VASCULAR RINSE & CHILL EFFECTS ON MEAT QUALITY AND SHELFLIFE OF BEEF

Ligia da Cunha Moreira[1], Charles Connolly[1] and James R. Claus[1]*

[1]Meat Science and Muscle Biology Laboratory, Department of Animal Sciences, University of Wisconsin-Madison, Madison, Wisconsin 53706, United States of America

*Corresponding author email: jrclaus@wisc.edu

IC MST 2018
64th International Congress of Meat Science and Technology
Grand Hyatt, Melbourne, Australia, 12th - 17th August 2018

INTRODUCTION

- Rinse & Chill® (RC) is a process applied to the carcass immediately after exsanguination that infuses a chilled substrate solution into the carotid artery 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 [2].
- Recent studies have shown the application of RC in bison carcasses reduced toughness by 24% [3].
- In a lamb study, Fowler et al. [4] reported an improvement in fresh meat color as well as a significant reduction in shear force (11 newtons) as a result of RC application.

OBJECTIVES

- The aim of our study was to determine the effect of vascular RC on meat quality and shelf life of cull dairy cows in comparison to conventional carcass harvest procedures.

MATERIALS AND METHODS

Treatments

Twenty-four lean cows (LC) and twelve grain-finished cows (GF) were randomly assigned of two treatments, Control (CC): stunned, exsanguinated and processed under standard plant protocol with high voltage electrical stimulation (ES); Rinse and Chill® (RC; MPSC Inc., Eden Prairie, MN): stunned, exsanguinated, RC infused and processed under standard plant protocol with no high voltage electrical stimulation.

- LC CC: n=10: carcasses were conventionally chilled (plus ES)
- LC RC: n=12: chilled using RC (without ES)
- GF CC: n=6: conventionally chilled (plus ES)
- GF RC: n=5: chilled with RC (without ES)

Ground beef manufacture

- LC ground beef: LC lean muscles
- GF ground beef: LC ground beef plus GF fat

Dependent variables

- Temperature and pH (1, 4, 8, 12, and 24 h PM)
- Total aerobic plate count (APC) on carcasses at 24 h PM
- Moisture and fat: ground beef (SMART Trac II)
- Shear force and cooking losses (aged postmortem: 14 d, LC; 10 d, GF)
- Color CIE on Longissimus (LM), semimembranosus (SM), and ground beef (displayed 1, 4, 7 d); Chemical states of myoglobin measured on ground beef at 4 d PM, displayed for 1,4,7 days. Microbial analysis (APC, enterobacteriaceae, lactic acid bacteria) on 7 d PM.

Statistical analysis

Animal served as the experimental unit and data were analyzed with PROC MIXED model.

RESULTS AND DISCUSSION

Table 1: Least square means of carcass and meat quality traits for two cow types[1]

Dependent variables[2]	LC		GF	
	CC	RC	CC	RC
Live wt. (lb.)	1602[a]	1656[a]	1795[a]	1680[a]
Dressing (%)	48.6[b]	51.3[a]	56.2[a]	61.6[a]
Carcass APC (log)	0.93[a]	0.40[b]	-	-
WBS (kgf)	3.25[ab]	3.61[a]	4.77[a]	3.57[b]
Moisture (%)	69.04[a]	69.34[a]	62.32[a]	61.76[a]
Fat (%)	9.71[a]	10.91[a]	18.63[a]	20.29[a]

[1]Carcass chilling treatment: CC=control, RC=rinse and chill; Cow type: Lean cow (LC), grain-finished cow (GF)
[2]Dependent variables: Live weight, dressing percent, total aerobic plate count (APC), Warner-Bratzler Shear (WBS; aged postmortem: 14 d, LC; 10 d, GF), Moisture and fat content of ground beef. [a-b]Means within a row with unlike superscript letters are different (P<0.05). SED, standard error of the difference.

- Vascular RC resulted in a greater dressing percentage for LC (P<0.05), but was not significantly different for GF cows. Similar findings were observed by Yancey et al. [5] in Charolais cattle carcasses vascular infused.
- RC resulted in lower (P<0.05) APC on the surface of LC carcasses compared to the control.

