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EFFECTS OF POST-BLEEDING VASCULAR INFUSION OF CATTLE WITH A SOLUTION OF SUGARS, SODIUM CHLORIDE, AND PHOSPHATES OR WITH CALCIUM CHLORIDE ON CARCASS TRAITS AND MEAT PALATABILITY[1]

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Summary

We evaluated the effects of post-exsanguination vascular infusion at 10% of live weight of a solution of sugars, sodium chloride, and phosphates (MPSC) or of calcium chloride on carcass traits and meat palatability. Dressing percentages were 4% higher for carcasses infused with the MPSC and 2.5 % higher for carcasses infused with calcium chloride than for controls. USDA quality grades were not affected by vascular infusion. Infusion with calcium chloride caused undesirable intermuscular fluid accumulation and two-toned color in several muscles. It also caused higher Warner-Bratzler shear values and lower trained sensory panel scores ($P<.05$). MPSC infusion may offer financial benefits by increasing dressing percent, but it has no other major effects.

(Key Words: Vascular Infusion, Meat Quality, Meat Palatability.)

Introduction

Vascular infusion near the end of bleeding is a relatively new technique developed to improve and reduce variation of meat quality. The process involves stunning, exsanguination by severing the jugular veins, and infusion of fluids containing sugars and minerals through the right carotid artery. These fluids are delivered using a pumping system at pressures slightly below the blood pressure of resting live cattle. In several studies reported in the literature, vascular infusion has increased tenderness, decreased carcass weight loss, accelerated pH decline postmortem, and increased chilling rates of muscle. In other studies, injection of .3M calcium chloride into muscles at 24 to 48 hours postmortem has improved tenderness.

Our objectives were to determine dressing percentages, carcass shrink, by-product weights, yield and quality grade information, Warner-Bratzler shear force, and trained sensory panel scores of steaks from cattle that had received carcass infusion treatments.

Experimental Procedures

Grain finished Hereford × Angus steers (n=36) were obtained from a commercial feedlot where they had been fed a typical corn-based diet for 140 to 155 days. Cattle were shipped approximately 310 miles to the Kansas State University Beef Research Unit where they were provided feed and water until 12 hr prior to slaughter. The animals were slaughtered in two groups of 18, about 70 days apart (three head in each of two treatments and a control group) on 2 consecutive days. The average live weight at slaughter was 1181 ± 75 lb. Steers were slaughtered at the KSU Meat Laboratory by humane procedures. They were stunned with a captive bolt, the jugular veins were severed, and bleeding continued for approximately 3 min. Then the carcass was infused to 10% of its live weight via the right carotid artery using a delivery system developed by

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the Meat Processing Service Corporation, Inc. (MPSC, Inc.) of Eden Prairie, MN. Cattle were assigned randomly to one of the following treatment groups: 1) noninfused, control (Con); 2) infused with the standard MPSC solution containing 98.52% water, .97% sugars, .23% sodium chloride, and .28% phosphate blend (MPSC-infused); and 3) infused with .3 M (3.3%) $CaCl_2$ in water ($CaCl_2$-infused). The infusion process was conducted by employees of MPSC who developed the technology, specialized equipment, and technique over the last decade. It delivers fluids at pressures slightly below the normal blood pressure of cattle. Cattle were weighed on a rail scale prior to bleeding and after vascular infusion. They were dressed using standard procedures and chilled at 36EF using a 1 min cold water spray every 15 min for 8 hr after cooler entry. Carcasses were ribbed at 24 hr postmortem, and USDA yield and quality grade traits were obtained. Carcasses were regraded at 48 hr postmortem. *Longissimus lumborum* and *semitendinosus* muscles were removed and vacuum aged for 13 days, at which time they were cut into 1-inch-thick steaks and frozen for later Warner-Bratzler shear force and descriptive attribute evaluation by a trained sensory panel. After thawing, steaks were cooked in a Blodgett modified broiling oven to 150EF and cooled for 2 hours; then ½-inch-diameter cores (parallel to muscle fibers) were evaluated for Warner-Bratzler shear force on an Instron Universal Testing Instrument. Steaks for sensory panel evaluation were cooked and cooled the same way. No more than eight samples (representing different treatments) were presented in one panel session. Steaks were cut into ½ × ½ × 1 inch cubes for evaluation and scored on a scale of 8 = extremely tender, extremely flavorful, extremely juicy, no connective tissue; 1 = extremely tough, extremely bland, extremely dry, abundant connective tissue.

