INCREASING THE STIMULATION RESPONSE FROM MEDIUM VOLTAGE ELECTRICAL STIMULATION

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Keywords: electrical stimulation, lamb, pH decline

Introduction

Electrical stimulation is an important component of sheep meat processing because it reduces the variability in sheep meat eating quality (Hopkins and Toohey, 2006). Additionally the ability to meet a pH temperature window is increasingly becoming a requirement for the processing of lamb in Australia based on the results of the Sheep Meat Eating Quality (SMEQ) program. The SMEQ program has identified that for optimal eating quality the meat destined for the overseas (air freight) or domestic markets should reach pH 6 when the carcass temperature is between 18-25°C (Thomson *et al.*, 2005). Australian processors are installing electrical stimulation units given the low rate of compliance to the window (Toohey *et al.*, 2006). A new approach to stimulation has been developed in Australia based on medium voltages (MVS) (Shaw *et al.*, 2005) which are favoured over the traditional high voltage systems because the power levels and pulse widths comply with occupational health and safety regulations (Anon, 2002). The system is devised of 6 segmented electrodes which ensure that only one carcass contacts the electrodes at any one time. The current remains constant and the voltage is varied (peak 300V) by controlled electronics which determine the resistance of the carcass and this feed back system alters the voltage accordingly.

A preliminary validation study at an Australian abattoir into the effectiveness of the MVS post-dressing unit in terms of pH-temperature decline demonstrated that only 42% hit of carcasses met the SMEQ pH temperature guidelines (Pearce *et al.*, 2006). To reach the desired pH temperature window it appears necessary to increase the stimulation response to increase the pH drop. Alternative approaches to increase stimulation response were briefly touched on by Pearce *et al.* (2006) such as changing frequency and modulating the stimulation on/off times. The study by Pearce *et al.* (2006) indicated that the stimulation setting of 2.5ms pulse width, 1A current and 15hz was the best, resulting in 60% of the carcasses 'hitting' the pH temperature window. This study investigated the potential for the alternative settings to increase the stimulation response so to ensure a higher proportion of carcasses 'hit' the window.

Materials and Methods

The selections of treatments tested to increase stimulation response are listed in Table 1. Treatment 0 was the unstimulated control. Treatments 1 to 4 had a constant current, pulse width and frequency across the 6 electrode bars of the MVS unit which was hard wired into the abattoir. Treatments 5 to 10 had a constant current and pulse width but different frequencies across the 6 electrodes. The frequency of each electrode is specified in order i.e. treatment 5 had a frequency of 15Hz for electrodes 1 and 2, 20Hz for electrodes 3 and 4 and 25Hz for electrodes 5 and 6. Treatments 11 was a modulated treatment with constant current, pulse width and frequency across the 6 electrodes but the frequency of 25Hz was switched on and then off every 200 ms. The unstimulated control was tested over all 30 consignments, treatments 2, 3, 6 to 11 were tested over 8 consignments (n = 8x7 = 56), treatments 4 was tested over 13 consignments (n=91) and treatments 1 and 5 were tested over 23 consignments (n = 161). The total duration of stimulation was 34 s. The lambs in each consignment were of varying backgrounds and breed and selected from the abattoir daily kill sheets. Carcass pH and temperature measurements were taken at hourly intervals beginning approximately 25 mins post-slaughter. These carcasses were stored in chillers with a mean temperature of 2°C. The pH and temperature measurements were taken in the left portion of the *M. longissimus thoracis et lumborum* (LL) at the caudal end over the lumbar-sacral junction. Hot carcass weights were recorded and the GR tissue depth). Further details on sampling procedures and statistical analysis are outlined in Pearce *et al.* (2006).

Results and Discussion

A low initial pH, fast rate of decline, high temperature at pH 6.0 and high number of carcasses with a pH of 6.0 by 25°C were criterion used to define the treatment with the greatest stimulation response. Treatment 6 demonstrated the greatest stimulation response having the lowest initial pH, fastest rate of decline, highest temperature at pH 6 and highest number of carcasses with a pH of 6 by 25°C. The success of this treatment could be due to the frequency combination resulting in the greatest rate of muscle contraction, with a minimal degree of muscle fatigue which typically arises from stimulation with high frequencies (Takahashi *et al.*, 1986).

A commercial preference will be for a treatment that results in the high number of carcasses in the pH temp window, with a temperature at pH 6 between 18-25°C and a minimum number of carcasses not reaching pH 6 before 18°C. The treatments recommended to fit such criteria are 1 and 8. Treatment 8 had the lowest number below the pH temperature window, but had a temperature at pH 6 of above 25°C whereas treatment 1 had less in the window but an optimal temperature at pH 6 between 18-25°C. No difference was observed between treatments for hot carcass weight (HCW) and GR depth (P>0.1) (average HCW was 22.7 ± 0.7 kg and 11 ± 1 mm for GR depth).

Table 1: Initial pH, rate pH decline, temperature at pH 6, % of carcasses that reach pH 6 between 18-25°C above 25°C or below 18°C.

Tmt no	Pulse width (ms)	Current (A)	Frequency (Hz)	Count	Initial pH	Rate of pH decline (ph units/h)	Temp at pH6 (°C)	% at pH 6 18-25°C	% pH <6 at 25°C	% pH>6 at 18°C
0	No stimulation			210	6.73a[a]	-0.243a	16.4ab	18a	5a	77a
1	2.5	1	15	161	6.29d	-0.182b	22.3d	29de	35c	36e
2	5	1	15	56	6.15e	-0.108d	22.2d	19a	49d	32e
3	5	1	10	56	6.38c	-0.189b	25.5d	21a	62e	17g
4	5	1	18	91	6.26d	-0.162b	25.3d	15ab	61e	24f
5	2.5	1	15, 15, 20, 20, 25, 25	161	6.28d	-0.166b	22.6d	26d	32c	42d
6	2.5	1	10, 15, 25, 10, 15, 25	56	6.13e	-0.108d	28.7e	6c	83f	11gh
7	2.5	1	25, 15, 25, 15, 25, 15	56	6.21de	-0.133c	25.6d	33e	50d	17g
8	2.5	1	25, 25, 15, 15, 10, 10	56	6.25d	-0.142c	26.6d	28de	67e	6h
9	2.5	1	25, 25, 15, 15, 15, 25	56	6.16e	-0.116d	25.7d	20a	52d	28ef
10	2.5	1	35, 0, 35, 0, 35, 0	56	6.56b	-0.241a	14.9a	15ab	0a	85a
11	2.5	1	25hz on/off 200ms	56	6.51bc	-0.133c	15.2a	14ab	3a	83a
Ave					6.32[b] (6.34[c])	-0.159[b] (-0.164[c])	21.8 (21.5)	17.6 (17.7)	38.5 (36.6)	43.8 (45.7)
SED					0.04	0.06	2.2			

[a]Numbers down row not followed by same letters are significantly different (P<0.05), [b]Average of stimulated carcasses only, [c]Average of all treatments

Conclusions

Alternative frequency combinations such as treatment 6 resulted in the greatest stimulation response possibly due to a maximal rate of muscle contraction. This treatment may have application into abattoirs with installed MVS units that hot bone sheepmeat and require a fast pH declines to ensure minimal cold shortening of meat. A downside to this treatment is that under routine commercial practices the carcasses may be more predisposed to heat shortening (Thomson *et al.*, 2005). Therefore commercial application of treatment 1 and 8 appears more relevant to abattoirs that require an increased stimulation response due to the application of a fast chilling regime. Objective tenderness, drip loss and colour stability of treatments 0, 1, 5 and 8 will be assessed.

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