VASCULAR RINSING LAMB CARCASSES WITH CALCIUM CHLORIDE IN COMBINATION WITH ELECTRICAL STIMULATION CAUSES PROTEOLYTIC CHANGES ASSOCIATED WITH MEAT TENDERNESS

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I. INTRODUCTION

This study aimed to determine the impact of adding calcium chloride to the carcass vascular rinse solution (Rinse & Chill®, MPSC Inc.) in combination with electric stimulation on lamb meat tenderness. Calcium infusion in meat carcasses activates μ-calpain and m-calpain, which enhances proteolysis and improves meat tenderness. In a previous study[1], calcium was infused with a manual syringe pump and did not include electric stimulation or Rinse & Chill. The use of Rinse & Chill technology improves meat tenderness by accelerating a rapid pH decline early post-mortem[2]. This technology provides a commercial means to deliver calcium to prerigor muscles to impact proteolytic changes. We hypothesized that lamb carcasses vascularly rinsed with the Rinse & Chill solution containing the addition of calcium chloride coupled with electric stimulation would cause more proteolysis than the standard Rinse & Chill solution.

II. MATERIALS AND METHODS

Lambs (total n=13) of market age were randomly assigned to three different carcass vascular rinsing postmortem methods (treatment) which included: 1) RC (Rinse & Chill solution; 98.5% water; balance: glucose, polyphosphates, maltose; 10% live weight), 2) CA (RC + 0.3 M calcium chloride), and 3) ES-CA (electrical stimulation followed by CA). Lambs were humanely stunned and exsanguinated prior to carcass treatment. A cannula was inserted into the heart to infuse the test solutions through the vascular system. For ES-CA, carcasses were electrically stimulated for two consecutive 30-second periods (800 milliamps) before the rinse. Carcasses were chilled (3 ℃, 24 h) before fabrication. Longissimus dorsi (LD), semimembranosus (SM), and triceps brachii (TB) muscles were collected, vacuum packaged, and aged (3, 7 days). Muscle calcium was determined (ICP-OES, AOAC 985.01). Myofibril fragmentation index (MFI) was used to assess proteolytic changes[3]. MFI was calculated by multiplying absorbance (540 nm, 0.5 mg/mL protein) by 200. Warner-Bratzler Shear (WBS) was determined on strips from cooked chops (68.3 ℃, internal; 1-cm x 1-cm, strips). Data were analyzed as a split plot design (carcass treatment, whole plot factor; muscle, split-plot factor).

III. RESULTS AND DISCUSSION

CA and ES-CA increased the amount of calcium in the muscles (Table 1). MFI mean was largest for RC. CA and ES-CA were not different from one another in the LD and TB (Table 1). Addition of calcium was expected to enhance proteolysis associated with calpains thus producing a greater MFI than RC. Microscopically the supernatant of CA and ES-CA treatments appeared to contain more, very small myofibrillar fragments than RC. As such these fragments were not retained in the pellet used to determine MFI. Calcium-containing treatments resulted in shorter sarcomeres and visually apparent muscle degradative changes (Figure 1). For LD chops, treatments containing

calcium had lower WBS values (P<0.05, 22.3 N for CA, 20.9 N for ES-CA) than RC (29.6 N). For SM, WBS was lower for ES-CA than RC (30.1, 36.5 N; respectively).

Table 1 – Least square means[1] for calcium content and myofibril fragmentation index among treatments and muscles in lambs.

	Calcium (mg/kg)			MFI		
Treatment	LD	TB	SM	LD	TB	SM
RC	50.6^{e}	50.2^{e}	53.4^{e}	136.1^{a}	112.9^{b}	105.1^{b}
CA	699.4^{ab}	247.8^{de}	421.4^{cd}	63.0^{d}	50.1^{d}	82.8^{c}
ES-CA	915.8^{a}	415.0^{cd}	541.9^{bc}	51.0^{d}	52.8^{d}	60.8^{d}

[1]Means with unlike superscript letters within calcium or MFI are different (P<0.05; treatment * muscle. Calcium S.E.= 102.7; MFI S.E.= 6.61).

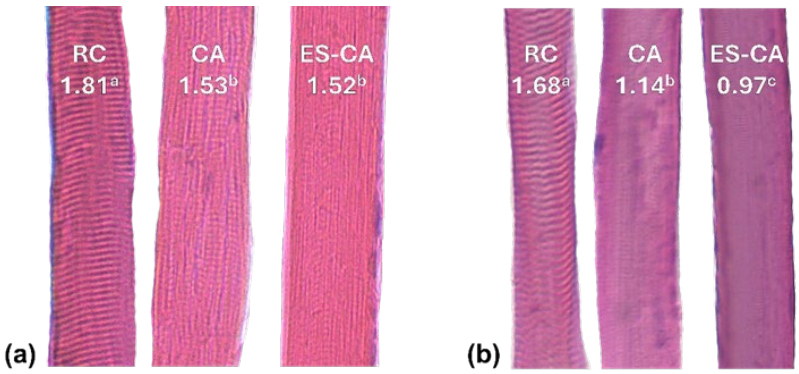

Figure 1. Effect of various carcass treatments on myofiber structure (eosin and hematoxylin stained, 40X). a) Longissimus dorsi. b) Semimembranosus. Sarcomere lengths (microns, means within a muscle with unlike letters are different, P<0.05, LD S.E. 0.0274; SM S.E. 0.0486).

IV. CONCLUSION

Based on microscopic assessment and instrumental shear determination, inclusion of calcium in the Rinse & Chill® solution may offer packers the opportunity to increase tenderness. However, the MFI method might not be reliable for assessing tenderness in highly proteolytically tenderized meats. Analysis of the amount of myofibrillar proteins at each MFI step warrants further investigation.

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REFERENCES

1. Polidori, P.; Trabalza Marinucci, M.; Fantuz, F.; Renieri, C.; Polidori, F. (2000) Tenderization of wether lambs meat through pre-rigor infusion of calcium ions. Meat Science, 55: 197–200.
2. Hwang, K.; Claus, J. R.; Jeong, J. Y.; Hwang, Y. H.; Joo, S. T. (2022) Vascular rinsing and chilling carcasses improves meat quality and food safety: A review. Journal of Animal Science and Technology, 64: 397–408.
3. Culler, R. D.; Smith G. C.; Cross, H. R. (1978) Relationship of myofibril fragmentation index to certain chemical, physical and sensory characteristics of bovine longissimus muscle. Journal of Food Science, 43: 1177-1180.