ELECTRICAL STIMULATION OF LAMB CARCASES

F. D. Shaw CSIRO Division of Food Science & Technology, PO Box 3312 Tingalpa DC, Queensland 4173, AUSTRALIA

I. J. Eustace Australian Meat Technology Pty Ltd., PO Box 6206 Acacia Ridge DC, Queensland 4110, AUSTRALIA

R. D. Warner Victorian Institute of Animal Science, Private Bag 7, Sneydes Road Werribee, Victoria 3030, AUSTRALIA

Keywords: Electrical stimulation, lamb, tenderness, meat quality

Background

Electrical stimulation (ES) improves the tenderness of muscles of lamb carcases (Riley et al 1980, Chrystall et al 1984, Shorthose et al 1986) and the improvement is of sufficient magnitude to be detected by consumers (Jeremiah et al 1983). Furthermore, it has recently been demonstrated that the basal toughness of unaged lamb is not acceptable (Devine and Graafhuis 1994) and therefore an ageing period, preferably following electrical stimulation, is necessary to ensure acceptable tenderness.

In New Zealand, electrical stimulation is used extensively for lamb carcases which are to be frozen. The systems in that country use high voltages and the costs associated with ensuring the safety of workers with these systems means that the total capital costs for their installation are considerable. The use of low voltages provides a practical, low-cost procedure for the effective stimulation of beef carcases (Fabiansson and Laser Reutersward 1985; Powell et al 1986) but low voltage stimulation of lamb carcases does not appear to have been widely used in commercial abattoirs. This is probably due to a general acceptance of the view that for best effect low voltage stimulation needs to be applied soon after sticking, which implies that, with lamb carcases, the skin and fleece would still be present. It is difficult to envisage a low voltage system making adequate electrical contact without creating hygiene problems by the passage of electrodes through the skin. The large numbers of sheep processed per hour precludes the use of individual animal probes (eg nostril or rectal probes) used with some low voltage systems for beef carcases. The availability of a low capital cost, effective low voltage stimulation system which avoids these drawbacks would encourage the adoption of the process of electrical stimulation of lamb carcases.

Objectives

To demonstrate that the use of electrical stimulation, including low voltage systems, up to 30 minutes after exsanguination, leads to a significant improvement in the tenderness of muscles from chilled lamb carcases.

Methods

Two trials were conducted, one with a high voltage (HV) system and one with a low voltage (LV) system. The high voltage system used an 1100V (peak), 14.3 pulses per second waveform. For the low voltage system, an alternating square wave with a peak voltage of 45V was used. This system is widely used for ES of beef carcases in Australia and complies with requirements of Australian electricity authorities for 'extra low voltage' equipment. Other countries permit peak voltages in excess of 45V. In each trial, lambs were processed normally in an abattoir which formed part of a research facility. Electrical stimulation was applied to each carcase after final inspection and washing, which was 23-30 minutes after electrical stunning. At this final stage, the carcase was suspended symmetrically from the Achilles tendons by a curved metal rod (gambrel). The gambrel was in turn supported from the overhead rail by a plastic skid which insulated the carcase from the rail. Two multi-point probes (Bouton et al 1978), were inserted into either side of the lateral aspect of the neck. These probes were joined together to form one electrode. The metal gambrel formed the other electrode. The duration of electrical stimulation current flow was 80 seconds. In both trials, there were control groups of unstimulated carcases.

The pH of the *longissimus thoracis et lumborum* (LTL) muscle was measured at 1 hour after stunning. Carcases were held in a chiller (ambient air temperature 2°C) overnight. The following day the LTL and *semimembranosus* (SM) muscles were removed and stored frozen for subsequent meat quality evaluation. After thawing, the muscles were cooked (1 h at 80°C) and tested for tenderness with a Warner-Bratzler shear blade fitted to an Instron Universal Testing machine.

