

Project Summary

Acid Marination for Tenderness Enhancement of the Beef Round

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Background

It has long been known that acid marination enhances beef tenderness. Most meat scientists attribute a substantial portion of the tenderness improvement to solubilization of collagen (a pH effect). However, if that were the only explanation, tenderness improvement during acid marination would occur immediately and there would be no benefit or detriment to changing the length of marination. That is, it would be possible to treat a muscle with the appropriate acid marinade and the product could then make its way through the distribution system without concern for over-tenderization.

Acids have been shown to enhance tenderness, but little work has been documented on the recommendation of acid strength to optimize tenderness and the length of time which the muscle remains acceptable to consumers.

The objectives of this project were to:

1. Determine the time course of tenderness enhancement from acid marination;
2. Evaluate differences among different acids for beef tenderness; and
3. Assess the impact of acid strength (concentration) on tenderness enhancement.

Methodology

Seventy-two bottom round (*biceps femoris*) muscles were purchased and trimmed of excess fat. The medial portion of this muscle contains an ischiatic head that was removed close to the seam of connective tissue, leaving one continuous muscle from which to fabricate uniform one-inch steaks. A control steak was removed from the fabricated muscle prior to injection. No treatments were given to the control steak. Experiment 1 solutions were diluted to low (0.1M) and high (0.5M) concentrations for lactic acid, acetic acid and sodium citrate dihydrate (food grade citric acid), resulting in six treatments. In Experiment 2, solutions were diluted to low (0.75M) and high (1.5M) concentrations for lactic acid, acetic acid and sodium citrate dihydrate, resulting in six treatments.

Experiment 1 samples collected were control, one and eight hr(s) after injection, and one, three, seven, 14, 21 and 28 day(s) after injection. In Experiment 2, samples were only collected up to 14 days after injection. All steaks were packaged after eight hours and frozen at the times indicated following injection. Steaks were marinated up to 28 days in Experiment 1 and 14 days in Experiment 2. Each muscle was injected with an acid solution to 107% of the fresh weight in Experiment 1 and 110% of the fresh weight in Experiment 2. Ten muscles were injected for each of the six treatments of either low or high concentration in Experiment 1. Three muscles were injected with each acid type of the low concentration, while four muscles were injected with each acid type of the high concentration in Experiment 2. The enhanced muscles were bagged, clipped individually and tumbled for 30 minutes to disperse the acid solution.

A steak was cut one hour post-injection and the remaining muscles were cut into steaks at eight hours. All steaks were individually vacuum packaged and frozen at the times indicated. Color readings were collected on the control, one and eight hour(s) post-injection steaks. All steaks were allowed to bloom at least one hour prior to measuring L^* , a^* , b^* color values at a 10° degree hue.

Findings

Tenderness - Experiment 1

No significant differences were found for tenderness in Experiment 1. The low concentrations of acids used for marination were not sufficient to degrade the connective tissue present. An audible shearing noise was observed as the connective tissue was being sheared during WBSF analysis, possibly indicating a lack of degradation.

Tenderness - Experiment 2

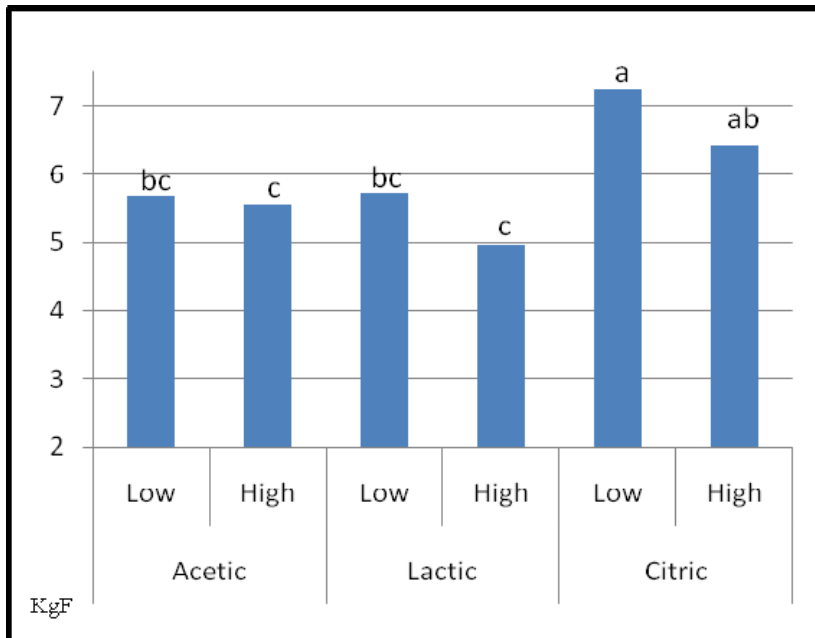
Lactic and acetic acids at low and high concentrations significantly ($P < 0.0001$) increased tenderness in Experiment 2 as compared to sodium citrate dehydrate, no matter the concentration (Figure 1). Overall, the treatments initially increased tenderness significantly ($P = 0.0008$) from control to one hour (Figure 2). A significant ($P = 0.04$) decrease in tenderness was observed from one hour to one day. Then, a significant ($P = 0.02$) increase in tenderness was observed from one to 14 days. Unlike in Experiment 1, there were no audible shearing noises observed as the cores were being sheared in Experiment 2. Sodium citrate dihydrate had little to no effect on tenderness; however, acetic and lactic acids at 0.75M to 1.5M had a positive effect on tenderness.

