Sodium Chloride and Sodium Tripolyphosphate Effects on Characteristics of Restructured Beef Roasts

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ABSTRACT

Restructured roasts were manufactured from three-piece boneless chucks. Four different treatments were prepared with eight replications. Excess fat and connective tissue were trimmed from the chuck muscles prior to processing. Half of the lean and 5% added fat were emulsified for 5 minutes, the rest of the lean was added and the product was emulsified again for 30 seconds. The mixture was divided into four equal portions to undergo treatment. Treatments contained different concentrations of sodium chloride (NaCl) and sodium tripolyphosphate ($Na_5P_3O_{10}$): T1 (0%, 0%), T2 (0%, 0.3%), T3 (1.7%, 0%), T4 (1.7%, 0.3%). Cooking loss, water holding capacity, Warner-Bratzler shear force, and sensory evaluations were conducted. Results showed significant differences ($p < .001$) between treatments for cooking loss and water holding capacity, but no difference ($p > .05$) between treatments in shear force. Sensory panel evaluations for flavor indicated preference for roasts containing NaCl, with or without $Na_5P_3O_{10}$, over roasts without NaCl.

Meat restructuring is a recent innovation in the packing and processing industry. Interests in meat restructuring technology began in the early 1940s but were not pursued until the late 1970s for economic reasons (Seideman and Durland, 1983). The primary function of restructuring is to render less desirable carcasses or less tender cuts into a more palatable and acceptable meat product. Economic pressure to minimize cost and maximize product use provides the incentive to develop new products using less valuable carcasses and carcass components and to increase product value (Seideman and Durland, 1983). Lower-grade carcasses (mature cows and bulls) that are normally used as ground meat, can now be used more efficiently (Marriot et al., 1988; Berry et al., 1986; Huffaman et al., 1984; Seideman et al., 1982). On better carcasses, the less tender or unpopular portions such as the chuck, shank, plate, and flank can be reformed into more consumer-acceptable products.

If restructured beef industry is to succeed, meat packers and processors must produce a restructured product to the specifications and needs of the consumer. Historically, restaurants and institutions have used some restructured meats due to the uniformity and portion control of the products (Chu et al., 1989).

For the average consumer, however, the product must first have eye appeal, no one will buy something that does not look good. Although many restructured meat items are pre-cooked, they still need to resemble intact muscle. A restructured roast

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must have the appearance and texture of a regular roast. Also, the product must be palatable. It should be tender yet cohesive. Upon serving, the meat should cut easily but remain intact, carry a fair amount of juiciness, and be flavorful. Although different seasonings are used, the taste should resemble that of intact muscle.

The purpose of this study was to analyze the cooking loss, water holding capacity, shear force, and the consumer flavor response of restructured beef roasts manufactured with varying levels of NaCl and $Na_5P_3O_{10}$.

MATERIALS AND METHODS

This research was conducted in the Meat Science Laboratory at Sul Ross State University, Alpine, Texas. Three-piece boneless vacuum packaged chucks (USDA Choice) were used in the study. Four different treatments were manufactured with eight replications. The chucks were trimmed of excess fat and the major muscle areas separated. External connective tissue was then trimmed from the individual muscle areas along with any external fat still present. The lean muscle tissue was then cut into approximately 0.75-inch cubes and the weight was recorded. Marbling was estimated at 15% and remained constant throughout the study. Fat (5%) was added to the lean to formulate a ratio of 80% lean to 20% fat.

Processing

Half of the lean along with the 5% fat were emulsified (Hobart Silent Cutter) for 5 minutes. The rest of the lean was added and the contents were emulsified again for 30 seconds. The mixture was divided into four equal portions and the different treatments performed. All ingredients used in this study were food grade. All restructured roasts regardless of treatment contained 0.9% ground white pepper, 0.1% celery seed, and 0.25% granulated onion. The treatments were as follows: Treatment 1 (T1), 0% NaCl, 0% $Na_5P_3O_{10}$; Treatment 2 (T2), 0% NaCl, 0.3 $Na_5P_3O_{10}$; Treatment 3 (T3), 1.7% NaCl, 0% $Na_5P_3O_{10}$; Treatment 4 (T4), 1.7% NaCl, 0.3% $Na_5P_3O_{10}$.

Test products were mixed for 4 minutes (Leland Food Mixer, model 7000) and stuffed (Vogt 12-1/2 Ideal Stuffer) into 11- by 30-inch fibrous casings. A 0.5 gram sample from each treatment was retained for determination of water holding capacity (WHC). Products were then chilled overnight before cooking.

A Blodgett convection oven was preheated to 350 ^{0}F and the four roasts inserted after the uncooked weights had been recorded. The roasts were cooked to an internal temperature of 120 ^{0}F before being flipped and cooked to a final internal temperature of 150 ^{0}F. The roasts were cooled at room temperature for 10 minutes, weighed, then stored in the cooler overnight. The percent cooking loss for each treatment was calculated.

