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Vascular rinsing and chilling: effects on quality attributes and metabolic changes in beef (#552)

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Introduction

Rinse & Chill® (RC) is a process applied early postmortem that provides the ability to manipulate muscle metabolism in a manner that can have a positive impact on tenderness and other meat quality traits. The RC process involves infusion of a chilled (4 °C) isotonic solution (98.5% water; balance: glucose, phosphates, and maltose) through the vascular system, beginning in the arterial and exiting the venous side of the vasculature. There is strong evidence that RC decreases shear force values (Farouk et al., 1992; Mickelson and Claus, 2017; Fowler et al., 2017) and improves color (Fowler et al., 2017; Moreira et al., 2018). However, these results seem to vary among species. Therefore, the objective of this study was to evaluate the effects of Rinse & Chill® on pH decline, shear force, sarcomere length, and cooking losses on different cull dairy cow carcass grades and to investigate the ability of different substrates to modulate the contractile response as an indirect measure of metabolic activity on beef early postmortem.

Methods

For each carcass grade (lean, LE; light, LI), ten carcasses were conventionally chilled (CC) and twelve carcasses were chilled using Rinse & Chill® technology (RC; MPSC Inc., Hudson, Wisconsin). The pH of each carcass was taken at 1, 4, 8, 12, and 24 h postmortem. Shear force and cooking losses were measured on Longissimus dorsi steaks aged (7 d) according to AMSA guidelines. Sarcomere length (SL) was determined by a laser diffraction method. Animal served as the experimental unit and data were analyzed with a PROC MIXED procedure. For contraction measurements, a muscle-fiber bundle from the Sternomandibularis muscles (n=14) was collected from cull dairy cows in a commercial packing plant, 15 minutes after bleeding. Part of the sample was frozen in liquid nitrogen for further analysis. The muscle-fiber bundle was attached to a force transducer (FT-302, iWorx, Dover, NH). Stimulation electrodes were used to elicit a supramaximal electrical stimuli at a frequency of 0.1 Hz (50 V, HCS-100 stimulator, iWorx). Muscle weight was standardized, and length was adjusted to obtain maximum twitch-tension output. After 3 minutes of rest in a test solution, 200 stimuli were given, and the contractile response was recorded. Four solutions were tested (A=RC solution, B=Fructose, C=Sodium phosphate, D=Dipotassium phosphate; substrates added at 1% except fructose 1.5%). Descriptive means for initial peak twitch force, final peak twitch force, percentage decline and percentage half-time decline were calculated to determine the response associated with each solution.

Results

There was a treatment effect on pH decline for LI and LE cows (Figure 1). For LI cows, RC resulted in lower ($P<0.05$) pH at 1, 4, 8 and 24 hours. For LE cows, RC resulted in lower ($P<0.05$) pH at 4 and 8-hours postmortem. Purge and cooking losses were not affected by chilling method (Table 1). However, RC compared to CC reduced ($P<0.05$) shear force by 51.9% for LI steaks and 55.8% for LE steaks (Table 1). CC steaks from LI cows were more tender ($P<0.05$) than those from LE cows. RC compared to CC had longer sarcomere lengths ($P<0.05$, Table 1). The contractile responses of the muscle after the exposure to the solutions were slightly different. The average percentage decline of peak twitch force was higher for solution B, followed by solutions A, D, and C (54.8%, 53.5%, 48.0%, 43.4%, respectively). Furthermore, the same pattern was observed for the average percentage decline at half time of the test (82.5%, 80.4%, 78.1% and 74.7%, respectively).

Conclusion

Packing plants that harvest lower grade cull dairy cows have the potential to dramatically improve the tenderness and thereby merchandize a greater amount of beef as whole muscle meats as a result of the application of the vascular Rinse & Chill® process. This improvement may be associated with accelerating postmortem glycolysis, thereby limiting cold shortening, although enhanced proteolysis may also be involved. Continuous electrical stimulation of isolated muscle-fiber bundles while being soaked in selected test solutions led to decreased and somewhat varied contractile force responses suggesting the potential to modify muscle metabolism.