Results and Discussion

The mean dressing percentage was about 4 % higher (P<.05) for MPSC-infused cattle and about 2.3 % higher (P<.05) for $CaCl_2$-infused cattle than for Con cattle (Table 1). Using a carcass price of $1/lb and an average carcass weight of 725 lb, carcasses from cattle infused with the MPSC solution had a $30 advantage over noninfused cattle. Carcass cooler shrink was not different between Con and MPSC-infused cattle, but cattle infused with $CaCl_2$ showed greater (P<.05) cooler shrinkage. No differences in hide, tongue, or head weights were found among treatment groups, but hearts and livers were heavier for steers infused with the MPSC solution. At 24 hours postmortem, lean was firmer and finer textured (P<.05) for Con carcasses than for those infused with either solution (Table 2). Percentage of purge from vacuum-packaged muscles was similar among treatments after 14 days of aging (Table 2). Infusion had no effect on USDA yield and quality grade traits (Table 3).

Muscles from carcasses infused with $CaCl_2$ had markedly higher (P<.05) Warner-Bratzler shear force values and lower scores for sensory panel tenderness (less tender), connective tissue (more abundant), and juiciness (drier) than those from MPSC-infused or Con carcasses (P<.05; Table 4).

Several muscles from carcasses infused with $CaCl_2$ were in a tetany contraction when rolled into the cooler. This contraction likely was the reason for significant toughening. Several studies had shown that injecting .3M $CaCl_2$ into muscles at 24 or 48 hours postmortem resulted in a tenderness improvement. Our .3M $CaCl_2$ infusion apparently incorporated enough calcium to cause extensive muscle contraction but not tenderization. No differences in tenderness or palatability traits were noted between carcasses infused with the MPSC solution and Con carcasses.

In conclusion, vascular infusion at 10% of live weight with the MPSC solution increased dressing percentage and had minimal effects on meat palatability of grain-fed steers. Infusion with .3 M $CaCl_2$ increased dressing percentage but caused undesirable intermuscular fluid accumulation, toughness, and lower flavor and juiciness scores.

Table 1. Effects of Vascular Infusion of Hereford × Angus Cattle with the MPSC Solution or Calcium Chloride on Carcass Weight, Dressing Percentage and Organ and By-Product Weights

Item	CON	MPSC	$CaCl_2$	SE
Live weight, lb	1166.9	1222.9	1156.1	44.2
Hot carcass weight, lb	727.9[b]	811.9[a]	747.7[b]	27.9
Dressing percentage	62.4[a]	66.4[b]	64.7[ab]	44.0
Carcass shrink percentage (24 h)	!.24	!.02	.70	.27
Chilled carcass weight (48 h), lb	725.0	807.0	759.0	11.5
Carcass shrink percentage (48 h)	.38[a]	.66[a]	1.28[b]	.28
Hide weight, lb	95.3	90.6	95.7	13.6
Tongue weight, lb	2.4	3.5	3.3	.2
Head weight, lb	27.8	31.3	29.3	9.3

[a,b]Means within the same row with different superscript letters differ (P<.05).

Table 2. Effects of Vascular Infusion of Hereford × Angus Cattle with MPSC Solution or Calcium Chloride on Longissimus Muscle Quality Attributes

