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Effect of Injecting Modified Connective Tissue Solutions on Quality of Beef Roasts

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Summary

Soluble collagen from enzymatically treated beef tendons was used in an enhancement brine to inject and tumble USDA select grade semitendinosus muscles. Similar samples injected only with water, salt and phosphates and non-injected ST roasts were used as controls. No treatment differences were found for package purge loss and shear force. Color of collagen injected samples was either similar to non-injected or salt/phosphate injected pieces. Sensory evaluation indicated that samples injected with enzyme treated collagen were tenderer, juicier, and more flavorful. Tendons can be modified and successfully used for injection of whole muscle products in model systems.

Introduction

Important amounts of connective tissue such as tendons, membranes, cartilages and ligaments are generated from beef fabrication and grinding operations. This material is usually of low value and rendered for protein and fat. Previous research has described modification and use of connective tissue in meat systems like ground beef, patties, sausages, frankfurters, bologna and restructured products, where it was successfully included for cost reduction, texture modification and fat substitution. However, applications in whole muscle products have not been reported. Injection and marination of beef cuts have proved to enhance overall eating quality and reduce palatability variations of the finished product. This enhancement technology is now common practice in the meat industry. Our objective was to improve connective tissue functionality so that it could be used as an ingredient for injection, marination and enhancement of beef whole muscle products.

Procedure

Beef Tendon Solutions

Beef chuck tendons were either cooked to 167ºF in a solution containing salt (5% w/w), phosphate (2% w/w) and bromelin (a pineapple derived proteolytic enzyme) or just salt and phosphate as a control. The resulting product was filtered through cheesecloth to obtain two types of solutions: heat solubilized collagen (C-collagen) and enzyme-degraded collagen (B-collagen), which were used as ingredients for injection.

Injection of Beef Roasts

Six USDA select grade semitendinosus (ST) muscles were cut in half to obtain 12 ST roasts. Three roasts were randomly assigned to each of the following injection treatments: 1) C-collagen, 2) B-collagen, 3) salt and phosphate (SP) and 4) no injection (NI).

All the solutions to be injected were adjusted to have the same level of salt (5% w/w) and phosphate (2% w/w). The eye of round pieces were injected to 15% weight increase, bagged and tumbled for 30 minutes. After tumbling the pieces were cut into six 0.75-inch steaks which were randomly assigned in groups of two steaks per three time periods: day 1, day 8 and day 15 post injection. The steaks were weighed, vacuum packaged and stored in the darkness at 41ºF.

Purge, Color and pH

At every time period, a two-steak package per experimental unit was opened and the steaks were blotted

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Table 1. Least square means[e] for lightness value (L*) by treatment and time.

Main Effect	L*value
Treatment[f]	
B	40.81[a]
C	50.85[a]
SP	44.35[b]
NI	51.49[a]
Std error	1.90
Time[g]	
Day 1	45.62[d]
Day 8	46.05[d]
Day 15	48.94[c]
Std error	1.11

[e]Means within a column lacking a common superscript letter are different ($P < 0.05$).
[f]Injection treatments B, C, SP, NI refer to samples injected with: bromelin degraded collagen, heat-treated collagen, salt/phosphate only and non-injected, respectively.
[g]Time refers to day 1, 8 and 15 post injection.

Table 2. Least square means[c] for package purge by time.

Time[d]	Purge (%)
Day 1	3.72[a]
Day 8	5.46[b]
Day 15	4.95[b]
Std error	0.403

[c]Means within a column lacking a common superscript letter are different ($P < 0.05$).
[d]Time refers to day 1, 8 and 15 post injection.

Table 3. Least square means[d] for cooking losses by injection treatment.

Treatment[e]	Cooking Loss (%)	Std error[f]
B	30.41[ab]	0.923
C	32.75[a]	0.923
SP	27.37[c]	0.923
NI	29.03[bc]	1.002

[d]Means within a column lacking a common superscript letter are different ($P < 0.05$).
[e]Injection treatments B, C, SP, NI refer to samples injected with: bromelin degraded collagen, heat-treated collagen, salt/phosphate only and non-injected, respectively.
[f] Injection treatments have different standard errors due to missing data.

Table 4. Least square means for Warner-Bratzler shear (WBS) force by treatment.

Treatment[a]	WBS (kg)
B	4.13
C	4.26
SP	3.92
NI	3.63
Std error	0.221

[a]Injection treatments B, C, SP, and NI refer to samples injected with: bromelin degraded collagen, heat-treated collagen, salt/phosphate only and non-injected, respectively.

Table 5. Least square means[d] for sensory flavor, tenderness, juiciness and overall acceptability scores.

