Effect of Salt, Trisodium Phosphate, Synthetic Antioxidants, and Conjugated Linoleic Acid on Sensory and Quality Characteristics of Beef Striploins

C.W. Rowe, F.W. Pohlman, A.H. Brown, Jr., and Z.B. Johnson[1]

Story in Brief

USDA Select (n = 12) and Choice (n = 10) striploins were enhanced to examine the use of trisodium phosphate in combination with salt, synthetic antioxidants and conjugated linoleic acid (CLA). Treatments included: Choice control (n = 5, non-inject; CC), Choice inject (n = 5, 0.4% trisodium phosphate, 0.5% salt and 0.006% BHA/BHT (butylated hyroxy anisol/butylated hydroytoluene); CI), Select inject (n = 4, 0.4% trisodium phosphate, 0.5% salt and 0.006% BHA/BHT; SI), Select inject + CLA (n =4 ,0.4% trisodium phosphate, 0.5% salt, 1.3% CLA and 0.006% BHA/BHT; CL), and a Select control (n = 4, non-inject; SC). Injected treatments allowed for lower cook loss and shear force (WBS). Injected treatments also improved tenderness and juiciness when examined by sensory panelists. Inclusion of CLA allowed for higher ($P < 0.05$) marbling scores among treatments.

Introduction

The beef industry has for years sold steaks on a system that utilizes the amount of intramuscular fat (marbling) in the muscle to segregate carcasses based on palatability. In this system Prime is the highest quality followed by Choice, Select, and Standard. Baublits et al. (2007) found that the addition of conjugated linoleic acid (CLA) could add artificial or what could be perceived as marbling to the meat. This is of great concern, not only due to the health benefits, but also the potential monetary benefits that it may have on the beef industry.

The benefits of phosphates and salt have been documented by many authors, showing that improvements in palatability and quality can be achieved. The high solution pH of trisodium phosphate could potentially stabilize color, and improve the water holding capacity of the muscle, which would improve the shelf life and yields respectively. The use of BHA/BHT (butylated hydroxyl anisole/butylated hydroytoluene) to help stabilize color and retard oxidation may enhance the overall quality of the meat as well.

Therefore, the objectives of this trial was to examine effects of: 1) the use of trisodium phosphate and salt in combination with BHA/BHT, 2) the use of CLA to enhance marbling of Select steaks, and 3) directly compare enhanced steaks to Choice and Select control.

Experimental Procedures

Muscles. Beef striploins (IMPS 180; n = 22) were obtained from a commercial packing plant and transported to the University of Arkansas Red Meat Abattoir and aged for 14 days and frozen. Total make-up of the muscles was 10 USDA Choice muscle and 12 USDA Select muscles. Muscles were allowed to thaw for 5 days in a cooler at 33.8°F. Muscles were then removed from their vacuum packages, and external fat and adjacent muscles were removed.

Treatments and solutions. Choice muscles were assigned to either the Choice control (CC) treatment or the Choice inject (CI) treatment. The Select muscles were assigned to one of 3 treatments. The treatments include the Select control (SC), Select inject (SI) or Select inject plus CLA (CL). The 2 non-injected control treatments were used to compare within quality grade and also as a standard for between quality grades. The Select inject (SI) and Choice inject (CI) were injected at the same time with the same brine to examine effects of phosphate, salt, and BHA/BHT on differing quality grades. The 2 treatments were injected to a final product weight of 0.4% trisodium phosphate, 0.5% salt, and 0.0006% BHA/BHT. The Select inject plus CLA (CL) treatment group was injected with a solution containing 0.4% trisodium phosphate, 0.5% salt, 0.0006% BHA/BHT, and 1.3% CLA to examine the effects of CLA on the muscle. All treatments were injected to 110% of their original weight (10% pump).

Sample processing. Muscle sections were then cut into 1 in steaks for their respective analysis. All steaks were vacuum packaged and stored at 33.8°F until subsequent analysis of Warner-Bratzler shear force (WBS), cook loss, and sensory evaluation.

Shear force and cook loss. Cook loss of steaks were determined using the steaks for WBS. After removal from their respective vacuum packages, steaks were weighed on a balance before cooking to obtain an initial steak weight. After cooling from cooking, steaks were weighed again, and that weight was subtracted from the initial steak weight, divided by the initial steak weight, and multiplied by 100 to convert the measure into a percent loss.

Striploin steaks were cooked in a Blodgett forced air convection oven (Blodgett Oven Co., Burlington, Vt.) until the internal temp of each steak reached 160°F. Internal temperature was monitored every 5 s using a Teflon-coated copper-constantan thermocouples (Omega Engineering, Inc., Stamford, Conn.) attached to a Doric multichannel data logger (VAS Engineering, Inc., San Diego, Calif.). After cooking, steaks were allowed to cool for approximately 2 h. When steaks reached room temperature, six 0.5 in cores were attained parallel to the muscle fibers from each steak for WBS (AMSA, 1995). Each core was then sheared with a Warner-Bratzler attachment on an Instron Universal Testing Machine (Instron Corp., Canton, Mass.) equipped with a 200 lb load cell and a 9.8 in/min crosshead speed.

