ASSESSMENT OF ELECTRICAL STIMULATION COMPLIANCE AT ABATTIORS USING MEDIUM VOLTAGE ELECTRICAL STIMULATION

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Abstract- **This study describes an evaluation of the current compliance of 5 medium voltage electrical stimulation units in Australia sheep abattoirs. According to Meat Standards Australia sheep meat eating guidelines electrical stimulation should enable carcasses to reach pH6 between 18-35^{o}C carcass temperature to optimise meat quality. At a number of abattoirs, a poor pH-temperature decline was observed reflecting a poor electrical stimulation performance. Most carcases at these plants had a pH of greater than 6 at a carcass temperature of 18°C so they did not meet the required pH- temperature window. At one abattoir where the system was optimised a high proportion of carcases reached pH of 6 or less before 18°C was reached.**

Index Terms - **Lamb, electrical stimulation, pH decline**

I. INTRODUCTION

Electrical stimulation (ES) is now an important component of sheep meat processing in Australia (Hopkins, Toohey, Pearce, Richards & Keane 2008). ES not only reduces the variability in sheep meat eating quality (Hopkins & Toohey 2006), but also enhances the proportion of meat reaching required pH temperature windows. Achieving pH-temperature compliance is a feature of the Sheep Meat Eating Quality (SMEQ) program which has now been incorporated into MSA Sheepmeat. The SMEQ program identified that for optimal eating quality the meat destined for the domestic or overseas (air freight) markets should reach pH 6 when the carcass temperature is between 18-25^{o}C (Thompson, Hopkins, D'Souza, Walker, Baud & Pethick 2005) and the range was subsequently increased to 18-35^{o}C. Based on the results of the SMEQ program a large percentage of Australian processors have installed new generation medium voltage electrical stimulation (MVS) units so as to obtain the necessary pH temperature decline to comply with the pH temperature window specification (Hopkins *et al.* 2008).

The MVS units are composed of a bar of segmented electrodes which ensure that only one carcass contacts the electrodes at any one time as they travel along the electrode bar at chain speed. 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 as described by Hopkins *et al*. (2008). The mode of operation is very different to the traditional high voltage systems (HVS) which apply a fixed voltage averaged across all carcases being stimulated (Devine, Hopkins, Hwang, Ferguson & Richards 2004). The results of Shaw *et al.* (2005) clearly showed that the approach to stimulation did achieve comparable results to a HVS system with the production of lamb meat with a similar tenderness and eating quality level. However at a number of the abattoirs that had installed the MVS units no further follow up or routine monitoring of performance had occurred.

This paper details an evaluation study of the current performance of MVS units at plants who have had a MVS unit installed for longer than 3 years. The hypothesis is that the pH decline of the loin will be slower if adequate electrical stimulation is not received.

II. MATERIALS AND METHODS

This electrical stimulation assessment was conducted as part of the Sheep CRC's Information Nucleus Flock slaughters across 5 plants in Australia (design details refer to Fogarty, Banks, van der Werf, Ball and Gibson (2007). Briefly, approximately 2000 lambs were produced in 2007 from AI mating to Merino and crossbred ewes located at 7 research sites across Australia (Katanning WA, Cowra NSW, Kirby NSW, Struan SA, Turretfield SA, Hamilton VIC, and Rutherglen VIC) representing a broad cross section of Australian production systems. These lambs were the progeny of 93 key industry sires representative of the major production types in the Australian sheep industry and have

been measured and sampled for carcase, meat and growth traits. Lambs were slaughtered at their target average carcase weight of 21.5kg. CRC lambs were slaughtered at 5 abattoirs across Australia.

Measurement of pH and temperature decline

To evaluate stimulation response through pH decline we have utilised the methods developed by the CRC for Sheep Industry Innovation (Pearce 2009) for the evaluation of pH decline. Our clear aim is to determine if the electrical stimulation at the plant is sufficient to achieve a carcass pH of 6 over the carcass temperature range 18-35°C.

The pH and temperature of each carcass was measured 4 times post-slaughter: (1) ASAP after slaughter at around 35°C, (2) When the carcasses reached ~ 20°C (3) When the carcasses reached ~ 12°C and (4) Ultimate pH: 24h post mortem (PM). Muscle pH was measured using an Orion 250A pH meter (Cat. No. 0250A2, Orion Research Inc., Boston, Masset., USA) with a glass body, spear-tipped probe (Cat. No. 8163BN, Orion Research Inc., Boston, Masset, USA), coupled with a temperature probe. While muscle temperature was measured using a stainless steel cylindrical probe attached to the same meter. The pH meter was calibrated before use and at regular intervals using buffers of pH 4 and pH 6.8 at room temperature. The pH and temperature measurements were taken in the left portion of the m. *longissimus thoracis et lumborum* (LL) muscle at the caudal end over the lumbar/sacral junction. About 19-24 hours after slaughter (day 1, boning day), ultimate pH and temperature of the LL was determined. The pH meter was calibrated with standard solution and kept at chiller temperature (approximately 2°C).

The rate of decline in pH and temperature during the first 24 h PM is defined by the CRC by (1) the pH of the carcass when the carcass reached 18^{o}C (pH18), (2) the temperature of the carcass when the carcass reaches pH6 (pH6TEMP) and (3) the initial pH (ΔpH). From this information each carcass is then assessed to determine if the carcass reached a pH of 6 between a carcass temperature of 18-35^{o}C (pH6W). The carcass was given a score of 1 (yes reached pH-temperature window) or 2 (no didn't reach pH-temperature window). For effective stimulation: the aim is to achieve a pH18 of less than 6.00, between 18-35^{o}C for pH6TEMP, a higher number as possible for pH6W and a ΔpH greater than 0.7.

