RELATIONSHIP BETWEEN THE NON-INVASIVE MEASURMENT OF PHYSIOLOGICAL RESPONSES OF CATTLE IMMEDIATELY PRIOR TO SLAUGHTER AND MUSCLE ULTIMATE PH

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I. INTRODUCTION

Animal welfare and sensory quality are increasingly important to meat consumers, and consequently also to the beef industry [1]. Meat & Livestock Australia (MLA) and other institutions have undertaken research to understand the factors which affect the quality of beef [2, 3]. The effect of cattle handling and the stress pre-slaughter on ultimate pH (pHu) and colour of beef carcasses have been extensively researched [1, 4, 5]. The incidence of Dark, Firm and Dry (DFD) meat has been greatly attributed to the stress that animals experiment during the slaughter procedures [6]. This condition of the beef generates changes of colour, tenderness and cooking losses, which decrease the acceptability of the product in consumers [7, 8]. DFD incidence has been reported to vary between 0.77% and 15% among countries that produce beef [6]. Although stress can be assessed through indicators such as hear rate (HR), and body temperature, common techniques to measure these parameters are linked to procedures that are stressful, time consuming and labour intensive [9]. In that sense, remote sensing techniques have been proven techniques to measure non-invasively surface temperature, HR and emotions in humans [10, 11]. These techniques may also be useful tools to measure these parameters in animals. This project was part of a project lead by MLA, which aimed to identify factors that could be influencing the high incidence of dark cutting carcasses that has occurred in cattle from King Island. Non-invasive biometric technologies were tested to measure physiological parameters immediately prior to slaughter, and to identify whether these parameters are related to muscle ultimate pH and colour.

II. MATERIALS AND METHODS

One-hundred-twenty grass-fed cattle from four farms located in King Island were selected. The cattle were transported by ship and truck to the abattoir. To obtain remote sensed information related to physiological parameters, thermal infrared [FLIR AX8 with a spectra range of 7.5 – 13 µm and an accuracy of ±2°C (FLIR® Systems)] and an RGB (Raspberry Pi Camera Module V2, with a resolution of 8-megapixel) cameras were placed in the stunning box to collect images and videos during the stunning process. Image and video processing was carried out using customized codes written in MATLAB 2016a (Mathworks Inc., Matick, MA, USA) to obtain HR (from the RGB videos), and eye temperature (from the thermal images). At about 24 hrs post-slaughter, and after ~30 min. blooming, AUSMEAT color score (1A = palest, 6 =darkest) and ultimate PH was measured on the *longissimus thoracis* of the beef carcasses, between the 12th and 13th rib. Based on these measurement carcasses were considered to present DFD when their colour was scored to be >3, and to present high ultimate pH (pHu) when >5.7. Image and video processing was carried out using customized codes written in MATLAB 2016a (Mathworks Inc., Matick, MA, USA) to obtain HR (from the RGB videos), and eye temperature (from the thermal images). The statistical analysis was performed including correlation coefficients (r) between HR and meat quality indicators, and between eye temperature and meat quality indicators. In addition, the data was divided into groups in order to perform one-Way ANOVA in SAS 9.4.

III. RESULTS AND DISCUSSION

Medium to high correlations were found between the HR obtained in the stunning box and the pHu and colour of the meat (R^2= 0.69, and R^2= 0.74 respectively; $P<0.0001$). Eye temperature did not show significant correlations with pHu or with meat colour ($P>0.05$ for both). The one-way ANOVA showed that the cattle that generated meat with dark colour (colour score >3; n=63) had higher HR in the stunning box than the group that generated meat with acceptable colour (colour score ≤ 3; n=57) ($P<0.001$; Figure 1.A). Similarly, the

cattle that produced carcasses with high muscle pHu (pHu >5.7; n= 48) had higher HR than cattle producing carcasses of normal pHu (pHu≤5.7; n=72)_(P< 0.001; Figure 1.B).

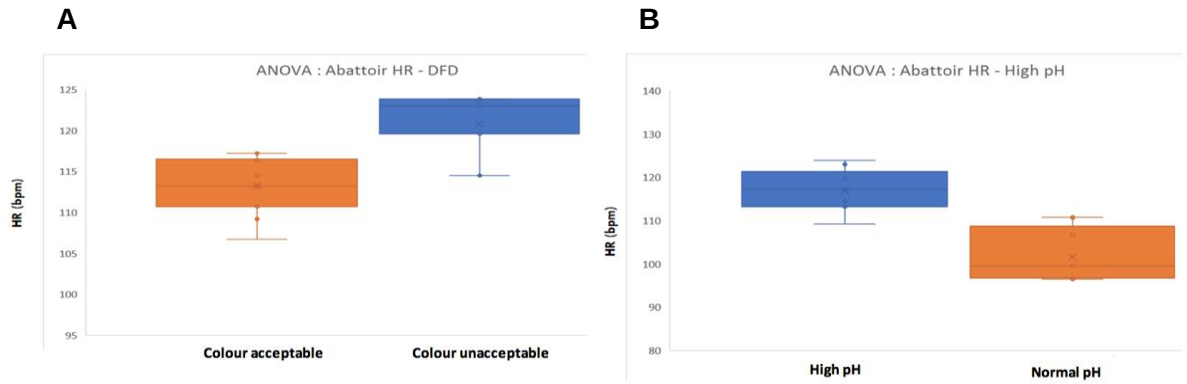

Figure 1, **A** Effect of colour group (Colour acceptable and score 1-3 vs colour unacceptable and score >3) on heart rate (HR) **B** Effect of ultimate pH (high pH >5.7 vs. normal pH ≤5.7.

IV. CONCLUSION

The results obtained in this research suggest that heart rate of cattle immediately prior to slaughter has a significant relationship with the subsequent pHu and colour of the *longissimus thoracis*. In addition, it showed that biometric technology can be a useful tool to assess physiological responses to stress in abattoirs.

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