ES samples and the appropriate salty taste was more intense in ES than C samples ($P<0.05$). The inappropriate sour taste was least intense in ES samples ($P<0.05$). The appropriate fatty/tallowy aftertaste was most intense in C samples, and the appropriate sweet aftertaste was more intense in ES samples than in ES/HB samples ($P<0.05$). The inappropriate sour aftertaste was more intense in C samples than in ES samples ($P<0.05$). ES samples were also perceived to be the warmest when served and C samples were perceived to the least warm when served ($P<0.05$). The inappropriate metallic aromatic was perceived earlier in ES/HB samples than in C samples, and the inappropriate lemon/sour aromatic was perceived more quickly in ES and ES/HB samples than in C samples ($P<0.05$). The appropriate sweet taste was also perceived more quickly in ES and ES/HB samples than in C samples ($P<0.05$) and the appropriate salty taste was perceived the most quickly in ES samples and least quickly in C samples, while the inappropriate sour taste was perceived more quickly in ES samples than C and ES/HB samples ($P<0.05$). These differences combined to give ES samples a higher flavour amplitude ($P<0.05$) and a more appropriate, well balanced and well blended flavour than ES/HB samples.

It should be noted, however, ratings of both flavour and texture amplitude were well above ratings normally expected for roast lamb.

Butt roasts (BR) from ES carcasses were slightly, but not significantly ($P>0.05$) more acceptable in tenderness than their counterparts from C carcasses. No other differences in acceptability of BR were apparent (Table 2). However, nearly twice the proportion of BR from ES/HB carcasses were rated unacceptable in flavour as their counterparts from C and ES carcasses. In addition, a higher proportion of shank roasts (SR) from ES carcasses and BR from C carcasses were rated unacceptable in juiciness than their counterparts from the other treatments and a higher proportion of BR from C carcasses were rated unacceptable in tenderness than their counterparts form ES carcasses ($P<0.05$). The highest proportion of unacceptable SR in overall palatability were from C carcasses and the lowest proportion was from ES carcasses while the highest proportion of unacceptable BR in overall palatability was from ES/HB carcasses and the lowest proportion was from C carcasses. Therefore, in the present study ES alone and in combination with HB produced only minor effects on consumer acceptance based on palatability traits.

CONCLUSION

ES is clearly beneficial and HB is clearly detrimental to lamb palatability. However, the beneficial effects of ES were not effective in preventing or offsetting the detrimental effects of HB on either lamb texture or flavour. In addition, both ES and ES/HB produced only minor effects on palatability and consumer acceptance.

REFERENCES

JEREMIAH, L.E. 1988. A comparison of flavour and texture profiles for lamb leg roasts from leg roasts from three different geographical sources. *Can. Inst. Food Sci. Technol. J.* 21:471.

PURI, S.D., and MULLEN, K. 1980. *Applied Statistics for Food and Agricultural Scientists.* G.K. Hall Med. Publ., Boston, Mass.

SAS INSTITUTE, INC. 1985. *SAS User's Guide: Statistics.* Statistical Analysis Systems Institute, Inc., Cary, N.C.