INCREASED UTILIZATION OF MUSCLES FROM THE TWO-PIECE BEEF CHUCK

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Story in Brief

Selected muscles from the two-piece beef chuck were used to determine the effect of four brine solutions on the assessment of palatability by a sensory panel. The supraspinatus, infraspinatus, rhomboideus/splenius, complexus and triceps brachii were selected based on size and tenderness ratings. All brine solutions were formulated to contain 1% salt and 2.5% phosphate. Muscles were pumped to 120% of their original weight. Three of the brines contained sodium lactate, isolated soy protein, or a combination of isolated soy protein and sodium lactate. A control was comprised of muscles without any brine injected. As the amount of solids in the brine increased, the yield of the steaks obtained from the muscles increased. Thaw loss was highest for the salt and phosphate brine with no difference between treatments in regard to cooking loss. A trained sensory panel indicated that injected steaks were more tender than the control. Sodium lactate was found to improve the water binding ability of steaks equivalent to the soy injected steaks without the detection of off flavors. This study suggests that more tender and juicy steaks can be obtained from the two-piece chuck by injection of a brine solution that contains sodium lactate without an objectionable increase in off flavors. The moisture retention of the steaks with sodium lactate is superior to steaks with only salt and phosphate.

(Key Words: Beef, Sodium Lactate, Soy Protein, Palatability.)

Introduction

An increase in the desire for more convenient meat items has prompted processors to develop new methods to improve the utilization of muscles historically associated with beef chuck roasts. One method that is currently used is restructuring. Restructuring is a process where selected muscles (usually obtained from the less utilized portions of the carcass) are trimmed of bone, fat, and connective tissue, ground and reshaped into a product that can be cut to steaks or utilized as a roast. Although restructuring is a technology that gives

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processors the ability to improve the tenderness of chuck muscles, the acceptance of these products at the retail level has been limited. This results from the "ground beef texture" perceived by many and the fact that these products must be sold under frozen storage conditions. In addition, during the manufacture of such a product, the processor must remove large amounts of connective tissue which requires more labor and produces a low-value by-product.

An alternative to the restructuring process is the injection of whole muscles with a brine solution that increases the tenderness of the muscle and creates a product that is more suitable for rapid cooking methods. This study investigates the utilization of various non-meat ingredients and the potential for increasing the utilization of the muscles from the chuck.

Materials and Methods

Two piece chucks (n=20) were selected from carcasses having marbling scores ranging from small to modest and preliminary yield grades from 3.0 to 3.5. Each chuck was vacuum packaged and transported to the Oklahoma State University Meat Laboratory. The infraspinatus, supraspinatus, triceps brachii, rhomboideus/splenius, and complexus muscles were removed and yields obtained. The chucks were randomly assigned to blocks of two. Muscles from the same anatomical location in each block were randomly assigned to one of five treatments. The treatments consisted of one control and four brine formulations. All brines were formulated to contain 1% salt, and 2.5 % sodium phosphate. Three of the brines additionally contained either 2% isolated soy protein (SI), 2% sodium lactate (SL) or a combination of SI and SL. All muscles were injected to 120% of their original weight and each treatment vacuum tumbled for two hr (20 min on, 10 min off). At the completion of each cycle, the muscles were stored at 40°F overnight. At the end of the storage period, each muscle was weighed to determine the amount of purge accumulated.

Each muscle was individually wrapped in oxygen permeable film and wrapped a second time with plastic-lined freezer paper. The muscles were placed in a freezer until cut into one inch steaks. Each steak was individually vacuum packaged and stored frozen until analyzed.

Steaks were allowed to thaw overnight at 40°F to allow for the insertion of copper-constantan thermocouples. Steaks were cooked to 104°F, turned and removed when 158°F internal temperature was reached. Weights of the steaks were obtained prior to and at the end of cooking to determine cooking losses.

Two steaks from each muscle were obtained for sensory evaluation by a trained panel. Panelists were initially subjected to salt solutions of increasing strength to screen for salt thresholds. Trained panelists evaluated tenderness, flavor intensity, saltiness, off-flavor, and connective tissue amount. Each panelist was given five samples per session for evaluation.