	Treatment[e] Means				
Attribute[f]	B	C	SP	NI	Std error[g]
Flavor	8.6[a]	6.8[b]	7.6[b]	7.3[b]	0.40
Tenderness	8.9[a]	7.7[b]	7.5[b]	6.8[b]	0.45
Juiciness	9.0[a]	7.0[b]	8.2[a]	7.0[b]	0.39
Overall acceptability	8.5[a]	6.8[c]	7.7[ab]	7.2[bc]	0.38

[d]Means within a row lacking a common superscript letter are different ($P < 0.05$).
[e]Injection treatments B, C, SP, NI refer to samples injected with: bromelin degraded collagen, heat-treated collagen, salt/phosphate only and non-injected, respectively.
[f]Attributes scored on a 15 cm hedonic scale (n=45 panelists).
[g]Injection treatments have different standard errors due to missing data.

with a paper towel to remove excess moisture and weighed to determine purge loss. The samples were allowed to bloom for 30 minutes and lightness (L*), redness (a*) and yellowness (b*) and pH were measured. The steaks were then vacuum packed again and stored under refrigeration.

Cooking Losses, WBS and Sensory Analysis

Steaks were cooked to 130°F internal temperature for Warner-Bratzler shear force determination (WBS) and sensory evaluation. Forty-five panelists scored the samples for tenderness, juiciness, flavor and overall acceptability. Cooking losses were calculated by weight difference.

Statistical Analysis

A regression and an analysis of variance using Proc Mixed from the Statistical Analysis System (SAS) were performed. Least significant differences were calculated for mean separation and Bonferroni confidence bands were constructed for the regression parameter estimates.

Results

The NI steaks were lighter and redder while b* value trends were not significantly different among treatments. C-collagen samples were as light as NI product and as red as SP-injected steaks. B-collagen injected samples were similar in color characteristics to SP-injected product. Over time, all samples became lighter and both a* and b* decreased in a quadratic fashion (Table 1, Figures 1 and 2). As expected, purge increased as a function of time, but no treatment differences were observed (Table 2). Collagen injection slightly increased cooking losses compared to SP-injected samples, but was not different than NI steaks (Table 3).

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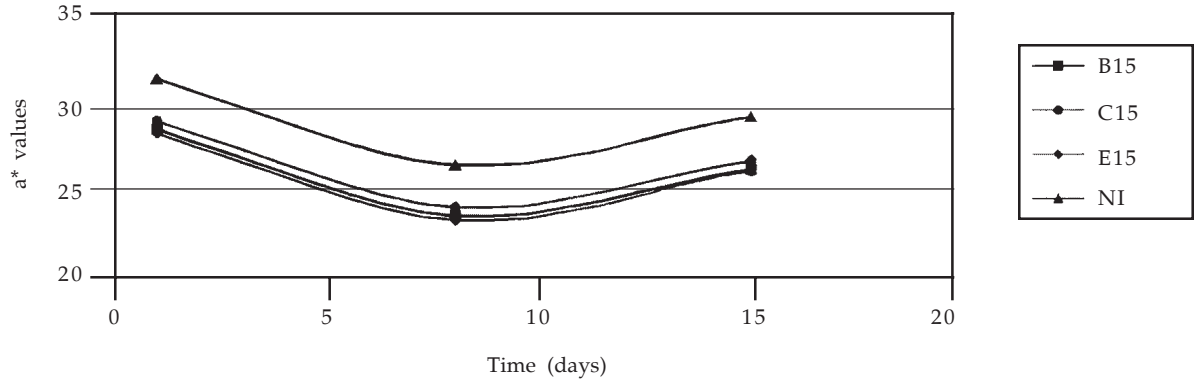

Figure 1. Predicted a* values by injection treatment.

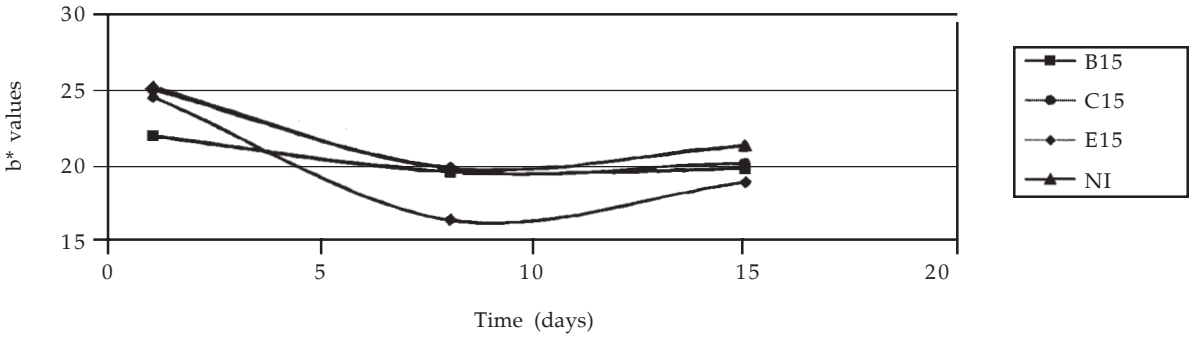

Figure 2. Predicted b* values by injection treatment.

Shear forces, however, were similar among samples (Table 4). Panelists perceived B-collagen steaks as being more flavorful and tender than any other treatment, and as juicy and acceptable as SP-injected steaks (Table 5). Injection of beef roasts with bromelin-degraded collagen improved palatability without significant changes to appearance and yield. Beef tendons can be upgraded through enzymatic hydrolysis and successfully utilized to inject beef cuts, adding value to both the raw materials and the finished product.

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