final report

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Electrical Stimulation of Beef sides

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SUMMARY

Widespread interest in electrical stimulation of beef carcasses has resulted from reports that it significantly enhances tenderness and is an essential adjunct to hot boning if a quality product is to be produced.

Because of the lack of space for full carcass stimulation on the slaughter floor in many Australian abattoirs, there is demand for a method of stimulating beef sides. This can be done where space is available after splitting and before the chillers. Experiments were therefore undertaken to determine the maximum time after stunning at which 800V RMS produces effective stimulation.

Stimulation with 800V RMS for a minimum of 60 seconds not later than 60 minutes after stunning resulted in a 45% improvement in tenderness in the LD muscle (striploin) of carcasses chilled in an export abattoir.

There was no improvement in tenderness other than that due to the prevention of cold shortening.

The design of a facility for on-line stimulation of beef sides will be the subject of a separate report.

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INTRODUCTION

Electrical stimulation (ES) is most effective if it is done as soon as possible after slaughter. The first location on the dressing line where high voltage stimulation is most conveniently applied to a carcass is between hide pulling and evisceration, but most existing works do not have sufficient space available in this area to stimulate for the required time. On the other hand, space is often available after carcasses are split and/or are being transferred to the chillers. Depending on the rate of dressing and the length of the line, the time between slaughter and splitting can vary from 15 minutes to about 45 minutes. The time for the sides to leave the slaughter floor can be in excess of one hour in some works.

Experiments have therefore been undertaken to determine the maximum time after stunning at which stimulation can be applied effectively to beef sides, and the minimum duration of stimulation at 800 V RMS which gives an effective result.

An experiment was also done to compare the effects of conditioning at 15°C and electrical stimulation.

EXPERIMENTAL

Experiment 1 - Time After Stunning And Duration Of Stimulation

Eighteen steers, each 1½-3 years old, were slaughtered in three groups of six in a commercial abattoir. Each side was stimulated for one of the following times (0, 30, 45, 60, 90 & 120 seconds) at 45, 60 and 80 minutes after stunning, according to the following statistical plan.

		Stimulation Duration		
Carcass	Side	Group 1 (45 minutes)	Group 2 (60 minutes)	Group 3 (80 minutes)
A	1	0	0	0
	2	45	60	45
B	3	60	90	90
	4	30	120	120
C	5	0	60	45
	6	60	90	90
D	7	45	60	45
	8	30	120	120
E	9	0	0	0
	10	30	90	90
F	11	45	0	0
	12	60	120	120

Stimulation was through a 50 mm dia rubbing bar, on which the external shoulder area of each side rested. The current return path was through the hook, roller and earthed rail. Power was supplied at 1100V peak (800V RMS) at 14.3 pulses per second, derived from 240V RMS 50 hertz mains supply.

After stimulation, any additional dressing required was done, and the carcasses were transferred to the works chillers. They were chilled overnight using the meatworks normal chilling cycle of 0°C air for 10 hours at 1-1.5 m/s, and 3°C for a further 10 hours.

Three hours after stunning, the Semitendinosis (ST) muscle was removed from each side, placed in a polyethylene bag and chilled on a tray in the carcass chiller. Next morning approximately 150 mm of the anterior end of the *Longissimus dorsi* (LD) muscle was removed. All samples were then transferred to the Meat Research Laboratory for tenderness assessment using the Warner-Bratzler shear device.

The Warner-Bratzler shear device records the force (in kg) required to shear through a sample of cooked muscle of standard size across the fibre direction. Samples weighing about 200 gm are cut from the muscle to be tested, and cooked for 90 minutes in polyethylene bags totally immersed in water maintained at 80°C. The cooked samples are then cooled in cold running water for 30 minutes. Excess surface moisture is removed with an absorbent paper towel, the samples rewrapped in polyethylene, and stored at 0-1°C overnight.

Subsamples of standard size are prepared from the cooked sample. Each Warner-Bratzler shear value is the mean of five values for that particular muscle.

A particular shear force value does not necessarily indicate a particular tenderness score allocated to that muscle by a taste panel. However, as a general statement, the higher the shear value, the tougher the meat. The following values can be used to assist in interpreting the shear values listed in the tables in this report:

0- 5 kg = tender
5-10 kg = slightly tough
10-15 kg = tough
>15 kg = very tough

Experiment 2 - Comparison Of ES And Conditioning At 15°C

Six steers, each 1½-3 years old, were slaughtered in a commercial abattoir. The carcasses were split, and one side of each carcass was stimulated for 60 seconds, 45 minutes after stunning. The sides were then allocated to chillers, at either 15°C or 0°C, according to the following plan.