Sensory evaluation. Steaks were sampled by an 8-member trained sensory panel across 2 sessions. At least 2 samples per treatment group were chosen at random for each session. Before each session, steaks were removed from their vacuum packages and cooked using the same method as described for WBS. Upon completion of cooking, steaks were cut into 0.4 in x 0.4 in cubes and placed in a food warmer (Alto-Shaam, Inc., Menomonee Falls, Wis.) at 145°F for approximately 10 minutes. Panelists were then given each sample at his/her own pace in a booth with a designated random serving order. Panelists were selected and trained in accordance to AMSA (1995) guidelines.

[1] All authors are associated with the Department of Animal Science, Fayetteville.

Marbling scores. Marbling scores were determined by 3 experienced graders. The average of the 3 scores was used as the experimental unit. The SC and SI are considered to be the standard for the CL treatment.

Statistical Analysis. All data were analyzed using PROC MIXED of SAS (SAS Inst., Inc., Cary, N.C.). Due to the nature of the trial and the inability to be able to block across all treatments, a one-way anova was used for the design. Each muscle section was assigned to only one treatment. Treatment means were presented as main effects using LSMEANS / PDIFF option of SAS.

Results and Discussion

Shear force and cook loss. Means for shear force are presented in Table 1. As expected, Select and Choice control steaks had greater shear values ($P < 0.05$) than enhanced steaks. Steaks from the 2 control treatments (SC and CC) were not different ($P > 0.05$) and steaks from the 3 enhanced treatments (CI, SI, and CL) did not differ ($P > 0.05$). The injected treatment groups having a lower shear force value is most likely due to the action of salt solubilizing the myofibrillar proteins and to the trisodium phosphate increasing the water holding capacity and therefore loosening the matrix (Baublits et al., 2006). This in turn caused lower shear values among treatments that were injected. This is in agreement with Robbins et al. (2003a) who found that steaks injected with a salt and phosphate blend had lower shear values than control steaks. Also in agreement, Hayes et al. (2006) found that in pork loins, a salt and phosphate treatment allowed for lower shear values than the control. Baublits et al. (2005), however, found no differences between enhanced and control bicep femoris steaks.

For cooking loss, also, steaks from the 3 enhanced treatments were similar ($P > 0.05$) and had lower ($P < 0.05$) cooking loss than steaks from the 2 controls, which did not differ ($P > 0.05$). This is likely a function of the salt solubilizing the myofibrillar proteins and forming a matrix to trap the water in the muscle. The trisodium phosphate also increases the amount of water in the muscle by raising the pH and causing a greater repulsion between the muscle fibers. The enhanced steaks having a lower cook loss is not in agreement with Robbins et al. (2003a) and Hayes et al. (2006), who found there to be no differences in cook loss between enhanced and non-enhanced beef steaks and pork loins, respectively.

Marbling score. Means for marbling scores are presented in Table 1. Marbling scores are of interest for this trial due to the novelty of the injected CLA adding artificial marbling to the steak. This is of significance because treatment CL is a Select muscle with CLA added in the solution. Steaks on treatment CL had the highest ($P < 0.05$) degree of marbling among all treatments. Steaks on treatments CI and CC were not different ($P > 0.05$) for marbling score, and steaks on treatments CC, SC, and SI were not different ($P > 0.05$) from each other. Baublits et al. (2007) previously presented that use of CLA can enhance marbling in striploins. The lack of difference between steaks from SI, SC, and CC is due to the muscles being similar in quality with the Select muscles being high Select and the Choice muscles being low Choice. This caused similar marbling scores among non-CLA injected steaks.

Taste panel. Means for sensory taste panel are presented in Table 2. There were no differences ($P > 0.05$) among treatments in regard to beef flavor and off flavor. Steaks from the 3 enhanced (CI, SI, and CL) treatments were rated as having greater ($P < 0.05$) myofibrillar tenderness, less ($P < 0.05$) connective tissue and greater ($P < 0.05$) overall tenderness than steaks from the 2 controls (SC and CC).

Steaks from the 3 enhanced treatments were similar ($P > 0.05$) to one another for juiciness, but juicier ($P < 0.05$) than steaks from the 2 controls. Relevant to quality grade, the steaks from the Choice control was found to be juicier ($P < 0.05$) than steaks from the Select control. This is in agreement with a wealth of literature all finding that a salt and phosphate combination was beneficial to sensory characteristics of meat. Hayes et al. (2006), Baublits et al. (2006), Robbins et al. (2003a), and Robbins et al. (2003b) all found that a salt and phosphate combination allowed for better tenderness and juiciness on pork and beef, respectively.

