ELECTRICAL STIMULATION OF BEEF CARCASSES IN AUSTRALIA

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INTRODUCTION

EXPERIMENTS conducted in many countries have clearly indicated that meat from electrically stimulated carcasses is more tender, as measured by taste panels and Warner-Bratzler shear determinations, than meat from comparable unstimulated carcasses. There is general agreement that the greater the applied voltage the greater is the enhancement of tenderness and commercial stimulation units throughout the world use voltages in the range 400 V - 1100 V (Davey et al., 1976; Savell et al., 1979). Studies in our laboratory have shown that stimulation of beef sides with voltages as low as 45 V DC lead to an increase in tenderness (Bouton et al., 1980). The finding that extra low voltages can improve tenderness has been confirmed in Sweden where a system using 15 V has been successfully tested (Fabiansson et al., 1979). In Australia, only voltages below 110 V DC and 32 V AC are classified as Extra Low Voltage (ELV) and are exempt from safety regulations. Installation costs for ELV stimulation systems are therefore minimal and thus there are financial, as well as safety, advantages in using ELV, as compared to higher voltages.

Two important factors in determining the effectiveness of stimulation with a particular voltage are (i) the time between the killing of the animal and the application of the stimulation current and (ii) the effectiveness of the contact between the electrode system and the carcass. For maximum effect, stimulation should commence as soon as possible after killing i.e. before dressing is commenced. With low voltage systems it is essential that contact be made with fat or muscle of the carcass and not just with the hide. This will normally mean that it is necessary for the electrodes to penetrate the hide with consequent risk of contamination of portion of the carcass by bacteria present on the hide. If stimulation is applied via a rectal probe the problem of carcass contamination by the electrode does not occur and the animal can be stimulated as soon as bleeding is completed (there is a risk of ecchymosis ("blood splash") if stimulation is applied before bleeding). Early studies in our laboratory used commercial bull electro-ejaculator probes but a robust simplified rectal probe has since been designed and is in commercial use.

This paper presents the results of 2 experiments, one with young steers and one with old cows, designed to determine the effectiveness of extra low voltage stimulation with a rectal probe.

MATERIALS AND METHODS

PULSED direct current*, with a pulse width of 2 msec and a pulse frequency of 40 pps was used. The stimulation period of 90 seconds was divided into three stages;

(i) 0 - 30 sec 25 V
(ii) 30 - 60 sec 35 V
(iii) 60 - 90 sec 45 V

In each experiment 4 animals were stimulated while 4 similar animals were not stimulated (controls). In experiment 1 the animals were Hereford steers (2-3 years; carcass weight 160-190 kg) while in experiment 2 the animals were cracker cows of various breeds (8-15 years; carcass weight 100-160 kg).

The rectal probe was inserted after stunning and before hoisting the animal. After hoisting the animal was "Stuck" and when bleeding had finished the stimulation unit was switched on. The time from stunning to stimulation was between 2 and 7 minutes. After stimulation the carcasses were dressed in the conventional manner, split and the sides transferred to a holding room (air temperature 12°C). The pH of 5 muscles (SM, BF, VL, LD and TB) was measured with a probe electrode at 1 hour after stunning. At 2 hours after stunning the sides were transferred to a small chiller (air temperature 1°C). At 24 hours after stunning the sides were removed from the chiller and boned out. The following muscles were removed from one side of each carcass for tenderness evaluation using the Warner Bratzler shear device (Bouton & Harris 1972).

Biceps femoris	(BF)	Silverside
Vastus lateralis	(VL)	Knuckle
Longissimus dorsi	(LD)	Striploin
Gluteus medius	(GM)	Rump
Psoas major	(PM)	Fillet

In experiment 2 the following muscles were also removed;

Semimembranosus	(SM)	Topside
Semitendinosus	(ST)	Silverside eye
Deep pectoral	(DP)	Brisket
Triceps brachii	(TB)	Blade

NOTE: * When interpreting the safety regulations the electrical authorities classify pulsed direct current as alternating current, not direct current, and therefore the maximum voltage allowed under the ELV classification

is 32 volts (Root Mean Square) which has a peak voltage of 45 V. Thus the highest peak voltage acceptable as ELV by the authorities was used in these experiments.