Carcass	Side	Treatment	Temperature (°C)
A	1	N.S	15
	2	STIM	15
B	3	N.S.	0
	4	STIM	0
C	5	N.S.	15
	6	"	0
D	7	STIM	15
	8	"	0
E	9	N.S.	15
	10	STIM	0
F	11	STIM	15
	12	N.S.	0

N.S. = not stimulated
STIM = stimulated for 60 seconds, 1100V peak at 14.3 pulses per second, derived from 240V RMS 50 hertz mains supply applied at 45 minutes after stunning.

After overnight chilling, approximately 150 mm of the anterior end of the LD muscle was removed and transferred to the Meat Research Laboratory for mechanical tenderness assessment using the Warner-Bratzler shear device.

The deep butt temperatures of stimulated and unstimulated sides in the 0°C and 15°C chillers were monitored using copper constantan thermocouples.

Sides were weighed before and after chilling to determine percentage weight loss.

The experiment was repeated, so that tenderness results were available from 12 animals.

Meat Colour Measurements

Objective colour data were obtained using a Hunter-lab Model D25(R) Color Difference Meter. Visual colour evaluation was assessed on a nine point hedonic scale by an untrained panel of not less than 10 people (1 = very pale pink, 5 = bright cherry red - extremely desirable, 9 = extremely dark red).

Statistical Treatment of Results

Analysis of variance was used to calculate standard errors and where appropriate, least significant differences (LSDs) at $P<0.05$ level.

RESULTS AND DISCUSSION

Experiment 1

Mean shear values for the three groups are shown graphically in Figures 1 & 2. This shows that there is negligible effect on tenderness when carcasses are stimulated 80 minutes *post* stunning. For sides stimulated 60 minutes *post* stunning, the improvement in tenderness of both the hot boned ST muscle (eye of silverside) and the conventionally boned LD (striploin) (i.e. boned out 24 hours later) is significant ($P<0.05$). At 45 minutes *post* stunning there was an effect on tenderness of the LD muscles boned at 24 hours, even for 30 second stimulation. However, a stimulation period of 60 seconds was required before a statistically significant ($P<0.05$) improvement in tenderness was obtained for the hot boned ST muscles. This finding has been confirmed from five separate block experiments. With a 90 second stimulation, while not statistically more tender than the 60 second treatment, the trend is towards a more tender product.

Experiment 2

The combined shear values for the two trials in this experiment are listed in Table 1. As 15°C is the temperature at which minimum muscle shortening occurs, the results were as expected. Stimulated muscles chilled at 0°C were as tender as the unstimulated muscles conditioned at 15°C. There was also a difference in tenderness in one of the two trials between the stimulated and unstimulated muscles stored at 15°C. American and New Zealand workers would interpret this effect as being due to the stimulated sides going into *rigor* earlier, leading to a rapid ageing effect at the high temperature.