Cooked steaks were objectively measured for tenderness using the Warner-Bratzler shear apparatus attached to an Instron Universal Testing Machine (Model 4502). Data collection and analysis software were used to obtain peak force and energy required to shear the samples. Approximately eight cores measuring one-half inch in diameter were obtained from each steak assuring that the muscles fibers were oriented parallel to the longitudinal axis. A 1 kN load cell traveling at a speed of 50 mm/min sheared each sample perpendicular to the direction of the muscle fibers. One steak from each muscle was used for analysis.

A randomized complete block design was used for statistical analysis with two chucks comprising one block and the muscles from those chucks were randomly assigned to one of five treatments. Main effects and interactions were analyzed by the general linear models procedure with mean separations using Tukeys Least Significant Difference approach (Steel and Torrie, 1960). All statistical analysis was performed using the Statistical Analysis System for personal computers.

Results and Discussion

The weights and yields associated with the selected muscles from the two-piece beef chuck are reported in Table 1. The total yield averaged 15.2% with the triceps brachii comprising the major portion. The smallest yield was obtained from the rhomboideus/splenis muscle.

Table 1. Weights and yields of selected muscles from the two-piece beef chuck.

	Muscle[a]				
	SS	IS	RS	CP	TB
Weight, lb	2.22	3.62	1.58	2.56	4.76
Yield, %	2.35	3.65	1.69	2.57	5.08

[a] SS = Supraspinatus
IS = Infraspinatus
RS = Rhomboideus/splenius
CP = Complexus
TB = Triceps brachii

After treatment with the brine solutions, the steaks cut from the muscles were heaviest (P<.05) for the muscles containing soy protein (Table 2). The differences in weights of the steaks are due to the loss of moisture (purge) after the muscles were tumbled and before the muscles were frozen. This loss was anticipated since the treatments with soy protein and sodium lactate contain more solids than do the other treatments, resulting in higher retention of the brine. Upon thawing of the steaks prior to cooking, the amount of moisture lost due to purge was greatest for the sodium phosphate and salt solution. Thaw loss associated with the other brines, as a percentage of the total weight, was not different from the control (Table 2). It can be assumed, therefore, that sodium lactate aids in the ability for the muscle proteins to retain moisture but does not show a synergistic effect for water binding ability in the presence of soy protein. Although the magnitude of the cook loss decreased with the addition of sodium lactate or soy protein isolate, there was no significant difference in the loss in weight due to cooking between treatments.

Thaw loss associated with different muscle types was greatest (P<.05) for the supraspinatus (Table 3). This increase in thaw loss requires further examination to determine the primary reason. There was no difference in the cook loss between the muscles studied.

A trained sensory panel indicated that all muscles became more tender with the addition of a brine solution (Table 4). Among the brines used, soy protein in the presence of sodium lactate was associated with the most tender

Table 2. Effect of brine solution on the thaw loss and cook loss of beef steaks.

	Treatment[a]					
	Control	SP	SL	SI	SIL	s.e.
Weight, lb.	0.73^{c}	0.84^{b}	0.92^{b}	0.96^{b}	0.98^{b}	.04
Thaw loss, oz	4.6^{c}	6.9^{b}	4.3^{c}	4.2^{c}	3.1^{c}	.40
Cook loss, oz	33.0	33.5	29.0	28.7	27.8	6.9
Moisture, %	74.2^{d}	79.1^{b}	76.1^{cd}	77.1^{bc}	73.8^{d}	1.1
Fat, %	6.5^{ab}	5.6^{b}	7.0^{a}	5.5^{b}	5.5^{b}	.3

[a] SP = Salt and sodium phosphate
SI = Isolated soy protein
SL = Sodium lactate
SIL = Isolated soy protein and sodium lactate

[b,c,] Means in same row with different superscripts are significantly different (P<.05)

Table 3. Effect of muscle type on the thaw loss and cook loss of beef steaks.

	Muscle[a]					
	SS	IS	RS	CP	TB	s.e.
Weight, lb	0.57[c]	0.96[c]	0.71[d]	0.78[d]	1.40[b]	.04
Thaw loss, oz	6.0[b]	3.5[d]	4.4[bcd]	5.2[bc]	3.8[cd]	.40
Cook loss, oz	30.0	29.3	29.5	31.7	31.5	6.9
Moisture, %	77.8[b]	75.88[bc]	75.6[bc]	74.7[c]	76.3[bc]	1.1
Fat, %	3.7[c]	7.01[bc]	8.1[b]	6.5[c]	4.7[d]	.30

[a] SS = Supraspinatus
IS = Infraspinatus
RS = Rhomboideus/splenius
CP = Complexus
TB = Triceps brachii

[b,c,d,e] Means in same row with different superscripts are significantly different (P<.05)

Table 4. Effect of brine solution on sensory assessment by a trained panel.