RESULTS AND DISCUSSION

THE 1 hr pH values for muscles from stimulated and control carcasses are listed in Table 1. For all muscles except the TB (blade) the differences between stimulated and control values were statistically significant ($P < 0.05$).

TABLE 1

Mean pH values at 1 hour after slaughter for muscles from stimulated and control (unstimulated) beef carcasses.

	EXPT. 1 (steers)		EXPT. 2 (Cracker Cows)	
MUSCLE	Control	Stimulated	Control	Stimulated
SM (Topside)	7.0	6.1	6.9	6.2
BF (Silverside)	6.9	6.3	7.0	6.4
VL (Knuckle)	7.1	6.1	7.0	6.2
LD (Striploin)	7.1	6.3	7.0	6.6
TB (Blade)	7.0	6.8	6.9	6.8
MEAN	7.0	6.3	7.0	6.4

For statistical significance ($P < 0.05$) values for individual muscles (between treatments) must differ by 0.3

The WB shear values for muscles from the stimulated and control carcasses are listed in tables 2 and 3. In experiment 1 (Table 2) only the values for the PM (fillet) were not significantly different ($P < 0.05$). In experiment 2 (Table 3) the differences were less marked and for several muscles the differences were not statistically significant.

TABLE 2

Warner Bratzler shear values (kg) for muscles from stimulated and control (unstimulated) beef carcasses.

EXPT. 1 - HEREFORD STEERS

MUSCLE	Control	Stimulated
BF (Silverside)	11.5	4.7
VL (Knuckle)	11.7	6.0
LD (Striploin)	19.8	13.4
GM (Rump)	10.2	5.0
PM (Fillet)	3.5	3.2

For statistical significance ($P < 0.05$) values for individual muscles (between treatments) must differ by 3.9.

TABLE 3

Warner Bratzler shear values (kg) for muscles from stimulated and control (unstimulated) beef carcasses.

EXPT. 2 - CRACKER COWS

MUSCLE	Control	Stimulated
BF (Silverside)	14.2	9.6
VL (Knuckle)	16.5	9.9
LD (Striploin)	15.0	15.7
GM (Rump)	13.3	8.5
PM (Fillet)	5.4	5.8
SM (Topside)	16.1	10.6
ST (Silverside)	14.2	13.5
DP (Brisket)	12.9	13.1
TB (Blade)	10.4	10.0

For statistical significance ($P < 0.05$) values for individual muscles (between treatments) must differ by 4.3

The results of experiment 1 show clearly that meat from carcasses that have been stimulated with 45 V via a rectal probe is more tender than meat from similar unstimulated carcasses. While it could not be claimed that the muscles from the stimulated carcasses of the cracker cows were tender, even with these animals stimulation caused a marked reduction in the toughness of some muscles.

One of the recommended uses for electrical stimulation is in conjunction with hot boning. Because of the poor results with the forequarter and the moderately high 1 hr pH values, ELV stimulation with the rectal probe cannot, in general, be recommended for use with hot boning. If hot boning is to be undertaken it will be necessary, in most cases, to use high voltage stimulation.

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ADDENDUM

Use of the commercial stimulation unit in Australia.

A complete stimulation unit consisting of power supply and rectal probe is being produced commercially by an Australian company. The approximate cost of the unit is $A600. The company has currently sold some 40 units, the majority of these have been purchased by small country slaughterhouses with a kill of 1-6 head per day. In a few cases units have been purchased by small abattoirs with kill rates of approximately 15 head/hour. The unit is suitable for use in abattoirs with kill rates of up to 30 head/hour. For abattoirs with higher throughputs high voltage units are recommended. A high voltage unit similar to those used in New Zealand has been installed in one abattoir and is currently being evaluated.