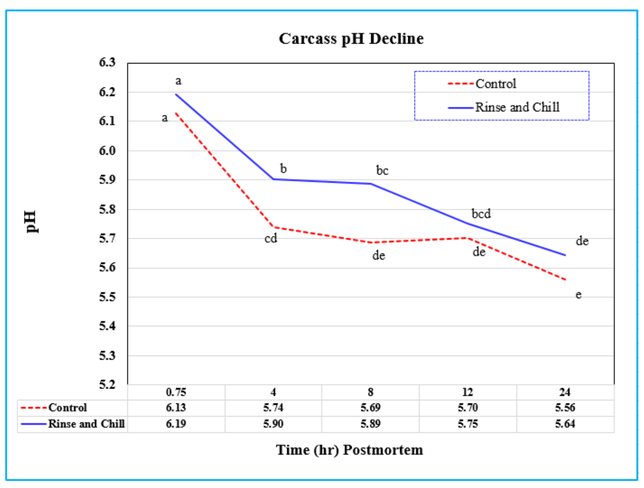




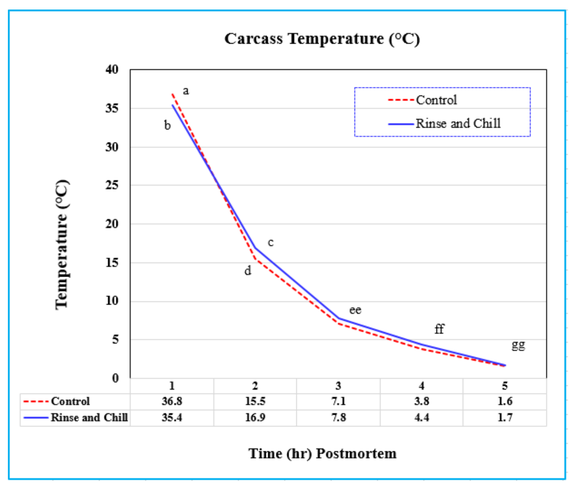




RESULTS AND DISCUSSION



	0.75	4	8	12	24
Control	6.13	5.74	5.69	5.70	5.56
Rinse and Chill	6.19	5.90	5.89	5.75	5.64



	1	2	3	4	5
Control	36.8	15.5	7.1	3.8	1.6
Rinse and Chill	35.4	16.9	7.8	4.4	1.7

Time (hr) Postmortem

- LC RC resulted in a higher (P<0.05) pH than C but no differences were found in pH at 24 h PM.
- LC RC had a lower (P<0.05) temperature in the LM and SM at 1 h PM than C.

Table 2. Least square means of chemical states of myoglobin on ground beef, Semimembranosus and Longissimus under continuous lighting display conditions[1].

	Lean cow						Grain-finished cow	
	GB		SM		LM		GB	
Day	CC	RC	CC	RC	CC	RC	CC	RC
				Oxymyoglobin				
1	2.18[a]	2.29[a]	3.14[a]	2.85[b]			2.22[a]	2.26[a]
4	1.95[b]	1.96[b]	2.82[b]	2.64[bc]	2.11[a]	2.23[a]	1.85[bc]	1.89[b]
7	1.76[c]	1.82[c]	2.46[cd]	2.28[d]	2.07[a]	2.02[a]	1.69[c]	1.84[bc]
				Deoxymyoglobin				
1	1.06[b]	1.06[b]	1.07[a]	1.06[a]			1.04[c]	1.03[c]
4	1.06[b]	1.06[b]	1.06[a]	1.07[a]	1.07[a]	1.07[a]	1.04[c]	1.04[c]
7	1.12[b]	1.29[a]	1.07[a]	1.06[a]	1.07[a]	1.07[a]	1.11[b]	1.18[a]
				Metmyoglobin				
1	0.87[cd]	0.84[d]	0.75[e]	0.78[d]			0.84[c]	0.83[d]
4	0.98[b]	0.97[bc]	0.81[c]	0.82[bc]	0.83[b]	0.83[b]	1.02[b]	0.97[b]
7	1.11[a]	0.94[bcd]	0.84[b]	0.88[a]	0.86[ab]	0.87[a]	1.19[a]	0.99[b]

[1]Carcass chilling treatment: CC=control, RC=rinse and chill. Ground beef (GB), Semimembranosus (SM) and Longissimus (LM) Dependent variables: Oxymyoglobin (%R610nm/%R525nm), deoxymyoglobin (%R474nm/%R525nm), metmyoglobin (%R572nm/%R525nm) higher values more pigment. [a-e]Means within a cow type and dependent variable with unlike superscript letters are different (P<0.05).

Lean Cows

Ground beef
- RC had higher deoxymyoglobin at day 7 compared to control.
- RC had lower value for metmyoglobin on day 7 of display.

SM
- RC had lower oxymyoglobin compared to control at day 1
- RC had higher metmyoglobin at days 4 and 7.

LM
- RC did not affect the chemical states of myoglobin.

Grain-finished Cows
- RC higher deoxymyoglobin at day 7
- RC lower metmyoglobin at day 1 and 7.

Table 3. Least square means of chemical states of color parameters CIE L*, a* and b* on ground beef, Semimembranosus and Longissimus under continuous lighting display conditions[1].

