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Effectiveness of CPMS stimulation on goat meat

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Abstract

A 2 × 2 factorial study designed to assess the effects of mid voltage electrical stimulation and product ageing on goat meat quality was conducted at Hardwicks Meat Works Pty Ltd Kyneton Victoria.
The results found there was a significant positive effect of mid voltage electrical stimulation on goat meat objective tenderness. Electrical stimulation reduced the loin muscle shear force value by 0.87kg compared to non stimulated carcasses at 1 days ageing. This advantage was largely retained after 6 days ageing where the difference in objective tenderness was 0.84kg in favour of the electrically stimulated carcases. Ageing the product from 1 to 6 days reduced objective shear force values on average by 0.4 kg (P=0.067). There was no significant interaction between the ageing and electrical stimulation treatments. The measured improvement in loin tenderness attributable to the electrical stimulation treatment was substantial considering the low current (400mA) and moderate carcass chilling rate used in this study

Collectively the results demonstrate that MLA mid voltage electrical stimulation system offers comparable commercial advantages to the goat meat industry with regard to enhanced product tenderness to those already identified for the sheep meat industry. Consequently, the technology should be recommended to the major Australian goat meat processing plants as an integral part of their plants quality assurance program for goat meat destined for either the fresh domestic and/or frozen export markets.

Executive Summary

Previous studies have found that the effectiveness of electrical stimulation (ES) post slaughter on improving the sensory eating quality attributes of lamb is influenced by the ES design specifications that control the level and pulse characteristics of electrical energy inputs administered to the carcass. MLA has developed a mid voltage electrical stimulation system for lamb that has a number of operational advantages over conventional ES systems. This study assessed the effect of the MLA-designed mid voltage ES unit installed at Hardwick's Meatworks Pty Ltd on the rate of muscle pH decline post slaughter and subsequent goat meat eating quality after 1 and 6 days of ageing.

Twenty feral goats 8-9 months of age and average carcass weight of 12.0kg were processed at Hardwicks Pty Ltd in a 2 × 2 factorial study designed to assess the effects of electrical stimulation and product ageing on goat meat quality. The goats received either no stimulation (control) or low current stimulation (constant current 400mA peak, 14Hz or pulses/second, 1millisecond pulse width, maximum voltage 300V peak at around 20 minutes post sticking. The 400mA setting was the setting being routinely used by Hardwicks Pty Ltd for lambs. Duration of the electrical stimulation treatment was 30 seconds.

The results found that the electrical stimulation treatment significantly ($P<0.001$) hastened the rate of pH decline in the first 45 minutes post slaughter. At subsequent measurement time points (1.5, 3, 4.5 and 24 hours post slaughter) the loin muscle pH of ES treated carcasses were marginally lower than the non stimulated carcasses but the differences were not significant. This is considered to possibly be a reflection of the low current stimulation setting (400mA) used by the plant. Previous studies on lamb have indicated a setting of 600mA gave optimal results under rapid chilling conditions. The rate of carcass chilling was also quite moderate. Average carcass loin temperature was 13.7°C when the loin muscle pH had declined to a pH of 6 or below at around 4.5 hours post slaughter.
There was a significant ($P<0.001$) positive effect of electrical stimulation on loin muscle Warner Bratzler shear force values when measured at both 1 and 6 days post ageing. The loin muscle from electrically stimulated carcases had on average 0.89kg lower shear force values than loins from non stimulated carcasses at 1 days ageing. This advantage was largely retained after 6 days ageing where the difference in objective tenderness was 0.84kg in favour of the electrically stimulated carcases. The measured improvement in loin tenderness attributable to the electrical stimulation treatment was substantial considering the low current (400mA) and moderate carcass chilling rate used in this study. Ageing the product from 1 to 6 days reduced loin muscle shear force value by 0.4kg but this effect was not significant ($P=0.067$).

Electrical stimulation also significantly influenced loin muscle colour when measured at 24 hours post slaughter using a Minolta chronometer. Loin muscle Minolta a values (a measure of degree of redness) and b values (a measure of degree of yellow) were respectively 1.65 units ($P<0.001$) and 0.53 units ($P=0.027$) higher than loins from non stimulated carcasses. Loin muscle Minolta L values (measure of overall lightness) were not effected by the electrical stimulation treatment ($P=0.729$)

Collectively the results demonstrate that MLA mid voltage electrical stimulation system offers comparable commercial advantages to the goat meat industry with regard to enhanced product tenderness to those already identified for the sheep meat industry. The measured improvement in loin tenderness attributable to the electrical stimulation treatment was substantial considering the low current (400mA) and moderate carcass chilling rate used in this study.