A linear regression procedure was used to derive the relationship between post-stimulation pH and temperature to allow the calculation of pH18 and pH6TEMP. The initial pH was taken as the very first pH reading taken at an approximate carcass temperature of 35°C. This regression algorithm was then used to calculate the pH at 18^{o}C and the pH6TEMP and subsequently the carcass was evaluated to determine if it reached pH6 between 18-35^{o}C. This process was conducted individually for each carcass for each treatment within each consignment. The ultimate pH of the LL was specifically used to determine if the carcass was had a high pH ie, the ultimate pH of the LL was above 6. If so; no value for pH6W was recorded.

It was not possible to calculate a value for all carcasses for pH6TEMP. Some carcases with a slow pH decline reached their ultimate temperature before they reached pH6. These carcases were given blank values for pH6TEMP. It was however possible to calculate a value for the pH of the carcass at 18^{o}C. The pH18 value was used to determine the window compliance pH6W.

Carcass measurement

Carcasses were trimmed according to the specifications of AUS-MEAT (Anon, 1992). Hot carcass weights were recorded and the GR measured (total tissue depth over the 12th rib, 110 mm from the midline) using a GR knife.

Data analysis

A REML procedure was used with Genstat (Version 11, VSN International) to analyse the pH decline and ultimate pH data. Fixed effects included in the model were site (IN01-IN08), Sex, Birthtype (BT- 1,2,3), Rearing type (RT- 1,2,3), sire type (Merino, maternal or terminal), Dambreed (Merino or crossbred/XB) and slaughter date to allow for kill group effects. Animals within sire and dam identification were included as random terms. All relevant interactions between fixed effects were tested. Hot carcass weight was included as a covariate and was significant for all traits.

III. RESULTS AND DISCUSSION

The pH decline performance of the participating abattoirs is listed in Table 1. A poor pH decline performance demonstrated by a slow rate of pH decline and thus a low proportion of carcasses reaching pH6 between 18-35°C was observed at all plants except Plant E. Plant E had a pH18 of less than pH6 and pH6Temp of between 18-35^{o}C indicating that the carcass had reached pH6 between 18-35^{o}C carcass temperature which corresponded as expected with the highest percentage in the pH-temperature window. The reason for this positive result is because this plant has undergone extensive pH testing and an optimum setting for their production system has been identified in previous studies (Pearce, Hopkins, Toohey, Pethick & Richards 2006; Pearce, Hopkins, Williams, Jacob & Phillips 2008). pH studies have been conducted also at Plant B in previous years with compliance levels ranging from 85% (Toohey,

Hopkins, McLeod & Nielsen 2006) to 40% (Hopkins, Stanley, Toohey, G.E., Pethick & van de Ven 2007) however this plant is now recording a sub-optimal pH decline response. Electrical stimulation optimisation has not occurred at the other plants.

Table 1. Compliance for pH decline across abattoirs.

Site	n	pH at 18°C*	Temp@pH6*	% In window (reaching pH 6 between 18-35°C)*
01 (Abattoir A)	156	6.30	12.62	12.8
03 (Abattoir B)	277	6.18	14.18	24.5
04 (Abattoir C)	277	6.14	12.16	13.2
05 (Abattoir C)	164	6.13	14.72	26.2
06 (Abattoir D)	252	6.21	13.01	17.1
07 (Abattoir D)	201	6.32	11.05	6.0
08 (Abattoir E)	384	5.86	23.46	76.0

*The aim is to achieve a pH18 of less than 6.00, a pH6Temp between 18-35°C and a higher number as possible for pH6W.

IV. CONCLUSION

This study has demonstrated that 4 abattoirs in Australia who process a significant proportion of Australian lamb and sheep meat have a poor pH-temperature decline with a low percentage of carcasses reaching pH6 between 18-35°C carcass temperature. The benefits of optimising electrical stimulation to improve pH-temperature compliance have been shown with flow through benefits for quality traits like tenderness (Pearce et al. 2008; Toohey, Hopkins, Stanley & Nielsen 2008).

Future studies will involve an extensive problem-solving program at these abattoirs to determine the reason for the poor electrical stimulation compliance. The operation of units will be examined to determine if poor functionality could be a result of any changes in production since installation such as changes in chain speed, chilling profiles or in product distribution processed at the plant.

A change in chain speed will determine if the number of electrodes in the stimulation unit is sufficient for the chain speed as a- its been observed that a 30-35sec time period on the stimulation unit is essential for optimal stimulation with MVS units. If the chain speed has increased then a higher number of electrodes may be required. If the plant has changed their chilling regime to a faster chill a higher stimulation dose will be required to achieve the pH-temperature window compliance.

The proportions of lamb and sheep meat products being processed at the plants is important to quantify. Lamb compared to mutton has a different stimulation response and may require stimulation to be individualised for each product. Furthermore if the plant has a high percentage of product being exported by sea with a long shipping time and minimal domestic product- the stimulation response to achieve the pH window of 18-35°C can be reduced to achieve the export market conditions as ageing will contribute to the final quality of the product.

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