Notes

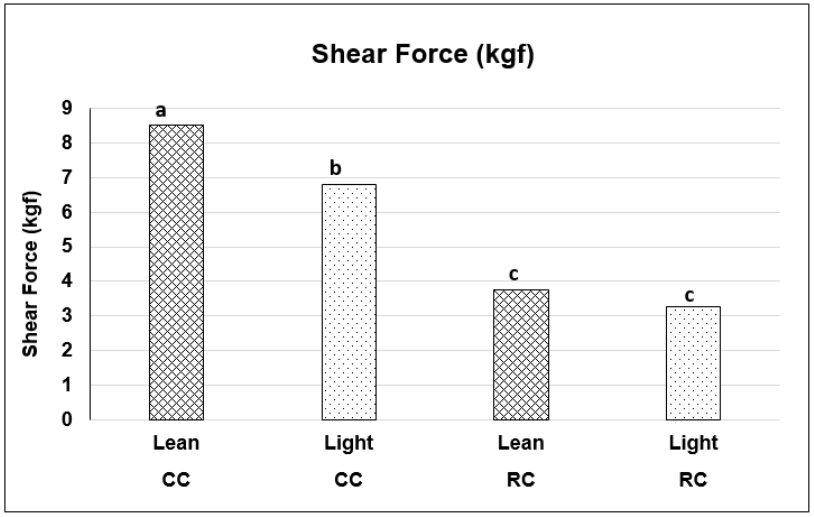

Figure 2
Shear force (kgf) values for lean and light cows from control and RC treatments. [a-c] means with unlike letters are different.

Table 1. Least square means of the effects of carcass chilling treatment on two cow types[1]

Dependent variables [2]	Lean		Light	
	CC	RC	CC	RC
Purge (%)	3.10[a]	2.60[a]	2.91[a]	2.99[a]
Cooking loss (%)	24.26[a]	24.46[a]	21.48[a]	23.17[a]
Shear force (kgf)	8.51[a]	3.76[c]	6.80[b]	3.26[c]
Sarcomere length (μ)	1.44[b]	1.80[a]	1.40[b]	1.80[a]

[1]Carcass chilling treatment: CC: Control and RC: Rinse and Chill; Cow type: Lean and light cows.
[2]Dependent variables: Standard error of differences (0.285, purge; 1.29, cooking loss; 0.561, shear force; 0.0649). [a-c] Means within a row with unlike superscript letters are different (P<0.05).

Table 1
Least square means of the effects of carcass chilling treatment on two cow types[1]

Notes

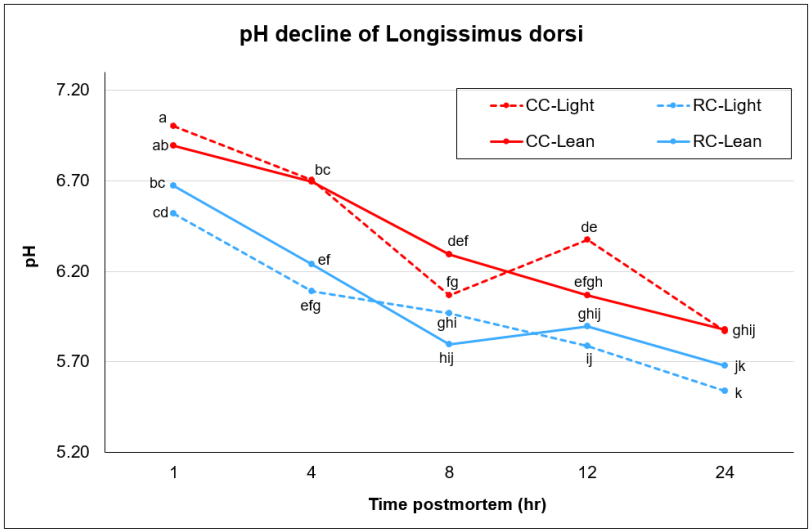

Figure 1
pH decline of LE and LI cows for control (CC) and rinse and chill (RC) treatments. [a-k]means with unlike letters are different (P<0.05)

Notes