EFFECTS OF VASCULAR INFUSION WITH A SOLUTION OF SUGARS, SODIUM CHLORIDE, AND PHOSPHATES PLUS VITAMINS C, E, OR C+E ON DISPLAY COLOR

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Summary

Three groups of 12 (n=36) grain-finished, crossbred Charolais steers were humanely slaughtered, and nine in each group were infused via the carotid artery with an aqueous solution of sugars, sodium chloride, and phosphates plus either vitamin C, E, or C plus E. Three in each group served as non-infused controls. Vascular infusion improved redness of *longissimus thoracis* (ribeye) muscles at 24 hours postmortem, but had little effect on display color stability for steaks. Vascular infusion with the solutions containing vitamin E improved color panel visual evaluations of ground beef at 4 days simulated retail display.

(Key Words: Beef, Vascular Infusion, Color.)

Introduction

Vascular infusion near the end of bleeding is a relatively new process developed by MPSC, Inc. of Eden Prairie, MN. The process involves stunning animals by conventional captive bolt methods, and bleeding by severing the jugular vein. Solutions of substrates are infused via the carotid artery, utilizing a pumping system at pressures slightly below the blood pressures of resting live cattle. Vascular infusion has improved dressing percentages as compared to non-infused control carcasses. The process was developed as a carcass rinsing technique that alters the postmortem pH decline of beef muscles and could improve beef color stability.

Vitamins C and E have antioxidant activity. Vitamin C has improved color stability of ground beef when added during processing, and vitamin E improves steak and ground beef display color stability when fed to cattle at supranutritonal levels. Our study was designed to evaluate the effects of postmortem infusion of vitamins C and E on beef display color stability.

Experimental Procedures

Three groups of 12 grain-finished, crossbred Charolais steers were slaughtered using conventional slaughter procedures on three separate slaughter dates. At each slaughter date, nine were infused at 10% of live weight with a solution of 98.52% water, .97% sugars, .23% sodium chloride, and .28% phosphates (MPSC, Inc. Eden Prairie, MN) plus either 500 ppm vitamin C (n=3; MPSC+C), 500 ppm vitamin E (n=3; MPSC+E), or 500 ppm vitamin C plus 500 ppm vitamin E (n=3; MPSC+C+E). The remaining three at each slaughter date were bled conventionally and served as non-infused controls. Carcasses were chilled at 35°F, with spray chill for the first 12 hours, and ribbed between the 12th and 13th ribs after 24 hours chill. The exposed *longissimus thoracis* (LT) muscle was allowed to bloom for 20 minutes. Instrumental CIE L*, a*, and b* values were then taken from the exposed LT.

Carcasses were fabricated at 48 hours postmortem and sections of the LT, *psoas major* (PM), *semimembranosus* (SM), and *quadriceps* muscles were removed. Steaks 1 inch thick were cut from LT, PM, and SM,

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and then L*, a*, and b* color values were obtained from the steaks after air exposure for 20 min.

Subcutaneous fat was removed from the rib and loin sections of each carcass and frozen. The *quadriceps* muscle was ground and combined with the subcutaneous fat to produce a 20% fat ground beef (GB). The GB was mounded into 1 lb. portions, placed on foam trays, and overwrapped with oxygen permeable polyvinylchloride film (23,250 cc/ m^2/24 h). GB displayed for 4 days at 35°F under 150 foot candles of deluxe-warm-white fluorescent light with twice daily defrost. GB was evaluated for CIE L*, a*, and b* color values and visual color by a trained panel. The color panel utilized a five-point color scale (1 = very bright cherry red, 5 = dark red to tan or brown).

Results and Discussion

Color at 24 hours postmortem

The LT muscles from cattle infused with MPSC+E were lighter colored (higher L* values) than those from both MPSC+C+E and non-infused, control cattle at 24 hours postmortem ($P<0.05$; Table 1). The LT muscles from all infused cattle were more red (higher a* values) and more yellow (higher b* values) than those from non-infused, control cattle ($P<0.05$).

