INFLUENCE OF CARCASS VASCULAR RINSING WITH CALCIUM CHLORIDE ON NON-ELECTRICALLY STIMULATED AND STIMULATED CARCASSES ON MEAT QUALITY OF LAMBS

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I. INTRODUCTION

Infusing calcium chloride into carcasses before rigor mortis presents a promising avenue for enhancing meat quality and tenderness. This technique targets the activation of μ-calpain and m-calpain, two key enzymes responsible for the postmortem breakdown of myofibrillar and cytoskeletal proteins (Huff Lonergan et al., 2010). The effectiveness of intra-arterial infusion in non-stimulated carcasses with a 0.3 M solution of $CaCl_2$ (10% live weight) was previously demonstrated (beta-adrenergic agonist fed lambs), resulting in reduced shear force across varying postmortem intervals (1, 7, 14 days; Koohmaraie et al., 1991). The emergence of Rinse & Chill® technology (MPSC Inc., Hudson, United States) has further facilitated the commercial viability of calcium chloride infusion into carcasses, fostering opportunities for continued exploration and application of such methods (Hwang et al., 2022). This study aimed to assess the impact of calcium chloride infusion into lamb carcasses on pH decline, meat color, and Warner-Bratzler shear force (WBS). It was hypothesized that the infusion of calcium chloride coupled with electrical stimulation would lead to a reduction in shear force, thereby contributing to increased meat tenderness.

II. MATERIALS AND METHODS

The study was conducted over three different trial periods with lambs (n=40) which consisted of various breeds (commercial crossbred, Dorset, Hampshire, Suffolk, Polypay, Southdown), age (6-9 months), and live body weight (59.4 ±29.5 kg). Lambs were randomly assigned to three vascular rinse treatments (TRT) that included: (RC= Rinse & Chill® solution; saccharides, phosphates), (CA= 0.3M $CaCl_2$ + RC), and (ES-CA= electrical stimulation, 800mA current, peak 350V for 60 seconds, followed by CA). Animals were stunned by penetrating captive bolt. The vascular rinsing process entailed inserting a catheter into the heart and rinsing the carcass at 10% of its body weight. Treatments were applied to the carcass immediately upon exsanguination. Carcasses were skinned, eviscerated, and chilled (3℃, 24 h). Carcass temperature and pH were recorded (semimembranosus, SM) from 1 to 20 h postmortem (PM). At 24 h PM, the longissimus dorsi (LD), SM, and triceps brachii (TB) were excised, vacuum packaged, or overwrapped in oxygen-permeable film. Color measurements (CIE L*, CIE a*, chemical states of myoglobin) were determined during storage (3 and 7 d PM). Purge, Warner-Bratzler shear force (WBS) on cooked (68.3 ℃ internal) LD, SM, and TB chops, and cook loss (3 and 7 d PM) were determined. Data was analyzed as a split-split plot design with means ($P<0.05$) separated using PROC MIXED (SAS Institute).

III. RESULTS AND DISCUSSION

Live animal weights and hot carcass weights were not different ($P>0.05$) among the treatments. For carcass pH, ES-CA treatment was lower (5.59, $P<0.05$) than the CA (5.69) and RC (5.85) treatments, while CA was lower ($P<0.05$) than RC (Figure 1). The lower pH, indicative of more rapid and extensive glycolysis observed in ES-CA can be attributed to the muscles repeatedly contracting and relaxing because of electrical stimulation along with the elevated calcium level in the sarcoplasm further enhancing contraction of the muscles. RC had higher ($P<0.05$) CIE L* values than CA and ES-CA by 1.9 and 2.3 units, respectively. Additionally, RC showed greater ($P<0.05$) CIE a* values compared to CA and ES-CA by 1.5 and 1.4 units, respectively, and higher Chroma C values by 2.3 and 2.2 units, respectively. Furthermore, RC exhibited greater ($P<0.05$) oxymyoglobin levels than CA and ES-CA by 3.6% and 2.5%, respectively, while metmyoglobin was lower ($P<0.05$) in RC compared to CA and ES-CA by 4.5% and 4.8%, respectively.

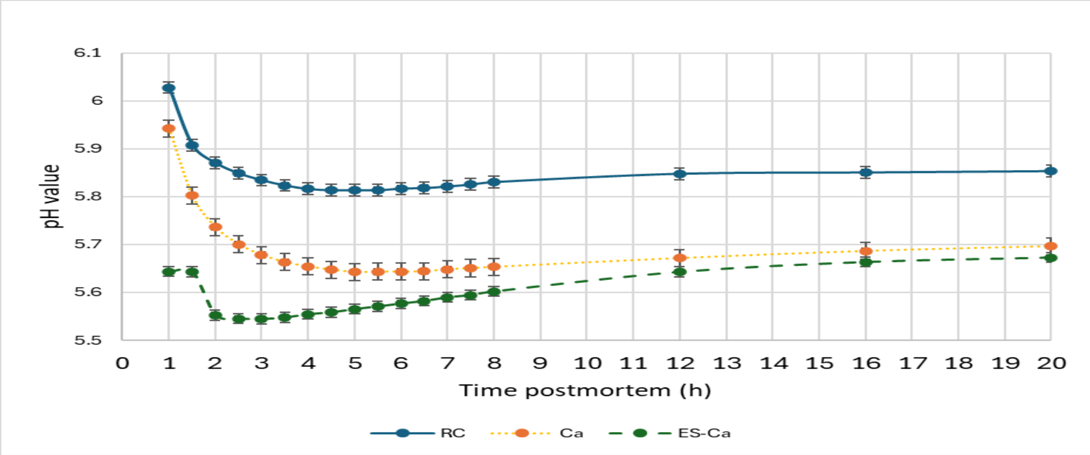

Figure 1. Carcass pH of each treatment group at hours 1-20 postmortem (PM)

The SM muscle had lower CIE L* (P<0.05) than the LD and TB muscles. At day 3 PM, CIE a* was lower (P<0.05) in the LD muscle compared to TB and SM. On day 7 PM, CIE a* was higher (P<0.05) in the TB muscle compared to LD and SM. TB from the RC had the least purge in the LD and SM compared to CA and ES-CA. RC had lower (P<0.05) cook loss than ES-CA by 3.0%. In CA and ES-CA, the LD showed lower (P<0.05) WBS values than RC by differences of 28.2% and 34.8%, respectively. With ES-CA, the SM exhibited the lowest (P<0.05) WBS. RC had the greatest WBS at day 3 (P<0.05), with no differences (P>0.05) found between TRT on day 7 (Table 1).

Table 1. Least square means of cooked lamb chops from vascularly rinsed carcasses on Warner-Bratzler Shear (newtons)

	Muscle			Day	
TRT	LD	SM	TB	3	7
RC	29.64^{b}	36.49^{a}	27.36^{b}	35.66^{a}	26.67^{b}
CA	22.31^{c}	34.60^{a}	29.73^{b}	28.77^{b}	28.99^{b}
ES-CA	20.85^{c}	30.14^{b}	29.26^{b}	26.69^{b}	26.81^{b}

$^{a\text{-}c}$Means with unlike letters within treatment and muscles are different (P<0.05, TRT*Muscle interaction, S.E.= 1.452)

$^{a\text{-}b}$Means within treatment and day with unlike letters are different (P<0.05, TRT*Day interaction, S.E.= 1.229)

IV. CONCLUSION

The implications of vascularly delivering calcium chloride throughout the carcass on meat quality are noteworthy, particularly in shear force reduction, suggesting the potential to enhance tenderness. More rapid chilling to reduce the effect of the rapid drop in pH may benefit meat color and moisture retention.

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