Analytical Procedures

The water holding capacity was determined by the filter paper press method, as used by Kim, 1988. Four pre-dried Whatman No. 1 filter papers were placed on four separate 12 by 6 inch plexiglass plates. A 0.5 gram sample from each treatment was placed on the corresponding filter paper. The plates containing the samples were then stacked and a cover plate added. The samples were pressed simultaneously with a Carver Laboratory Press (Type C) at 500 psi for 1 minute. The filter paper was removed from the press and dried at room temperature. The area of total juice (Ring Zone) and meat film were marked and traced with a Compensating Polar Planimeter (Lietz, Model 47788). The WHC was recorded as the meat film area divided by the total juice area.

Shear force (in lbs.) was measured using three of the core samples taken from each treatment. Each core was sheared twice and the average of six measurements was recorded.

After the casing was removed, a 1-inch thick slice was taken from the center of each treatment. Fifteen 0.5-inch diameter core samples were extracted at various locations on each slice and placed in a numbered container. A seven-member taste panel was established to test the various treatments. A Duo-Trio Differentiation test was used to determine an individuals ability to distinguish between treatments. The panelists also evaluated the individual treatments for flavor. A six point scale was used (1--highly unacceptable to 6--highly acceptable) to evaluate the product flavor.

The data accumulated were analyzed using SPSS/PC+ vol. 3.0 (SPSS Inc., 1986). Multivariate Analysis of Variance (MANOVA) was performed to detect differences in cooking loss, water holding capacity, and shear force. One Way Analysis of Variance was used to detect differences between variables and treatments, using Duncan's Multiple Range Test to test homogeneity of treatments. Significant differences were accepted at $P<0.05$.

The Duo-Trio Differentiation test was analyzed by the number of correct responses in relation to the number of total responses. The Flavor Evaluation of Treatments test was analyzed to determine the sample mean and the standard deviation of each treatment to rate the flavor of individual treatments on a qualitative basis.

RESULTS and DISCUSSION

Results (Table 1) indicate that the use of NaCl with $Na_5P_3O_{10}$ in the formulation of restructured beef roasts was very effective ($p<.001$) in reducing cooking loss and increasing water holding capacity. Restructured roasts made with 1.7% NaCl and 0.3% $Na_5P_3O_{10}$ had less cooking loss and higher water holding capacity than roasts made with 1.7% NaCl, roasts made with 0.3% $Na_5P_3O_{10}$, and roasts with neither NaCl nor $Na_5P_3O_{10}$. These results support the findings of Mann et al. (1989), Marriot et al. (1985), and Huffman et al. (1984). There was no significant difference in shear force tenderness ($p>.05$) among the four formulations.

Results of the sensory evaluation for flavor indicates that restructured roasts made with both NaCl and $Na_5P_3O_{10}$ have no measurable difference in flavor from roasts made with NaCl alone, but are more flavorful than restructured roasts without NaCl.

Based on flavor, the product of Treatment 1 was considered unacceptable, whereas the product from Treatment 2 was slightly unacceptable and products from Treatments 3 and 4 were considered slightly acceptable. These findings expand on the findings of Huffman et al. (1984). This test also reported that roasts with no NaCl and 0.3% $Na_5P_3O_{10}$ were more flavorful than roasts with neither additive.

CONCLUSIONS

The use of $Na_5P_3O_{10}$ in conjunction with NaCl for the manufacture of restructured beef roasts resulted in decreased cooking loss and increased water holding capacity, but had no effect on tenderness compared to restructured roasts containing NaCl only, $Na_5P_3O_{10}$ only, and neither NaCl nor $Na_5P_3O_{10}$. Roasts containing NaCl were more acceptable to flavor panelists than those with no NaCl. The manufacture of restructured roasts containing NaCl and $Na_5P_3O_{10}$ might be beneficial to the industry for reducing cooking loss, increasing water holding capacity, and increasing flavor.

Table 1. Mean and standard deviation (SD) of cooking loss, water holding capacity (WHC), Warner Bratzler shear force, and flavor evaluation as affected by various treatments of sodium chloride and sodium tripolyphosphate.

Treatment		Cooking loss		WHC		Shear force		Flavor	
NaCl	$Na_5P_3O_{10}$	Mean	SD	Mean	SD	Mean	SD	Mean	SD
		%				lbs			
(1) 0%	0%	30.1[a]	2.8	43.29[a]	12.05	2.74[a]	0.80	2.4[a]	1.2
(2) 0%	0.3%	28.1[a]	5.4	61.07[b]	18.99	2.44[a]	0.44	2.7[a]	1.4
(3) 1.7%	0%	23.3[b]	4.1	85.71[c]	10.79	3.21[a]	1.28	4.3[b]	1.2
(4) 1.7%	0.3%	15.0[c]	5.0	93.50[c]	9.89	2.78[a]	0.69	4.2[b]	1.1

Note: Means within a column followed by different letters are significantly different ($P<0.001$).

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