CARCASS CHILLING METHOD AND ELECTRICAL STIMULATION EFFECTS ON MEAT QUALITY AND COLOR IN LAMB

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I. INTRODUCTION

Electrical stimulation (ES) is widely recognized in the meat industry as a way to speed up blood removal, pH decline, and improve tenderness. Rinse & Chill® (RC) is a process applied to the carcass immediately after exsanguination that infuses a chilled substrate solution into the vascular system which also facilitates the removal of blood. This process was developed with the aim of more rapidly chilling carcasses but also to improve tenderness and meat color [1]. A recent study showed the application of RC in bison carcasses reduced toughness by 24% [2]. Fowler *et al.* [3] reported an 11-newton reduction in shear force in addition to color improvements in RC lamb carcasses. Both RC and ES appear to parallel each other for similar quality outcomes. The aim of our study was to determine the effects of early postmortem carcass vascular rinsing and chilling application combined with different electrical stimulation applications on various lamb meat quality properties.

II. MATERIALS AND METHODS

Five treatments were randomly implemented on carcasses from eight-month-old lambs that had an average hot carcass weight of 23.4 kg (*n*=21 per treatment). Treatments included a control (C), control with electrical stimulation (CES:15 Hz, 700 mA, 500 µs pulse width, 45 s pulse duration), RC, RC with ES applied before the rinse (ESRC:15 Hz, 700 mA, 500 µs, 45 s), and RC with ES applied after the rinse (RCES:15 Hz, 600 mA, 1000 µs, 45 s). The RC process involved vascular rinsing the circulatory system early postmortem (*pm*) using a chilled (14 °C) isotonic substrate solution (98.5% water; balance: glucose, polyphosphates, maltose). Carcass pH and temperature were taken at 0.75, 1, 2, 3, 4, 5, 8, 12, and 24 h *pm*. At 24 h *pm*, both *Longissimus et lumborum* (LL) and *Semimembranosus* (SM) muscles were excised and shipped (2°C) to the University of Melbourne. On day (d) 3 *pm*, SM and LL were cut up and vacuum packaged. Color chops (15 mm) were aged fresh to 6 d *pm* then displayed. The remaining samples were frozen and stored (-18 °C). LL was also aged to 22 d *pm* (2 °C) before being cut up and frozen. Color measurements (CIE L*a*b*; reflectance estimators of the chemical states of myoglobin) were obtained on 0, 1, 3, and 5 d of display. Scanning reflectance spectrophotometry was used to estimate the percentage of oxymyoglobin (OMb,%R610 nm/%R525nm), deoxymyoglobin (DMb,%R474nm/%R525nm) and metmyoglobin (MMb,%R572nm/%R525nm). Samples were cooked in a water bath to an endpoint temperature (70°C). The likelihood of cold shortening was determined (pH>6, temperature <15°C). A pH decay rate was calculated as lambda (exponential decay constant). A starting pH value of 7.4 was used and an endpoint of 6.0 for each carcass. Other dependent variables included purge, pH, rebloom, Warner-Bratzler shear (WBS; 1-cm wide strips), cooking loss, and consumer sensory evaluations. Animal served as the experimental unit and data were analyzed using PROC MIXED models (SAS Institute).

III. RESULTS AND DISCUSSION

Lambda, the pH decay rate, was the greatest (P<0.05) for CES (0.102) followed by ESRC (0.069). C (0.026), RC (0.025) and RCES (0.020) did not differ (P>0.05) in lambda from one another but were different (P<0.05) than CES and ESRC. The probability of cold shortening occurring was reduced (P<0.05) the most by ESRC (down to 5%) in comparison to C (30%) and CES (14%). ESRC and CES had a consistently lower (P<0.05) than all other treatments up to 3 h *pm*. With the exception of CES, ESRC had a lower (P<0.05) pH though 5 h *pm*. An overall treatment effect showed ESRC (3 d *pm*) resulted in greater (P<0.05) purge than C in the SM with no difference in the LL. However, CES had greater (P<0.05) purge than C. A cooking loss treatment effect (3 d, 22 d, LL) showed ESRC resulted in greater (P<0.05) loss than C and CES. Cooking loss did not differ among C, CES, RC, and RCES. No differences were detected in ultimate pH, carcass shrink and sensory evaluations. No treatment differences were found for WBS in LL (3 d, 19.5; 22 d, 13.2 newtons; means pooled across treatments). Rebloom (22 d *pm*) C chops had greater (P<0.05) estimated OMb than RC, RCES and ESRC. There was a treatment effect (3 d aged LL) for CES having a greater (P<0.05) OMb and DMb content than RCES. Additionally, CES had greater (P<0.05) DMb than RC. Treatments were not different in CIE L* (3 d *pm*) on the LL. Similarly, there were no CIE a* differences among treatments for the LL or SM. RCES LL was more yellow (CIE b*; P<0.05) and had a greater (P<0.05) hue angle than C and CES. The RC SM had greater (P<0.05) values for CIE b*, hue angle, and chroma than C.

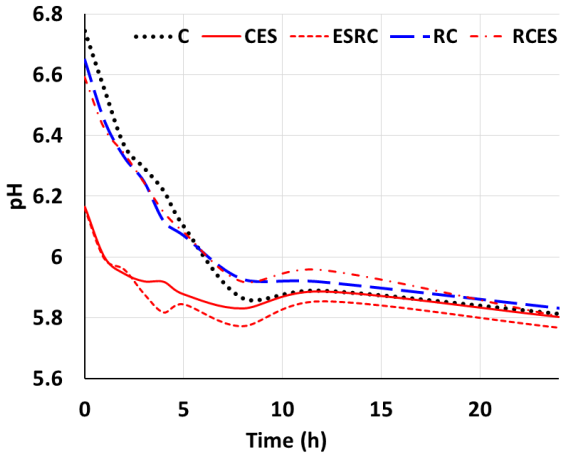

Figure 1. Plot of pH decline in lamb longissimus muscle as affected by carcass treatment (time 0 was 0.75 h postmortem).

IV. CONCLUSION

Although no tenderness differences were found, based on known cold shortening conditions (pH and temperature) the application of ES followed by RC has commercial potential to reduce the likelihood of cold shortening. Also, the order in which RC and ES are applied may influence color.

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REFERENCES

1. Dikeman, M. E., Hunt, M. C., Addis, P. B., Schoenbeck, H. J., Pullen, M., Katsanidis, E., & Yancey, E. J. (2003). Effects of postexsanguination vascular infusion of cattle with a solution of saccharides, sodium chloride, and phosphates or with calcium chloride on quality and sensory traits of steaks and ground beef. Journal of Animal Science, 81, 156–166.
2. Mickelson, M. A. & Claus, J. (2016). Carcass chilling method effects on colour and tenderness of bison meat. 62nd International Congress of Meat Science and Technology, Bangkok, Thailand (pp. 1–4).
3. Fowler, S. M., Claus, J. M., & Hopkins, D. L. (2017). The effect of applying a rinse and chill procedure to lamb carcases immediately post-death on meat quality? Meat Science, 134, 124–127.