Table 1. Least Squares Means of CIE L*, a*, and b* Color Values for Longissimus Thoracis Muscles 24 h Postmortem and Longissimus Thoracis, Psoas Major, Outside and Inside Semimembranosus Steaks at 48 h Postmortem from Cattle Infused[a] with Either MPSC+Vitamin C (MPSC+C), MPSC+Vitamin C+Vitamin E (MPSC+C+E), MPSC+Vitamin E (MPSC+E), or Non-infused, Control Cattle (CON)

Muscle		CON	SE	MPSC+C	SE	MPSC+C+E	SE	MPSC+E	SE
Longissimus	24 h L*	39.0[c]	0.83	40.0[bc]	0.83	39.9[c]	0.83	42.4[b]	0.83
thoracis	24 h a*	20.5[c]	0.53	22.2[b]	0.53	22.0[b]	0.53	23.2[b]	0.53
	24 h b*	17.2[c]	0.65	19.7[b]	0.65	19.3[b]	0.65	21.1[b]	0.65
	48 h L*	41.4[c]	0.79	41.4[c]	0.84	42.5[bc]	0.79	44.4[b]	0.79
	48 h a*	18.8	0.50	19.7	0.57	19.3	0.54	19.3	0.54
	48 h b*	16.6	0.65	17.3	0.69	17.0	0.65	18.0	0.65
Psoas	48 h L*	40.7[c]	0.72	39.6[c]	0.72	42.8[b]	0.72	43.4[b]	0.72
major	48 h a*	20.4	0.47	21.0	0.47	20.7	0.47	20.2	0.47
	48 h b*	17.9	0.61	18.1	0.61	18.5	0.61	18.4	0.61
Outside	48 h L*	38.9	0.78	38.4	0.74	39.6	0.74	40.8	0.70
Semimembranosus	48 h a*	20.2	0.75	20.8	0.71	19.9	0.71	21.4	0.71
	48 h b*	17.2	1.00	18.2	0.95	17.1	0.95	19.3	0.90
Inside	48 h L*	41.4	0.91	40.6	0.86	40.7	0.86	42.0	0.81
Semimembranosus	48 h a*	22.7	0.56	23.0	0.53	23.2	0.53	23.5	0.50
	48 h b*	21.3	0.71	20.7	0.67	21.4	0.67	22.1	0.64

[a]98.52% water, 0.97% saccharides, 0.23% sodium chloride, and 0.28% phosphates infused at 10% of live weight.

[b,c]Means within a row having different superscript letters differ ($P<0.05$).

Color at 48 Hours Postmortem

At 48 hours postmortem, LT steaks from cattle infused with MPSC+E were lighter colored (higher L* values) than those from both MPSC+C-infused and non-infused, control cattle (P<.05; Table 1). The PM steaks from both MPSC+E and MPSC+C+E-infused cattle were lighter colored (P<0.05) than from MPSC+C-infused and non-infused, control cattle. No differences existed among treatments for a* or b* values (P>0.05). No treatment differences existed for SM L*, a*, or b* values.

Display Color Evaluation

No time × treatment interaction (P>0.05) existed for GB L*, a*, or b* values. However, a time x treatment interaction existed for the GB visual color panel scores (Table 2). On display days 1 through 4, the GB from MPSC+E-infused cattle was more cherry red (P<0.05) than that from MPSC+C-infused cattle. The panel also found the GB from MPSC+E and MPSC+C+E-infused cattle to be more red (P<0.05) than that from non-infused, control cattle on display day 4. Postmortem application of vitamin E via vascular infusion can improve GB display color stability.

Table 2. Time × Treatment Interaction Least Squares Means for Display Color Scores[1] for Ground Beef Obtained from Cattle Infused[a] with Either MPSC+Vitamin C, MPSC+Vitamin C+Vitamin E, MPSC + Vitamin E, or Non-infused, Control Cattle

Display Day	CON	SE	MPSC+C	SE	MPSC+C+E	SE	MPSC+E	SE
0	1.2	0.17	1.2	0.17	1.2	0.17	1.2	0.15
1	2.7^{bc}	0.15	2.8^{b}	0.13	2.5^{bc}	0.15	2.4^{c}	0.13
2	3.9^{b}	0.17	3.9^{b}	0.15	3.5^{bc}	0.17	3.1^{c}	0.15
3	4.5^{b}	0.17	4.3^{bc}	0.16	3.9^{cd}	0.17	3.5^{d}	0.15
4	5.0^{b}	0.17	4.7^{bc}	0.15	4.4^{cd}	0.17	4.1^{d}	0.15

[a]98.52% water, 0.97% saccharides, 0.23% sodium chloride, and 0.28% phosphates infused at 10% of live weight.

[b,c]Means within a row having different superscript letters differ (P<0.05).

[1]Display Color Score: 1 = Very bright cherry red or pale red, 2 = Bright cherry red or pale red, 3 = Slightly dark red to tan or brown, 4 = Moderately dark red to tan, 5 = Dark red to tan or brown.

3.5 = Margin of acceptability.