Contents

1 Background

1.1 Background -

Previous studies have shown that the effectiveness of electrical stimulation (ES) post slaughter on improving the sensory eating quality attributes of lamb is influenced by the specific design specifications of the ES system. MLA has developed a mid voltage electrical stimulation system for lamb that has a number of operational advantages over conventional electrical stimulation systems. Results generated in the R&D phase of the ES project demonstrated a significant improvement in both the objective and consumer sensory measurements of lamb eating quality in favour of lambs receiving an electrical stimulation treatment post slaughter compared to non stimulated lambs. Since the release of these results to industry the lamb processing industry have responded positively resulting in the adoption, installation and routine use of MLA mid voltage ES technology by many of the major Australian lamb processors as an integral part of their production quality control procedures.

To assess the relevance of the mid voltage ES system to the goat meat industry MLA in collaboration with Hardwicks Pty Ltd installed a system at Hardwicks multi species plant at Kyneton Victoria.. The system was engineered to operate at commercial chain speeds for both sheep and goats as the carcasses exited the kill floor. DPI Victoria was commissioned by MLA to specifically evaluate the effect of the ES unit on goat meat eating quality.

2 Project Objectives

1. To test the effectiveness of CPMS mid voltage stimulation of processed goat carcasses on selected meat quality attributes.

3 Methodology

3.1 Animals

A total of 20 mixed sex (4 females/16 males) young feral goats 8 to 9 months of age were processed at Hardwicks Pty Ltd All the goats were sourced from the one property where they had been managed as one group since birth. The goats were transported direct from the property to the abattoir.

3.2 Treatments

A 2 $\times$ 2 factorial study was designed to assess the effects of electrical stimulation and product ageing on goat meat eating quality.

- ***Electrical stimulation:*** The 20 goats were processed in two blocks of 10 head with electrical stimulation treatment applied post-exsanguination. Goats in block 1 received no stimulation (controls). Goats in block 2 received low current stimulation (constant current 400mA peak, 14Hz or pulses/second, 1millisecond pulse width, maximum voltage 300 V peak) approximately 20 minutes after sticking. The duration of the stimulation was for 30 seconds

- ***Ageing:*** At 24 hours post slaughter, the left loin muscle was boned divided into two halves which were allocated to either a 1 or 6 day ageing treatment.

3.3 Carcass Measurements

Individual carcass measurements recorded on the day of kill included carcass weight, GR fat depth and loin pH and temperature profiles for the first 4 hours post slaughter. At boning (24 hours post slaughter), loin ultimate pH and meat colour (CIE L*, a* & b*) were also recorded.

3.4 Meat cuts

Loin (*M. longissimus thoracis et lumborum*) muscles from the left hand side of the carcass were boned from the 20 goats at Hardwicks Pty Ltd 24 hours after slaughter. Cutting lines used to remove the loin muscle complied with SMEQ protocols. Each loin was split into 2 halves labelled, vacuum packed and aged in accordance with time allocated then tested for Warner Bratzler (WB) shear force.

3.5 Statistical Analysis

Carcass traits (weight, GR fat depth, sex) and objective meat quality traits (pH, colour, shear force) were analysed using an analysis of variance procedure (Genstat 5.4.1, 1997). Electrical stimulation and ageing time were listed as treatments. No co-variates were fitted.

4 Results and Discussion

4.1 Carcass and objective meat quality traits

A summary of the carcass measurements recorded for the 20 goats used in the study is detailed in Table 4.1 below.

Table 4.1 Data statistics for carcass traits of goats processed for the electrical stimulation study

TRAIT	MEAN	STD DEVIATION	RANGE
Carcass Wt (kg)	11.96	1.88	8.60- 15.10
GR fat depth (mm)	3.8	1.45	1.00- 7.00
Meat colour (CIE L*)	37.00	2.01	33.02- 40.50
a	14.30	1.47	10.01- 16.19
b	3.35	0.77	1.20- 4.65
Meat pHu (24hrs)	5.60	0.13	5.45- 5.94
	5.02	0.80	3.06- 7.13
Shear force (1& 6 days ageing)			

4.2 Effects of electrical stimulation and ageing on meat quality

The mid voltage electrical stimulation treatment significantly ($P<0.001$) hastened the rate of pH decline in the first 45 minutes post slaughter. At subsequent measurement time points (1.5, 3, 4.5 and 24 hours post slaughter) the loin muscle pH of ES treated carcasses did not differ significantly from non stimulated carcasses. This is considered a reflection of the low current stimulation setting