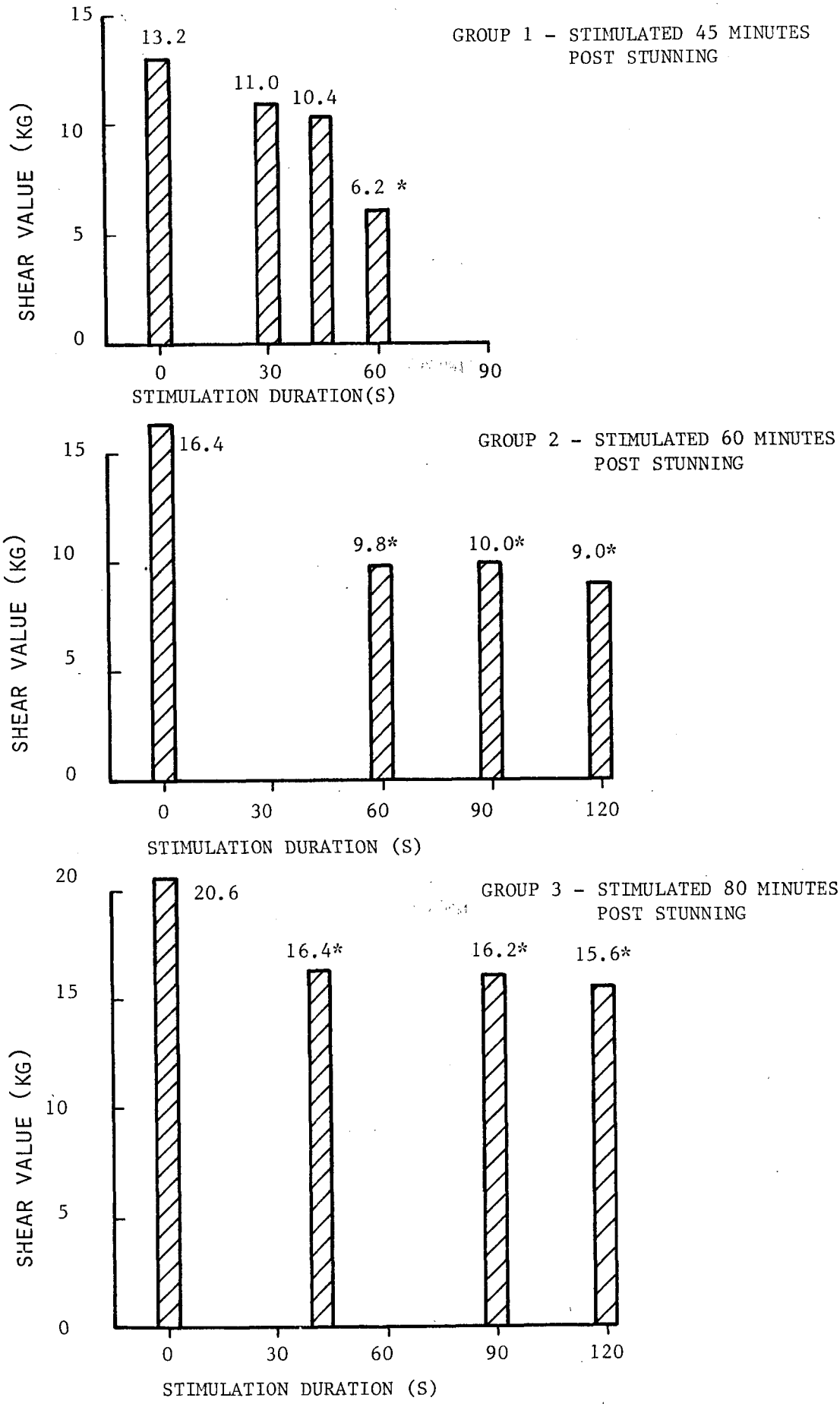
TABLE 1: SHEAR FORCE VALUES (KG) FOR LD MUSCLES REMOVED AFTER 24 HOURS' CHILLING

	Unstimulated	Stimulated
0°C chill	11.35	6.75
15°C "	6.6	4.2

Least significant difference ($P<0.05$) - 2.4

The chilling rates of the stimulated and unstimulated sides of one carcass in the 0°C chiller are given in Figure 3. The deep butt temperature of the stimulated side is always 2-3° higher when entering the chiller, and its temperature falls at a slightly faster rate than that of the unstimulated side. This would not reduce the chilling time as claimed by some trade literature.

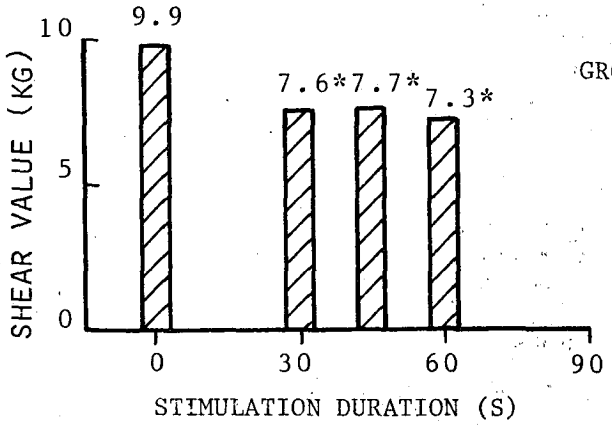
The mean weight loss for the six sides chilled at 0°C was 1.6%, whereas the sides chilled at 15°C had a mean weight loss of 2.4%. After 24 hours' chilling, the appearance of the sides at 15°C was also inferior to that of the sides at 0°C. The cut meat surfaces were darker and the fat was distinctly less white (tired).