Color - Experiment 2

Product enhanced with acetic acid in high concentration had a significant effect on lightness causing the meat to become darker from zero to one hour and then greatly darker from one to eight hours. Product enhanced with citric and lactic acids in high concentration became significantly darker from zero to one hour, but did not become darker from one to eight hours. There were no differences in lightness from zero to eight hours for low concentration treatments. At the injection site of either acetic or lactic acids, the color of the meat was altered from red to dark gray. All discolorations were permanent. Product enhanced with acetic acid in high and low concentrations became significantly less red from zero to one hour and then again significantly less red from one to eight hours. Product enhanced with lactic acid in high and low concentrations became significantly less red from zero to one hour, but there were no differences from one to eight hours. Product enhanced with citric acid in high and low concentrations exhibited no differences in redness.

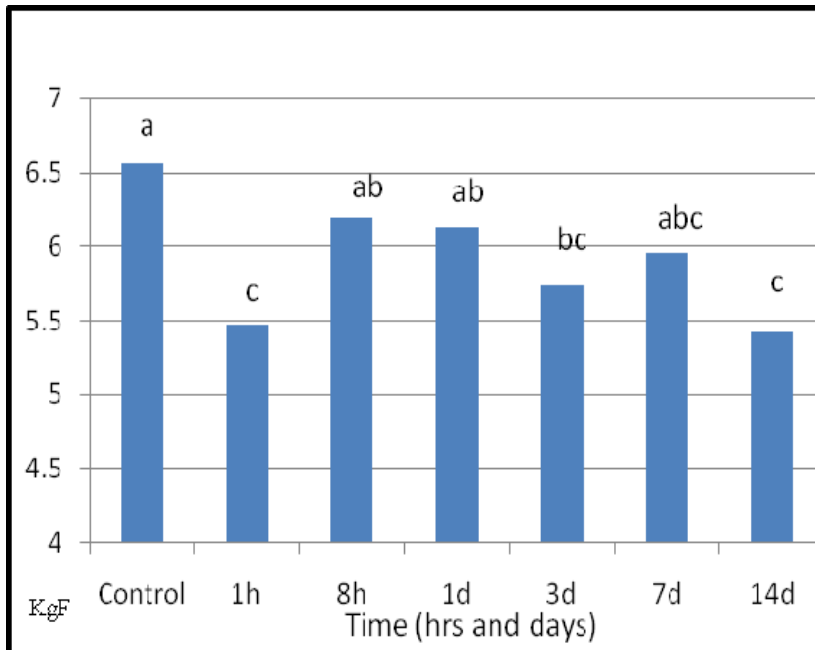
Implications

Acid marination could be used to marinate beef to increase tenderness during distribution. Beef marinated in lactic or acetic acid at either 0.75M or 1.5M for 14 days was not over tenderized, indicating both acids and concentrations are good for marination. Tenderness enhancement can be achieved using either acetic or lactic acid at 0.75 M; however, meat marinated with acid posed color acceptability issues. Steak discoloration remained unaltered over time.



^{a,b,c} Means in the columns having different superscripts are significant

Figure 1. Experiment 2 Treatments vs. WBSF



^{a,b,c} Means in the columns having different superscripts are significant

Figure 2. Experiment 2 Time vs. WBSF



Acid discoloration



Control Steaks

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