	Lean Cow						Grain-finished Cow			
	GB		SM		LM		GB		LM	
Day	CC	RC	CC	RC	CC	RC	CC	RC	CC	RC
				CIE *L**				CIE *L**		
1	44.88[abc]	46.67[a]	38.60[a]	39.00[a]	--	--	51.79[a]	51.87[a]	39.56[b]	38.56[b]
4	44.35[bc]	45.69[ab]	39.62[a]	38.55[a]	40.15[b]	41.28[ab]	50.99[ab]	50.55[ab]	38.88[b]	40.06[ab]
7	43.854[c]	43.43[c]	39.68[a]	38.21[a]	40.70[b]	42.09[a]	50.34[ab]	49.62[b]	40.76[ab]	41.92[a]
				CIE *a**				CIE *a**		
1	20.01[a]	21.65[a]	22.79[a]	22.37[a]	--	--	22.05[a]	21.64[a]	20.88[bc]	23.55[a]
4	15.85[b]	17.05[b]	22.41[a]	21.25[ab]	19.07[a]	19.83[a]	16.80[b]	17.40[b]	20.69[bc]	22.62[ab]
7	13.06[c]	15.75[b]	21.45[ab]	19.97[b]	16.87[b]	17.26[b]	12.80[c]	15.88[b]	19.25[c]	20.00[c]
				CIE *b**				CIE *b**		
1	9.90[ab]	10.84[a]	9.43[ab]	9.21[ab]	--	--	12.04[a]	11.89[ab]	8.63[bc]	10.09[a]
4	8.70[bc]	9.56[ab]	9.89[a]	9.32[ab]	7.92[b]	8.85[a]	11.05[bc]	11.11[abc]	8.75[abc]	9.89[ab]
7	7.94[c]	7.46[c]	9.77[a]	8.98[a]	7.33[b]	7.98[b]	10.67[cd]	9.83[d]	8.21[c]	8.69[bc]

[1]Carcass chilling treatment: CC=control, RC=rinse and chill. Ground beef (GB), Semimembranosus (SM) and Longissimus (LM) Dependent variables: CIE L*, a* and b*. [a-d]Means within a cow type and dependent variable with unlike superscript letters are different (P<0.05).

Lean Cows

Ground beef
- RC higher a* - more red at day 7

SM
- No difference between treatments for L*, a* or b*

LM
- RC had higher L* for day 7 and higher b* at day 4

Grain-finished Cows

Ground beef
- No difference for L* and b*
- RC had higher a* at day 7

LM
- No difference for L*
- RC had higher a* and b* at day 1

Table 4. Least square means of microbial measurements of lean cow ground beef under storage conditions[1].

Day	APC		Lactics		Entero	
	CC	RC	CC	RC	CC	RC
1	2.4[b]	2.32[b]	1.18[d]	1.51[d]	1.13[b]	1.08[b]
4	2.49[b]	2.35[b]	2.62[c]	3.1[bc]	1.12[b]	1.11[b]
7	4.2[a]	4.03[a]	3.34[b]	4.14[a]	1.72[a]	1.94[a]

[1]Carcass chilling treatment: CC=control, RC=rinse and chill. Dependent variables: total aerobic plate count (APC), lactic acid bacteria and enterobacteriaceae (Entero). [a-c]Means within a microbiological measurement unlike with superscript letters are different (P<0.05).

APC
- No difference between treatments for APC

Lactics
- RC had higher lactics at day 7

Enterobacteriaceae
- No differences between treatments

CONCLUSIONS

- Rinse & Chill® technology has potential to:
  - ✓ Decrease the carcass temperature early postmortem
  - ✓ Increase dressing percentage
  - ✓ Reduce carcass surface microbial counts
  - ✓ Improve the quality and shelf life of meat from cull cows
  - ✓ Results may be influenced by cow type

ACKNOWLEDGMENTS

- Authors are grateful to the Wisconsin Beef Council, American Foods Group LLC, and MPSC Incorporated for supporting this research.

REFERENCES

1. USDA, Livestock Slaughter 2016 Summary. Retrieved from: http://usda.mannlib.cornell.edu/usda/curr ent/LiveSlauSu/LiveSlauSu-04-19-2017.pdf
2. 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.
3. 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).
4. Fowler, S. M., Claus, J. M., & Hopkins, D. L. (2017). The effect of applying a rinse and chill procedure to lamb carcasses immediately post-death on meat quality? Meat Science, 134,124–127.
5. Yancey, E. J., Dikeman, M. E., Addis, P. B., Katsanidis, E., & Pullen, M. (2002). Effects of vascular infusion with a solution of saccharides, sodium chloride, and phosphates with or without vitamin C on carcass traits, Warner-Bratzler shear force, flavor-profile, and descriptive-attribute characteristics of steaks and ground beef from Charolais cattle. Meat Science, 60(4), 341–347.
6. Hunt, M. C., Schoenbeck, J. J., Yancey, E. J., Dikeman, M. E., Loughin, T. M., & Addis, P. B. (2003). Effects of postexsanguination vascular infusion of carcasses with calcium chloride or a solution of saccharides, sodium chloride, and phosphates on beef display-color stability. Journal of Animal Science 81, 669-675.