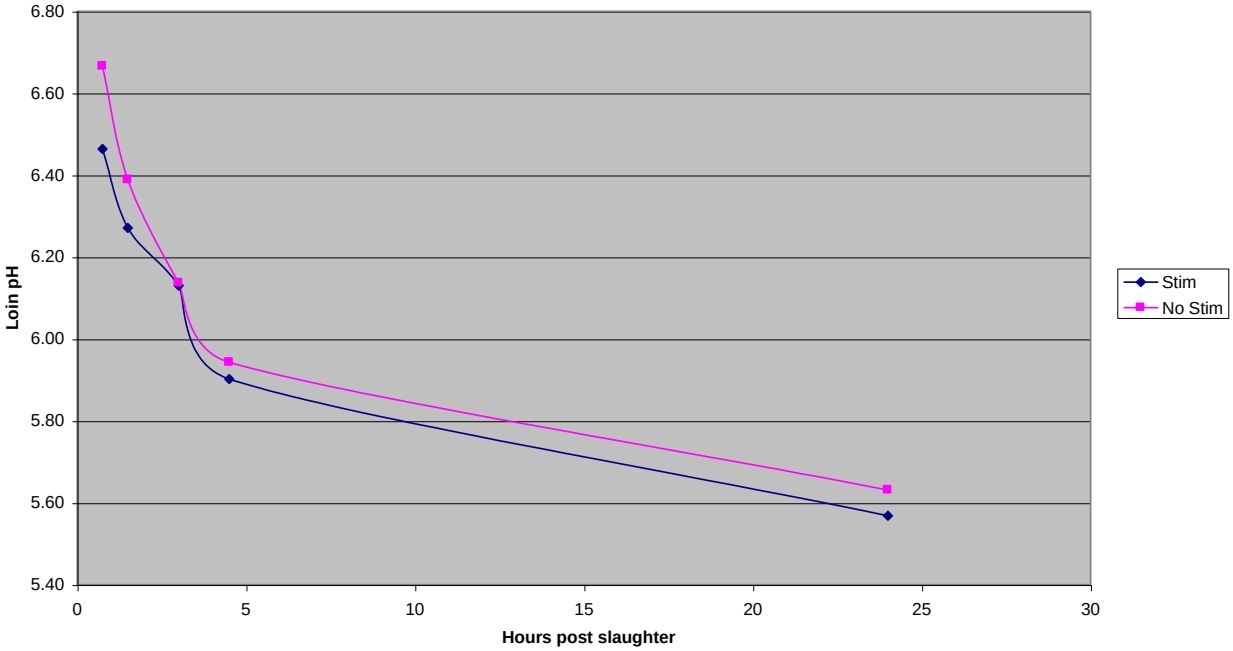
of 400mA being used by the plant. The rate of carcass chilling was also quite moderate. Average carcass loin temperature was on average 13.7°C when the average loin pH had declined to below a pH of 6 at 4.5 hours post slaughter. Table 4.2 summarises the effect of electrical stimulation on meat pH, objective tenderness and colour.

Table 4.2 Effect of electrical stimulation on meat quality traits

Trait	No stimulation (n=10)	Electrical stimulation (n=10)	Significance
CWT (kg)	11.5	12.4	ns
GR fat depth (mm)	4.5	3.1	P<0.001
Objective tendereness			
WB shear force kg (1 day)	5.66	4.77	P<0.001
WB shear force kg (6 days**)**	5.24	4.40	P<0.001
Loin pH (hours post slaughter)			
0.75	6.67	6.47	P<0.001
1.5	6.39	6.27	P=0.053
3	6.14	6.13	ns
4.5	5.94	5.90	ns
24	5.63	5.58	ns
Minolta meat colour			
a	13.5	15.1	P<0.001
b	3.1	3.6	P=0.027
L	36.9	37.1	ns

Figure 1 summarises the post slaughter loin muscle pH decline trends for the goats monitored in the study. Figure 2 summarises the post slaughter temperature decline trends for the same nominated time points. Loin muscle temperatures were on average 13.7°C for both stimulated and non stimulated carcasses when muscle pH was around 6 .

Figure 1 Effect of electrical stimulation on loin muscle pH decline from sticking to 24 hours post slaughter

