Interaction of Electrical Processes Applied During Slaughter And Dressing With Stimulation Requirements

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INTRODUCTION

Since the introduction of carcass electrical stimulation for accelerated conditioning (AC), a number of other electrical inputs to carcasses have become widely used during slaughter and dressing. These include stunning, spinal discharge, immobilisation in various forms, and back-stiffening during hide-pulling. There is evidence that the other inputs affect the onset of rigor and hence impact on the amount and timing of the stimulation required for successful conditioning of the carcass. This changes the basis on which the original accelerated conditioning and aging (AC&A) specifications [1],[2],[3] were developed for the New Zealand meat industry.

A data logger has been developed that extracts the key parameters of all electrical inputs applied to a carcass. The parameters recorded include peak voltage, peak current, pulse width, pulse period and duration of application where applicable. The logger is readily installed and does not affect plant operations. Trials in two beef and two lamb plants were carried out in which all the electrical inputs were logged for approximately 700 animals per plant (beef plants) and 10,000 animals per plant (sheep plants). Representative carcass temperature and pH profiles were also recorded, and the data used in a model to simulate how processing was likely to affect tenderness. The trials also identified possible improvements that could be made in the equipment and processes.

ELECTRICAL PROCESSES USED IN THE PLANTS

The electrical processes used in the four plants are summarised in Table 1. The following points are noteworthy:

- During the brisket stun at Plant A, a current could leak from the brisket electrode via the body and hind-quarters to the metal of the stunning box. The current could then return to the neck electrode via a neck lifter and the animal's neck. This plant did not usually use low voltage stimulation.
- In Plant B, the animals were rolled from the stunning box onto an earthed metal table where the halal cut was administered. The live lead of a low voltage immobiliser was attached to the mouth region while the other lead was permanently connected to earth. The immobilisation currents were very high, and only the forequarters were reliably immobilised. It would appear that the current was short-circuiting via the shoulder to the table. Low voltage stimulation was only used on bulls, which were not included in this trial.
- As recorded, the electrode voltage in Plant C's high voltage stimulation tunnel frequently fell below the required minimum of 1050 volts peak and could be as low as 930 volts peak at full load. The electrical treatments were otherwise conventional. The electric fence had a minimal effect on the pH.
- Plant D used 15 seconds each of low voltage immobilisation and spinal discharge in quick succession directly after slaughter. The stimulation tunnel electrode peak voltage as recorded was under the 1050 volt peak minimum 70% of the time, and went as low as 830 volts peak at full load.

Table 1.
Electrical processes and their durations in the trial plants

Plant	Type	Stunning	Immobilisation	Stimulation	Comments
Plant A	Beef	Head (4.4 s) Brisket (14.6 s)	Not used	Not used	Stimulation not used, but leakage current provides stimulation effect.
Plant B	Beef	Head (4 s)	Low voltage (7.8 s)	Low voltage (58 s)	Stimulation not used in this trial.
Plant C	Sheep	Head (3 s)	Spinal discharge (4.2 s) Electric fence (25 s)	High voltage (90 s)	Stimulation tunnel voltage lower than specified.
Plant D	Sheep	Head (1 s)	Low voltage (15 s) Spinal discharge (15 s)	High voltage (90 s)	Stimulation tunnel voltage much lower than specified.

MEAT QUALITY ISSUES

- As observed, only Plant A was processing meat in a way that appeared to reliably meet the required AC&A tenderness levels with acceptable drip loss. (Refer to Table 2, below for the pH results). The leakage current described seemed to provide significant stimulation.
- Meat at Plant B was hot boned and immediately packed into cartons. The cooling curves showed that the temperature at the bottom of the cartons was below 10°C approximately 16 hours after slaughter. Given that the recorded mean pH of the striploins was 6.3 ± 0.2 when packed, rigor may not have been advanced enough by 16 hours to protect the bottom layer of meat from cold shortening. The meat pH should be below 6.0 before the temperature drops below 10°C.
- Plant C did not get the pH fall expected after stimulation, with an average pH of 6.1 after the high voltage stimulation tunnel. Simulations of the tenderometer shear force expected yielded 8.7 and 8.8 kgF at 24 hours post-slaughter, compared with the specified maximum for acceptable AC&A tenderness of 8 kgF.
- The carcasses in Plant D were so strongly stimulated by the low voltage immobilisation and spinal discharge applied after slaughter that the pH was already close to 6.0 before the carcasses entered the stimulation tunnel. The stimulation tunnel had a minimal effect on pH (Table 3). The stimulation showed that the product should still have met the tenderness criteria by aging, but drip loss was reportedly a problem.