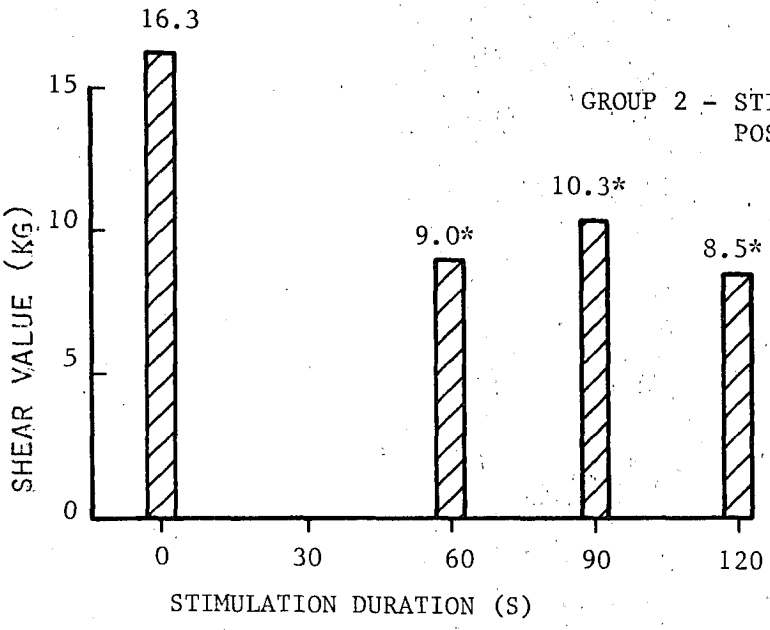
* A statistically significant difference from control.