Results

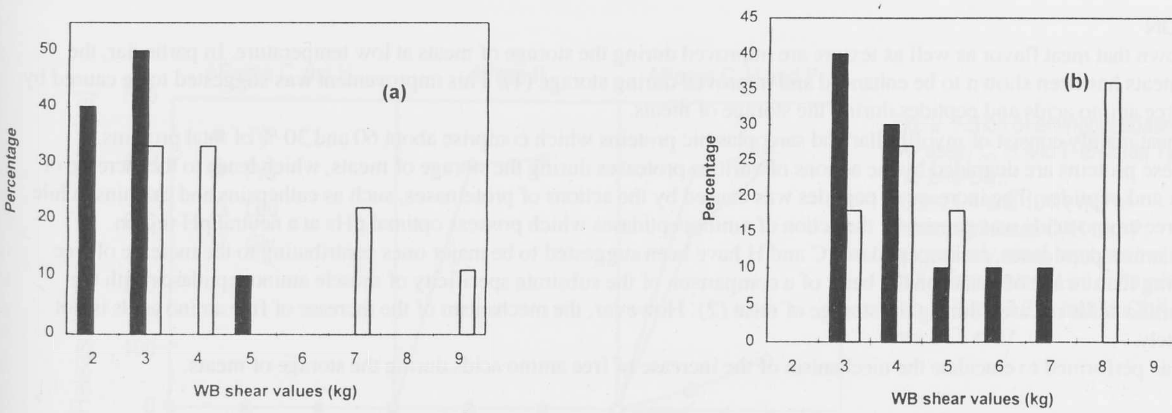
Table 1: Effect of HV stimulation on pH and tenderness (W-B shear peak force values) of muscles from lamb carcases

GROUP	n	pH (1 HOUR)	LTL W-B PF	SM W-B PF
Control	9	6.8	5.6	7.9
Stimulated	10	6.0	3.2	6.0
Stat. Signif. (P<)		0.001	0.03	0.06

Table 2: Effect of LV stimulation on pH and tenderness (W-B shear peak force values) of muscles from lamb carcases

GROUP	n	pH (1 HOUR)	LTL W-B PF	SM W-B PF
Control	11	6.6	6.0	10.5
Stimulated	10	6.2	4.6	8.5
Stat. Signif. (P<)		0.001	0.12	0.02

Figure 1: Distribution of WB shear value for LTL muscles from carcases stimulated with high (a) or low (b) voltage (□ Control, ■ Stimulated)



Discussion

Both stimulation systems caused a significant fall in pH and an improvement in tenderness in the LTL and SM muscles. The histogram plots illustrate that ES has led to a reduction in the percentage of muscles with high W-B values. This is a common finding with ES. The finding that low voltage stimulation can be effective when applied at 20 minutes, or longer, after slaughter differs from earlier literature reports that low voltages should only be used soon after exsanguination (Morton and Newbold 1982) before deterioration of the nervous system prevented reliable current flow. However, it has recently been reported that low voltage (85 volt) stimulation applied to pig carcases 20 minutes after exsanguination was effective in improving meat tenderness (Taylor and Martoccia 1992).

Conclusion

Whilst the effect of low voltage stimulation may not have been optimal it was clearly beneficial. Further trials are planned to investigate whether an in-line low voltage ES system for lamb carcases can be developed.

References

Chrystall, B.B., Devine, C.E., Ellery, S. and Wade, L. (1984). New Zealand Journal of Agricultural Research 27:513.
Bouton, P.E., Ford, A.L., Harris, P.V. and Shaw, F.D. (1978). Journal of Food Science 43:1392.
Devine, C. E. and Graafhuis, A.E. (1994). Meat Science 39:285.
Fabiansson, S. and Laser Reutersward, A. (1985). Meat Science 12:205.
Jeremiah, L.E., Tong, A.K.W. and Gibson, L.L. (1993) *Proceedings of 39th International Congress of Meat Science and Technology Calgary*, 133.
Morton, H.C. and Newbold, R.P. (1982). Meat Science 7:297.
Powell, V.H., Harris, P.V. and Shorthose, W.R. (1986). Food Technology in Australia 38:230.
Riley, R.R., Savell, J.W., Smith, G.C. and Shelton, M. (1980). 45:119. Journal of Food Science 45:119.
Shorthose, W.R., Powell, V.H. and Harris, P.V. (1986). Journal of Food Science 51:889.
Taylor, A.A. and Martoccia, L. (1992). *Proceedings of 38th International Congress of Meat Science and Technology*, *Clermont-Ferrand France* 431.

Acknowledgement

This work was supported by the Meat Research Corporation.