

A Research Note

Effects of Lactic Acid on Epimysial Connective Tissues of Muscles Used for Restructured Beef Steaks

ABSTRACT

Isolated strips of epimysium from beef forequarter muscles were treated with several acids and other chemicals to degrade the connective tissue. Lactic acid significantly reduced the shear force to penetrate the strips. Muscles were excised intact from beef clod, immersed in 0.5M lactic acid for 30 min at 23°C, diced and restructured into steaks. This significantly decreased the amount of connective tissue, shear force values in the restructured steaks, and water binding compared to steaks made from untrimmed muscles.

INTRODUCTION

RESTRUCTURED BEEF PRODUCTS made from forequarter muscles have unacceptable sensory properties unless the objectionable connective tissues are removed (Booren et al., 1981; Secrist, 1982; Berry et al., 1986a,b, 1987). Strange and Whiting (1990) demonstrated that the epimysium is a major contributor to these connective tissues. Recio et al. (1986) reported that thorough hand-trimming significantly improved sensory textural scores but would be expensive. Perimysial and endomysial collagens were not objectionable and perhaps even desirable (Strange and Whiting, 1990).

Marinades have traditionally been used by chefs to tenderize meats (Kijowski and Mast, 1986). Kotula and Heath (1986) reduced shear values of chicken meat by tumbling in 10% acetic acid.

Because a major source of the objectionable connective tissue is on the surface of the muscle, it may be possible to treat intact muscles with treatments which would be too severe for the interior of the muscle or for incorporation into the final product. The damaged or degraded exterior surface would be a small portion of the meat surface after dicing and the overall binding between meat pieces and product quality could be retained. The purpose of our study was to develop a feasible chemical method to degrade epimysial connective tissue for restructured steaks.

MATERIALS & METHODS

Epimysial strips

Epimysial connective tissue sheets were removed from five U.S. Choice beef chucks and scraped free of muscle tissue. Strips (50 × 8.5 mm) were cut by a punch with the fiber direction running the long dimension of the strip, vacuum packaged and stored frozen (-35°C).

Ten thawed epimysial strips per treatment were randomly selected, weighed, immersed in solutions of organic and inorganic acids, sodium hydroxide or urea for 15 min at 21–23°C and then thoroughly rinsed with tap water. The sodium citrate solution was titrated to pH 2.0 with hydrochloric acid. The strips were promptly tested on the Instron Universal Testing Machine for shear strength using the Lee-Kramer multiple blade shear cell with crosshead moving at 10 mm/min and full scale deflection of 250 kg. Strips were placed with their long direction across the shear blades. Peak shear forces were calculated as Newtons per gram.

Restructured steaks

Supraspinatus, Infraspinatus and Triceps brachii muscles were removed intact from a clod (#114 NAMF) and cut into pieces (typically about 300g each). Pieces were randomly assigned to: (1) untrimmed control, (2) trimmed control, or (3) treated with lactic acid. The trimmed control muscles had all epimysial connective tissue removed by hand. Steaks from these muscles would serve as a reference, to demonstrate the quality obtained by complete removal of the epimysium without adverse effects from any other treatments. Lactic acid treated muscles were immersed in 0.5M lactic acid for 30 min at 23°C and rinsed with tap water for 10 min. Untrimmed control and hand-trimmed control muscles were immersed in tap water. The total amount of muscle per treatment averaged 1.7 kg.

After treatment the muscles were hand-cut into 1.2 cm cubes, mixed in a Hobart mixer with 0.75% NaCl and 0.12% sodium tripolyphosphate for 2 min, stuffed into 5.5 cm cellulose casings, refrigerated (6°C) for 2–4 hr and frozen at -40°C. The product was partially thawed, cut into 2.5 cm thick steaks, vacuum packaged and refrozen (-40°C).