EFFECT OF ELECTRICAL STIMULATION ON TENDERNESS OF ST MUSCLE (EYE OF SILVERSIDE) REMOVED 3H POST MORTEM

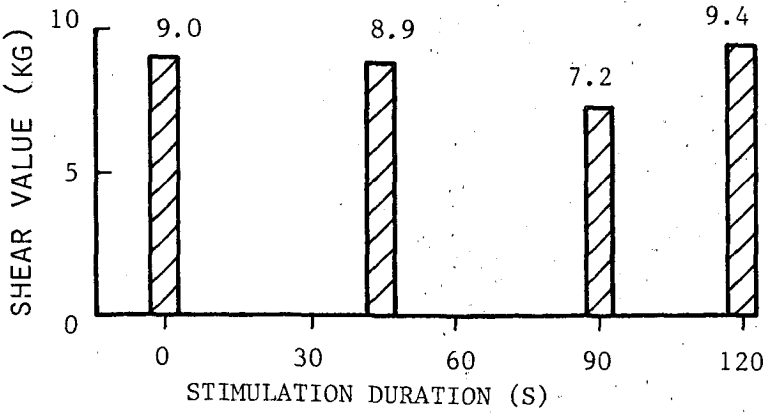
FIGURE 1



GROUP 1 - STIMULATED 45 MINUTES POST STUNNING



GROUP 2 - STIMULATED 60 MINUTES POST STUNNING

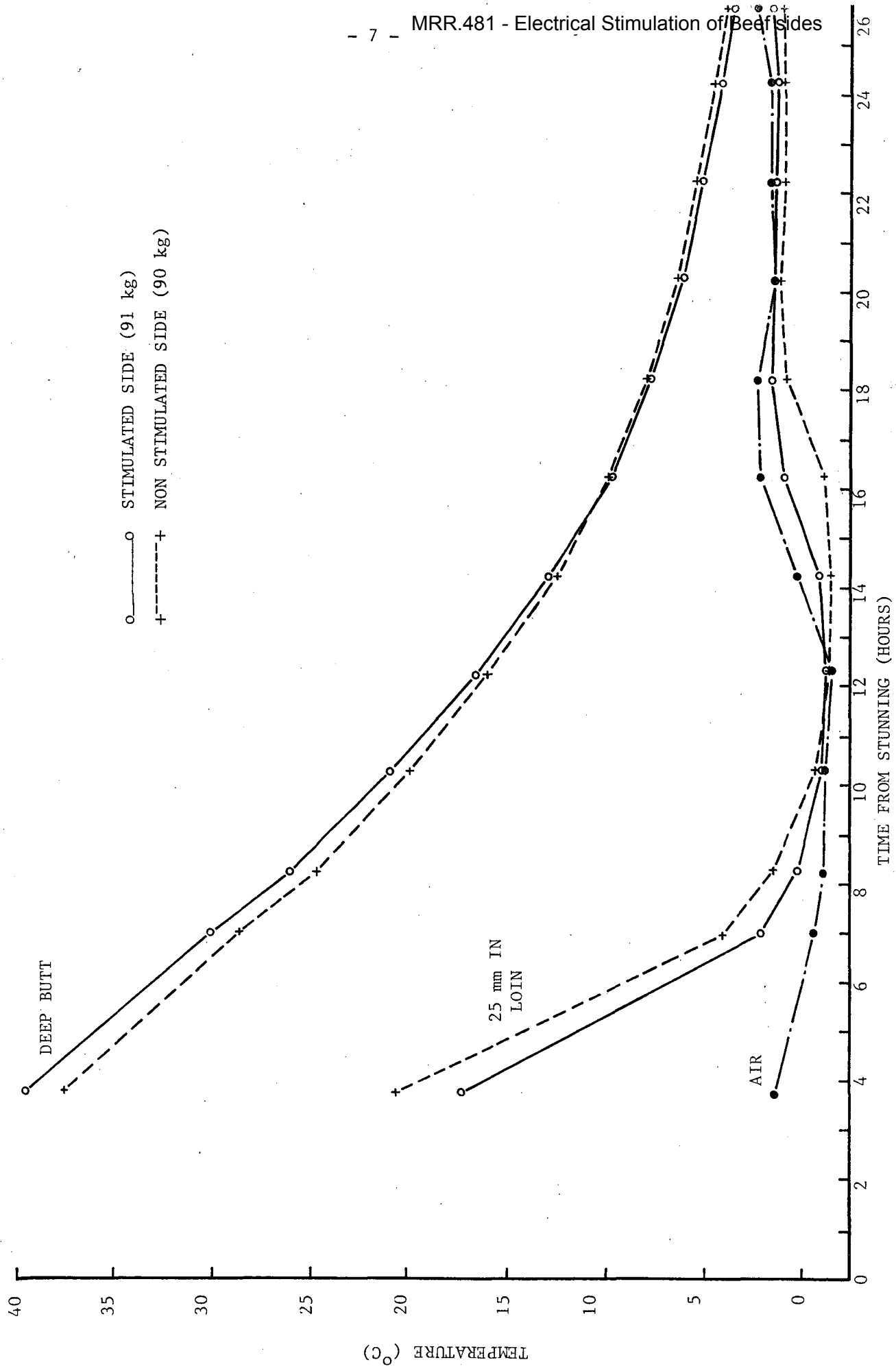


GROUP 3 - STIMULATED 80 MINUTES POST STUNNING

* A statistically significant difference from control

EFFECT OF ELECTRICAL STIMULATION ON TENDERNESS OF LD MUSCLE (STRIPLOIN) REMOVED 24H POST MORTEM

FIGURE 2



CHILLING RATE OF STIMULATED AND NON-STIMULATED SIDES
AIR TEMP 0°C AIR VELOCITY 0.5-1 MLS FIGURE 3

The results of microbiological sampling of the carcass surfaces before and after chilling are presented in Table 2. There was no significant difference in the total aerobic plate count on the surfaces of sides in either the 0°C or 15°C chiller. This is most likely due to the rapid drying of the surface tissue.

TABLE 2: MEAN LOG_{10} NUMBER OF BACTERIA ON SURFACE OF CARCASSES BEFORE AND AFTER CHILLING

	Unstimulated		Stimulated	
	Before	After	Before	After
0°C	2.9	2.7	3.0	3.2
15°C	2.9	3.1	3.4	3.6

pH Measurements

The pH values for the LD and ST muscles were recorded immediately prior to and one hour after stimulation. The pH values for both muscles before stimulation ranged from 6.2-7.0 and are lower than normal because a downward hide puller is in use at the meatworks. Downward hide pullers apply a voltage ranging from 140-180V for 8-10 seconds to stiffen the carcass while the hide is pulled over the shoulders and head. The stiffening probes usually contact the carcass in the vicinity of the LD. At one hour after stimulation, the pH values had fallen to 5.8-6.2, while the unstimulated sides had a pH within the range 6.3-6.6.

Colour

In both the scientific and especially the trade literature describing the features of electrical stimulation equipment, much has been made of the colour "brightness" or "redness" of stimulated meat. From both objective and visual colour analysis of meat at 24 hours or more *post* slaughter there was no significant difference between the colour of stimulated and unstimulated meat.

CONCLUSION

Electrical stimulation of beef sides, using 1100V peak (800V RMS) for 60 and 90 seconds, within 45 and 60 minutes respectively of stunning, significantly improves the tenderness of cuts when removed from sides of beef after overnight chilling. Stimulation time at the above voltage should be *at least* one minute. Stimulation should *never* be done later than one hour after stunning, and breaks in production should not allow this time to be exceeded.

There is no improvement in tenderness other than that due to the prevent of cold shortening.

At 24 hours *post* slaughter there is no significant difference in colour between stimulated and unstimulated meat.

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