	Treatment[a]					
	Control	SP	SL	SI	SIL	s.e.
Tenderness	4.3[c]	4.9[d]	5.3[cd]	5.7[bc]	5.9[b]	.1
Juiciness	4.4[d]	4.8[cd]	5.3[b]	5.1[bc]	5.3[b]	.1
Connective tissue	4.5[c]	4.7[d]	5.2[c]	5.5[c]	5.8[b]	.1
Flavor intensity	4.4[c]	4.7[c]	5.1[b]	4.6[c]	5.1[b]	.1
Saltiness	5.5[b]	4.9[c]	4.0[d]	4.8[c]	3.8[d]	.1
Off flavor	3.6[bc]	3.7[b]	3.6[bc]	2.9[d]	3.2[cd]	.1

[a] SP = Salt and sodium phosphate
SI = Isolated soy protein
SL = Sodium lactate
SIL = Isolated soy protein and sodium lactate

[b,c,d,e] Means in same row with different superscripts are significantly different (P<.05)

steaks ($P<.05$), followed by the steaks containing soy protein and sodium lactate added separately. From the data obtained by the sensory panel, sodium lactate appears to work synergistically with soy protein to increase tenderness. Although this can be partially explained by the increased ability to retain moisture, other factors not yet determined must also be considered.

The perception of juiciness by the trained sensory panel indicated an increase with the addition of sodium lactate or soy protein (Table 4). The highest juiciness scores were associated with the steaks that contained sodium lactate, followed by those steaks containing soy protein without sodium lactate. All brine solutions were scored higher for juiciness, but the steaks containing only salt and phosphate were not significantly different from the control. The detection of connective tissue decreased with the addition of soy protein and sodium lactate to the brine solution. This decrease in the detection of connective tissue is most likely due to the dilution of the connective tissue by the added moisture and solids. There is an additive effect between soy and sodium lactate that would substantiate the dilution effect.

Flavor intensity increased above the control with the addition of sodium lactate to the brine solution (Table 4). The ability of sodium lactate as a flavor potentiometer has been indicated by other researchers. The perception for salt intensified ($P<.05$) with the addition of the brine solution which would be expected since all the steaks contained salt except for the control. The addition of sodium lactate further intensified the sensory panel's ability to detect salt. Off flavors associated with the steaks were indicated with the addition of soy protein. It is interesting to note that although soy increased the perception of off flavors, the addition of sodium lactate to the brine containing soy protein reduced those off flavors such that they were not different from the control.

The sensory panel indicated that the infraspinatus muscle was the most tender of the muscles studied with the complexus muscle being the least tender (Table 5). Juiciness and tenderness followed a similar rating for the muscles. Flavor intensity was highest ($P<.05$) for the triceps brachii, followed by the infraspinatus and the rhomboideus/spleneus. Saltiness and off-flavor were not different among the muscles studied.

Implications

This study suggests that sodium lactate has potential as an ingredient in brine solutions for the stability and palatability of muscles obtained from the chuck. The improvement in tenderness through the injection of brine solutions may be a viable alternative to the restructuring of beef muscles.

Table 5. Effect of muscle type on the sensory assessment by a trained panel.

	Muscle[a]					
	SS	IS	RS	CP	TB	s.e.
Tenderness	5.0[c]	6.3[b]	5.2[c]	4.1[d]	5.4[c]	.1
Juiciness	4.8[c]	5.5[b]	5.2[bc]	4.3[d]	5.0[c]	.1
Connective tissue	5.1[c]	6.0[b]	4.8[d]	4.4[e]	5.4[c]	.1
Flavor intensity	4.7[c]	4.8[bc]	4.8[bc]	4.6[c]	5.1[b]	.1
Saltiness	4.5	4.6	4.6	4.9	4.5	.1
Off flavor	3.2	3.5	3.4	3.6	3.3	.1

[a] SS = Supraspinatus
IS = Infraspinatus
RS = Rhomboideus/splenius
CP = Complexus
TB = Triceps brachii

[b,c,d,e] Means in row with different superscripts are significantly different ($P<.05$)

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