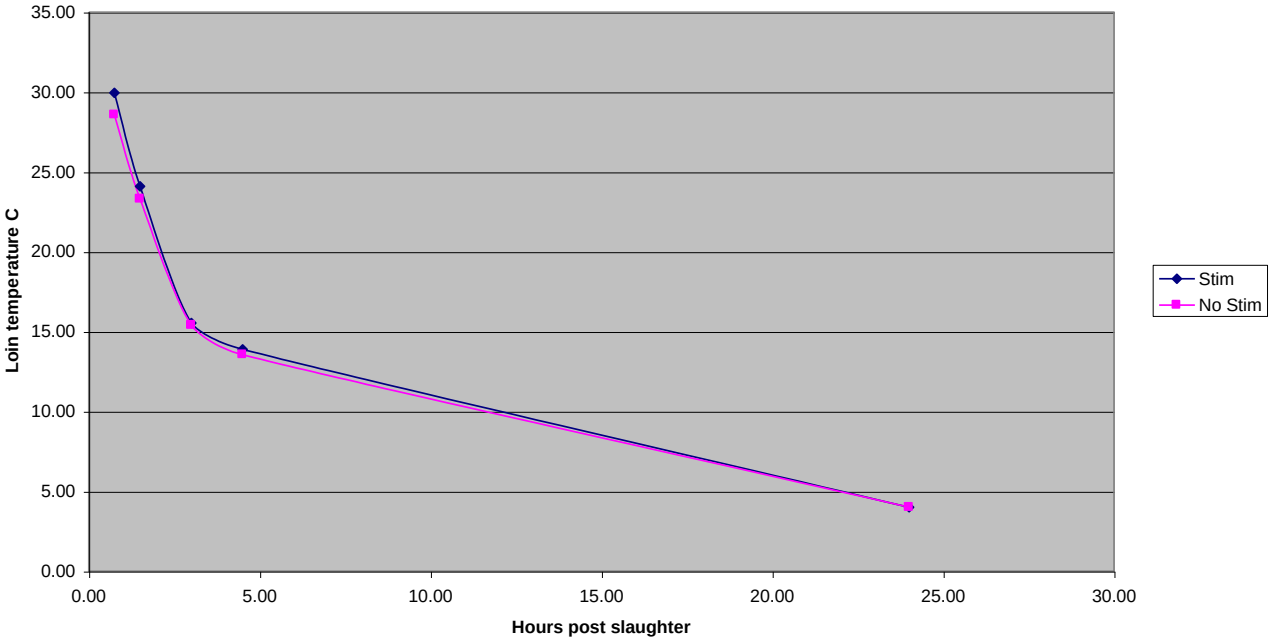


The mid voltage electrical stimulation treatment also had a significant (P<0.001) effect on loin muscle Warner Bratzler shear force values. Electrical stimulation reduced the loin muscle shear force value by 0.87kg compared to non stimulated carcasses at 1 days ageing. This advantage was largely retained after 6 days ageing where the difference in objective tenderness was 0.84kg in favour of the electrically stimulated carcases.

Ageing the product from 1 to 6 days reduced objective shear force values on average by 0.4 kg (P=0.067). There was no significant interaction between the ageing and electrical stimulation treatments.

The measured improvement in loin tenderness attributable to the electrical stimulation treatment was substantial considering the low current (400mA) and moderate carcass chilling rate used in this study.

Figure 2 Loin muscle temperature decline from sticking to 24 hours post slaughter



5 Success in Achieving Objectives - Section

5.1 Success in Achieving Objectives -

The project has successfully achieved its stated objective. A 2 × 2 factorial study designed to assess the effects of mid voltage electrical stimulation and product ageing on goat meat quality has been successfully completed at Hardwicks Meat Works Pty Ltd. The results found there was a significant positive effect of mid voltage electrical stimulation on goat meat objective tenderness when loin muscle shear force values were measured after 1 and 6 days ageing.

6 Impact on Meat and Livestock Industry – now & in five years time - Section

6.1 Impact on Meat and Livestock Industry – now & in five years time -

The results indicate that mid voltage electrical stimulation technology offers comparable meat quality benefits to the goat meat industry to those already identified for the sheep meat industry. The study found that mid voltage electrical stimulation of goats within 20 minutes of slaughter significantly improved goat meat objective tenderness under moderate carcass chilling conditions when measured after one and six days ageing. Consequently, it is anticipated that the technology should be recommended to the major Australian goat meat processing plants as an integral part of their plants quality assurance program for goat meat destined for either the fresh domestic and/or frozen export markets. In the case of chilled export goat meat the enhancement in product tenderness

obtained from electrical stimulation is likely to be negated if the chilled product experiences and extended (10 or more days) ageing time in transit. Adoption of the technology by the goat meat processing industry will also be dictated by the capital and installation costs associated with a mid voltage electrical stimulation unit. For multi species plants these costs are less of an issue as they can also be in part defrayed against the plant's lamb unit production costs. Evidence that the improvement in objective tenderness from electrical stimulation does translate into a positive consumer response would also accelerate goat meat industry adoption of the technology.

7 Conclusions and Recommendations

7.1 Conclusions and Recommendations –

The results found that mid voltage electrical stimulation technology offered comparable meat quality benefits to the goat meat industry to those already identified for the sheep meat industry. The study found that mid voltage electrical stimulation of goats within 20 minutes of slaughter significantly improved goat meat objective tenderness under moderate carcass chilling conditions when measured after one and six days ageing. Consequently, it is anticipated that the technology should be recommended to the major Australian goat meat processing plants as an integral part of their plants quality assurance program for goat meat destined for either the fresh domestic and/or frozen export markets.