Implications

The use of CLA in enhancing marbling can be used without impacting the sensory, quality and instrumental color characteristics of beef striploins. It can also be assumed that a Select grade steak can successfully be enhanced to a Choice or higher quality grade. Salt and phosphate can also be added to help in the sensory and quality characteristics while the BHA/BHT can be added to help with the physical and quality characteristics. As with all research, more research is needed to find optimal ways to enhance the steaks.

Literature Cited

AMSA. 1995. Research Guidelines for Cookery, Sensory Evaluation and Instrumental Measurements of Fresh Meat. American Meat Sci. Assoc. in cooperation with the National Livestock and Meat Board, now the National Cattlemen's Beef Assoc., Centennial, Colo.

Baublits, R. T., et al. 2005. Meat Science. 7:205-214.

Baublits, R. T., et al. 2006. Meat Science. 72:704-712.

Baublits, R. T., et al. 2007. Meat Science. 75:84-93.

Hayes, J.E., et al. 2006. Meat Science. 72:380-386.

Robbins, K., et al. 2003a. Meat Science. 64:279-285.

Robbins, K., et al. 2003b. Meat Science. 65:721-729.

Table 1. Least squares means ± standard error for physical characteristics of enhanced beef striploins.

Treatment	Shear force (lb)	Cook loss (%)	Marbling score[1]
Choice control[2]	5.93[b] ± 0.44	31.55[b] ± 1.13	526.00[ab] ± 20.63
Choice inject[3]	3.38[a] ± 0.44	22.58[a] ± 1.13	556.00[b] ± 20.63
Select + CLA[4]	3.80[a] ± 0.49	23.77[a] ± 1.25	675.00[c] ± 23.06
Select inject[3]	4.19[a] ± 0.49	24.07[a] ± 1.25	465.00[a] ± 23.06
Select control	6.59[b] ± 0.49	31.24[b] ± 1.25	481.67[a] ± 23.06

[1]Marbling scores = The first number is the level: 9 – abundant, 8 – moderately abundant, 7 – slightly abundant, 6 – moderate, 5 – modest, 4 – small, 3 – slight. The last 2 numbers are the degree of marbling within each respective level.
[2]Controls – non injected controls.
[3]Steaks were injected to a final weights of 0.4% trisodium phosphate, 0.5% salt, and 0.006% BHA/BHT (butylated hyroxy anisol/butylated hydroytoluene).
[4]Steaks were injected to a final weight of 0.4% trisodium phosphate, 0.5% salt, 0.006% BHA/BHT and 1.3% conjugated linoleic acid (CLA).
[a,b,c] Means, within a column, with no superscript in common differ ($P < 0.05$).

Table 2. Least squares means ± standard error for sensory characteristics of enhanced beef striploin steaks.

Treatment	Myofibrillar tenderness[1]	Connective tissue amount[1]	Overall Tenderness[1]	Juiciness[2]	Beef flavor[3]	Off flavor[4]
Choice Control[5]	6.29[a] ± 0.16	6.58[a] ± 0.15	6.31[a] ± 0.16	5.60[b] ± 0.19	6.91 ± 0.18	4.38± 0.15
Choice Inject[6]	7.47[b] ± 0.16	7.44[b] ± 0.15	7.42[b] ± 0.16	6.78[c] ± 0.19	6.93 ± 0.18	4.36 ± 0.15
Select + CLA[7]	7.22[b] ± 0.18	7.14[b] ± 0.17	7.14[b] ± 0.18	6.33[c] ± 0.21	6.64 ± 0.18	4.03 ± 0.16
Select Inject[6]	7.47[b] ± 0.18	7.28[b] ± 0.17	7.39[b] ± 0.18	6.56[c] ± 0.21	7.08 ± 0.18	4.34 ± 0.16
Select Control[1]	5.94[a] ± 0.18	6.33[a] ± 0.17	6.05[a] ± 0.18	4.97[a] ± 0.21	6.75 ± 0.18	4.48 ± 0.16

[1]1-8 scale: 1-extremely tough, abundant; 8-extremely tender, none
[2]1-8 scale: 1-extremely dry; 8-extremely juicy
[3]1-8 scale: 1-extremely non-beef like; 8-extremely beef like
[4]1-5 scale: 1-extreme off flavor; 5-no off flavor
[5]Controls – non-injected controls
[6]Steaks were injected to a final weight of 0.4% trisodium phosphate, 0.5% salt, and 0.006% BHA/BHT (butylated hyroxy anisol/butylated hydroytoluene).
[7]Steaks were injected to a final weight of 0.4% trisodium phosphate, 0.5% salt, 0.006% BHA/BHT and 1.3% conjugated linoleic acid (CA).
[a,b,c]Means within a column, with no superscript in common differ ($P < 0.05$).