Table 2.
pH Readings for Plant A (electrically stunned only)

	Carcass Weight (kg)	Left side pH 1 hr post mortem	Right side pH 1 hr post mortem	L & R side pH 1 hr post mortem	Left side pH 4 hr post mortem	Right side pH 4 hr post mortem	L & R side pH 4 hr post mortem
Mean	202.4	6.05	5.92	5.99	5.80	5.67	5.73
SD	12.1	0.03	0.11	0.11	0.20	0.20	0.20
n	11	7	7	14	11	11	22
Max	221.3	6.10	6.12	-	6.05	5.97	-
Min	176.0	6.01	5.78	-	5.49	5.41	-

The pH was measured at the carcass striploin, 13th rib approximately.

Table 3.
Mid-loin pH readings for sheep processed at Plant D, before and after stimulation

	Before stimulation		After stimulation	
	Left side	Right side	Left side	Right side
pH	5.96	6.13	5.96	6.02
SD	0.29	0.16	0.17	0.24
n	8	20	19	19

The pH was measured at the carcass mid-loin, 13th rib approximately.

DISCUSSION

Plant A (beef) was successfully stimulating its carcasses using 14 seconds of brisket stun while the animals were still in the stunning box. No stimulation was required to achieve a good quality product, as the presence of a leakage current through the body of the carcass appeared to cause significant stimulation. Similarly, Plant D (sheep) achieved adequate pH fall prior to the high voltage stimulation tunnel, using low voltage immobilisation and spinal discharge immediately after sticking. It is apparent that these electrical inputs are causing significant pH fall, and the applicability of the original stimulation standards to these conditions needs to be questioned. Indeed, it may be possible to eliminate stimulation entirely under some circumstances. However, the application of "excessive stimulation" very early in the dressing procedure may promote drip loss and other quality problems by causing the internal temperature of the carcass to rise excessively. This issue needs to be addressed.

Plant C used a conventional combination of inputs for processing sheep, with limited immobilisation after slaughter. There was only limited pH fall prior to the tunnel, as would be expected. However, the stimulation tunnel had peak voltages lower than specified and did not cause as much pH fall as is expected with correct voltage levels. The resultant tenderness (simulated data) would not have met the tenderness criteria. Plant D (sheep) also had lower stimulation tunnel voltages than specified, and achieved even less pH fall. In this case, the pH was already low before the tunnel, and the ultimate tenderness would be expected to be acceptable. Overall, the high voltage tunnels as tested did not demonstrate the same effectiveness at inducing pH fall as electrical treatments applied very soon after the head stun. This may have been due to the problems with lower than specified electrode voltage.

In contrast, Plant B (beef) failed to achieve a good pH fall despite using low voltage immobilisation immediately after stunning. It is believed that most of the current was short-circuited to the slaughter table and did not flow along the length of the animal. This is supported by the very low resistance measured, and the movement of the hind-quarters while on the table. Under these circumstances, little stimulation effect would be expected in the loin where the pH measurements were taken. Given that no other stimulation was applied, it is perhaps not surprising that the simulated tenderness levels were marginal.

CONCLUSIONS

The results obtained from these four plants have demonstrated clear links between pH fall and the application of pre-stimulation electrical processes. In two plants, sufficient pH fall was obtained with pre-stimulation processes alone to allow satisfactory conditioning and aging, as assessed by computer simulation of meat tenderness. However, the timing and duration of the treatments appear to be important, and if the treatments are applied inappropriately they may lead to drip loss and other quality problems because of overheating. Further, the treatments must be correctly applied to achieve good results. The logger identified areas in three of the four plants where significant improvements in the performance of plant processes could be readily achieved.

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