Item	CON	MPSC	$CaCl_2$	SE
Lean color, 24 h[a]	5.0	3.6	4.8	.37
Lean color, 48 h[a]	4.3	4.2	4.7	.37
Color uniformity, 24 h[b]	4.7	3.8	3.4	.37
Color uniformity, 48 h[b]	4.7	4.4	4.1	.37
Lean firmness, 24 h[c]	6.5[g]	4.5[g]	5.9[h]	.42
Lean firmness, 48 h[c]	5.7	5.8	5.9	.42
Lean texture, 24 h[d]	5.8[i]	4.7[h]	3.8[g]	.54
Lean texture, 48 h[d]	5.7	5.5	5.0	.54
Surface moisture, 24 h[e]	1.2	1.6	2.5	.24
Surface moisture, 48 h[e]	1.1	1.2	2.1	.24
Heat ring, 24 h[f]	1.4	1.5	.13	.21
Heat ring, 48 h[f]	1.3	1.2	1.3	.21
Longissimus muscle purge, %	2.3	3.2	3.5	.5
Semitendinosus muscle purge, %	2.7	3.8	3.1	.5

[a]1 = bleached red; 4 = cherry red; 8 = very dark red.
[b]1 = uniform; 5 = extreme two-toning.
[c]1 = very firm; 8 = extremely soft.
[d]1 = very fine; 8 = extremely coarse.
[e]1 = very dry; 8 = extremely moist.
[f]1 = none; 5 = extreme heat ring.
[g,h,i]Means within the same row with different superscript letters differ (P<.05).

Table 3. Effects of Vascular Infusion of Hereford × Angus Cattle with MPSC Solution or with Calcium Chloride on USDA Yield Grade and Quality Grade

Item	CON	MPSC	$CaCl_2$	SE
Hot carcass weight, lb	727.9[b]	811.9[a]	747.7[b]	12.6
Preliminary yield grade (PYG)	3.2	3.4	3.3	.11
Adjusted PYG	3.3	3.5	3.4	.10
REA, $in.^2$	12.2	12.9	11.9	.24
Kidney and pelvic fat, %	1.6	1.5	1.6	.18
USDA YG	3.0	3.2	3.3	.17
Fat cover score	3.8	3.8	3.6	.24
Bone maturity, 24 h	A[62]	A[51]	A[62]	5.0
Lean maturity, 24 h	A[68 b]	A[45 a]	A[70 b]	5.0
Overall maturity, 24 h	A[65]	A[48]	A[66]	-
Marbling 24 h	Slight[73]	Slight[67]	Slight[61]	1.0
USDA QG, 24 h	Select[73]	Select[67]	Select[61]	-
Lean maturity, 48 h	A[53]	A[54]	A[64]	5.0
Marbling, 48 h	Slight[72]	Slight[72]	Slight[91]	1.0

[a,b]Means within the same row with different superscript letters differ (P<.05).

Table 4. Effects of Vascular Infusion of Hereford × Angus Cattle with MPSC Solution or with Calcium Chloride on Warner-Bratzler Shear Force and Descriptive Attribute Sensory Panel

Item	CON	MPSC	$CaCl_2$	SE
Longissimus muscle				
Shear force, kg	3.4[a]	4.0[a]	5.8[b]	.39
Myofibrillar tenderness[c]	4.9[b]	5.9[b]	4.7[a]	.13
Connective tissue[c]	7.0[b]	7.1[b]	6.2[a]	.14
Overall tendereness[c]	6.1[b]	6.2[b]	4.9[a]	.14
Juiciness[c]	5.8[b]	5.8[b]	5.5[a]	.12
Flavor intensity[c]	5.9	5.9	5.7	.11
Off flavor[c]	7.7[b]	7.4[ab]	7.4[a]	.10
Semitendinosus muscle				
Shear force, kg	4.9	4.6	4.8	.13
Myofibrillar tenderness[c]	5.4	5.5	5.5	.13
Connective tissue[c]	6.1[a]	6.5[b]	6.1[a]	.14
Overall tenderness[c]	5.5	5.7	5.6	.14
Juiciness[c]	5.5[b]	5.3[a]	5.5[ab]	.12
Flavor tenderness[c]	5.7	5.5	5.4	.11
Off flavor[c]	7.6	7.7	7.7	.10
Ground beef shear force, kg	2.0	1.9	2.1	.18

[a,b]Means within the same row with different superscript letters differ (P<.05).
[c]8 = extremely tender, no connective tissue, extremely juicy, extremely flavorful, and no off flavor. 1= extremely tough, abundant connective tissue, extremely dry, extremely bland, and extensive off flavor.