Two randomly selected steaks from each treatment/clod were ground through a 3/16 in (48 mm) plate. pH measurements were made in duplicate by directly inserting a combination electrode and temperature compensator (Corning) into the ground meat. A subsample was further pureed with a polytron (Brinkman) and the hydroxyproline measured in triplicate (Woessner, 1961). For shear force determinations, uncooked restructured steaks were thawed and kept chilled. They were cut in half, weighed, and sheared at 50 mm/min and 500 kg full scale deflection. The average weights were 30.6g and eight determinations were made per treatment. To determine cooking losses, five partially thawed steaks from each treatment were weighed, cooked on a Farberware grill with one turning to an internal temperature of 70°C (ca 30 min) and reweighed. The process was replicated with three lots of meat.

Statistical analyses

Data analyses were made using analyses of variance and Dunnett's test to compare a treatment to the control treatment or Duncan's multiple range test to differentiate between treatments (Steel and Torrie, 1960).

RESULTS & DISCUSSION

EPIMYSIAL STRIPS were used to survey potential chemical treatments. Immersion in mineral and organic acids for 15 min reduced the shear strength (Table 1). The acid-treated strips became translucent and swollen, even gelatinous with the lactic acid treatment. The control strips remained opaque and white with intact fibrous structure evident. Treatment with sodium hydroxide toughened the strips and urea caused some translucency but no significant change in shear strength.

A second series of lactic acid treatments showed that treatment with 0.10 or 0.25M lactic acid for 15 min significantly reduced the shear force values. The weights of these strips were less than in the first series (0.206g vs 0.264g, respectively) and may account for the greater degradation.

The lactic acid treatment significantly reduced hydroxyproline content and reduced the shear values of the restructured steaks (Table 2). The difference in shear forces between the untrimmed and extensively hand-trimmed treatments was 35

LACTIC ACID TREATMENT OF EPIMYSIUM. . .

Table 1—Shear force values for epimysial strips after various chemical treatments

Treatment	pH of treatment	Shear force ^a (kN/g)
Water—Control	--	3.6
0.5M Hydrochloric acid	0.3	3.2
0.5M Phosphoric acid	0.2	2.7
0.5M Acetic acid	1.6	2.9
0.5M Lactic acid	0.9	2.3*
0.15M Citrate acid	2.0	3.0
2M NaOH	12.8	5.3*
8M Urea	7.8	2.9
Water-control		3.6
0.01M Lactic acid		3.5
0.10M Lactic acid		2.0*
0.25M Lactic acid		1.0*

^a Values are the means of ten strips; those with an asterisk are significantly different from their control by Dunnett's test ($p < 0.05$).

Table 2—Properties of restructured steaks after treating the epimysium with lactic acid

	Untrimmed control	Trimmed control	Lactic acid
Hydroxyproline (mg/g)	1.89 ^b	0.78 ^a	0.99 ^a
Shear force (N/g)	96 ^c	61 ^a	80 ^b
pH	5.80 ^a	5.78 ^a	5.52 ^b
Cooking loss (%)	27.5 ^a	29.3 ^a	34.4 ^b

^{a-c} Values in a row with the same superscript are not significantly different by Duncan's multiple range test ($p < 0.05$).

N/g. Shear force value of the lactic acid treated sample was significantly reduced 16 N/g from that of the untrimmed steaks. The pH of the steaks made from lactic acid treated muscles was lowered and cooking losses increased. A decrease in binding of the raw product was visually observed although the steaks held together when thawed and after cooking. Buffered rinses to raise the pH or use of other binding agents may improve binding. In industrial product manufacture, use of larger pieces of meat would decrease the proportion affected

by acid. Muscle portions exposed to the lactic acid were discolored giving the steaks a mottled appearance. This mottling decreased during frozen storage and was not evident after cooking.

Further research is needed to find ways to improve effectiveness of the acid treatment and quality of the final product. Other agents or conditions for degrading surface connective tissues, such as enzymes or heat, are unsuitable to use on the entire muscle or incorporate into restructured products. However, such agents used on the epimysium may effectively improve texture of such restructured products.

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