MEDIUM VOLTAGE ELECTRICAL STIMULATION COMBINED WITH MULTI-FREQUENCY WAVEFORM AND BEEF QUALITY FROM *BOS INDICUS*

Marília C. R. Durante[1], Patricia M. Ramos[1], Aluisio F. A. Ferreira[1], Maiara R. A. de Oliveria[1], Alessandra F. Rosa[2], David E. Gerrard[3], Saulo L. Silva[1*]

[1] Faculdade de Zootecnia e Engenharia de Alimentos, Universidade de São Paulo, SP, Pirassununga, Brazil.

[2] Smart Meat Consulting & Projects, Pirassununga, Brazil

[3] Department of Animal Sciences, Virginia Tech, Blacksburg, VA, 24061, USA

*Corresponding author email: sauloluz@usp.br

I. INTRODUCTION

Electrical stimulation (ES) is an important tool to improve meat quality; multifrequency waves were developed with a view to having a better effect on the carcass when subjected to the ES process. Acceleration of glycolysis rate, anticipation of *rigor mortis* onset and *post mortem* proteolysis [1] can have a positive effect in beef quality of cattle with resistant pH decline [2]. However, since carcass pH and temperature decline must be well coordinated, it is important to finely regulate the stimulation to achieve the best outcome for tropical adapted cattle. Since previous work was conducted testing medium voltage ES with single wave [3], the aim of present work was to test an alternative protocol for medium voltage ES combined with multi-frequency waveform and its impact on quality of prolonged aged beef.

II. MATERIALS AND METHODS

Carcasses (n=42) from Nellore non-castrated males were randomly selected to be used in the present study. After carcasses were split, the right halves were assigned to one of the following treatments: CON – non-stimulated carcass; SFW – single frequency electric stimulation 300V AC, 15 Hz (single square wave); MFW= 300V AC, 15 and 200 Hz simultaneously (multi-frequency waveform). For both ES treatments a cycle of 4 seconds on and 2 seconds off, with 60 seconds total time application were used. The left carcasses were stimulated within 20 minutes after slaughter while the right carcasses were kept as control. Hot carcasses were weighed (HCW) and chilled for 24h (0 – 2^{o}C). The pH and temperature declines were recorded immediately after ES in both halves, and at 3, 6, 9 and 24h *post mortem*. After chilling, carcasses were ribbed between 12th and 13th ribs for *Longissimus* muscle area (LMA) and subcutaneous fat thickness (SFT) measurements. Following, 4 steaks (2.5 cm tick) of *Longissimus* muscle were taken from each carcass side, vacuum packaged and aged for 1, 7, 14 and 21d. The steaks were used for cooking loss (CL) and Warner-Bratzler shear force (WBSF) determinations. The data was analyzed as a completely randomized design with 14 replications per treatment. The HCW, LMA and SFT were analyzed considering the fixed effect of treatment (CON, SFW, and MFW) and the random effect of slaughter. The pH and temperature decline were analyzed as repeated measurements, considering the fixed effects of treatment, time of measurement and their interaction and the random effect of slaughter (n=3). Carcass nested within treatment was used as the subject of repeated measurement. All analyzes were carried out using the Mixed procedure of SAS.

III. RESULTS AND DISCUSSION

There was no difference in HCW, LMA or SFT among treatments. The average HCW was 316 ± 7.4 kg, LMA was 77.5 ± 1.94 cm^2 and SFT 3.5 ± 0.41 mm. There was a treatment × time interaction for pH decline ($P < 0.001$), with both ES protocols showing lower pH when compared to control in all time points (P < 0.05; Figure 1). When comparing the ES protocols there was a difference only at 3h, when MFW showed greater pH than SFW (P < 0.05). No treatment × time interaction was observed for temperature decline, which was also similar among treatments. Temperature decline was affected (P < 0.001) by time *post mortem*, as expected. The initial and final average temperatures were 40.5 and 4.4 ± 0.34 °C, respectively, for ES treated carcasses and from 39.9 and 4.6 ± 0.30 °C for control carcasses. A treatment × time interaction was found for CL (P < 0.001) with greatest losses observed in steaks from MFW protocol aged for 7d and lowest losses in steaks from SFW protocol aged 1d (37 and 31 ± 0.8 %, respectively). There was a treatment x time interaction for WBSF (P < 0.001; Figure 2). The final WBSF values for beef from the ES carcasses were approximately 28% lower than the values for beef from control carcasses.

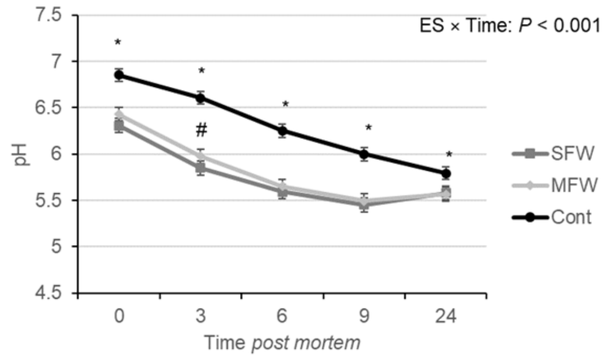

Figure 1. pH decline in *Longissimus* muscle from electrical stimulated (SFW or MFW) and control (Cont) carcasses from non-castrated Nellore males. *Differences between control and ES protocols within aging period (P < 0.05). #Differences between ES protocols within *post mortem* period (P < 0.05).

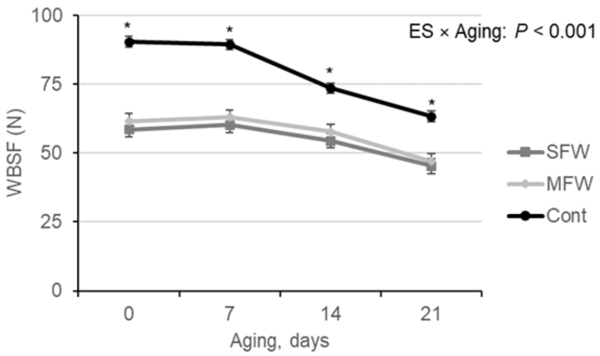

Figure 2. Warner-Bratzler shear force (Newtons) in *Longissimus* muscle from electrical stimulated (SFW or MFW) and control (Cont) carcasses from non-castrated Nellore males. *Differences between treatments within aging period (P < 0.05).

IV. CONCLUSION

Both ES protocols were efficient at accelerating the rate of pH decline, with a slightly more paced rhythm for the MFW protocol. The MFW means that several frequencies are applied to the carcass, resulting in a more uniform result regardless of the carcass size, because as multiple frequencies are used, the effect of resonance is mitigated in application. However, the impact on tenderization was similar at the beginning and throughout the aging period for both protocols, that were also considered tender after aging for 21d. Since Nellore is known to have greater calpastatin activity, the adequate pH decline and early calpain activation must be finely adjusted to enhance outcome for industry and consumers.

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