



PROJECT SUMMARY PRODUCT QUALITY

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Optimization and Commercial Implementation of Freeze/Age Process to Improve Beef Tenderness

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Background

Research from this laboratory has previously shown that the process of freezing, thawing, and then aging can improve tenderness of beef steaks from the Loin and Eye of Round. This effect was attributed to both the physical disruption of the muscle fibers by ice crystal formation and by increased post-mortem tenderization after freezing due to inactivation of calpastatin. Calpastatin is the inhibitor of the calpain enzyme which is responsible for tenderization during aging of meat. Freezing has been shown to decrease the inhibitory effects of calpastatin on calpains, thus allowing calpains to be more active upon thawing and enhancing the aging process. Although freezing and thawing can improve tenderness, the muscle fiber damage from ice crystals also releases more water from the tissue resulting in greater water losses during the aging and cooking processes.

Objective

The objective of this study was to evaluate the tenderness, water losses, and color stability of beef Strip Loins and Top Loin steaks in response to different methods of freezing/thawing/aging compared to aging in a fresh never-frozen state to identify parameters for commercial implementation of this process as a viable option to the beef industry.

Methods


Experiment 1. USDA Select carcasses (n = 60) derived from cattle that met USDA-Agriculture Marketing Service phenotypic requirements for Angus, that were not predicted tender by commercial VBG2000LED beef carcass grading camera were identified at a commercial beef packing plant. Untrimmed, boneless Strip Loins were collected and sorted into control or freeze/thaw/age (FRAGE) treatment. The FRAGE treatment Strip Loins were frozen in a blast freezer for 2 hours at -40°F. Frozen and Control Strip Loins were transported by refrigerated truck to the U.S. Meat Animal Research Center. Control Strip Loins were weighed and placed on aging racks at 33°F. FRAGE Strip Loins were thawed by storage in a combination of water and air over six hours. Thawed Strip Loins were placed on aging racks at 33°F. Paired Strip Loins from a given carcass (one Control and one FRAGE) were assigned randomly to either nine, 16, or 23 days post-mortem (DPM) aging.

Experiment 2. USDA Select carcasses (n = 20) derived from cattle that met USDA-AMS phenotypic requirements for Angus, that were not predicted tender by a VBG2000LED beef carcass grading camera were identified at a commercial beef packing plant. Untrimmed, boneless Strip Loins from both sides were collected and vacuum-packaged and transported by refrigerated truck at 30°F to the U.S. Meat Animal Research Center. Alternating sides from each carcass were assigned to either Control or FRAGE. The Control Strip Loins were weighed and placed on aging racks at 33°F. The FRAGE treatment Strip Loins were frozen in dry ice (-109.3°F) for six hours then held overnight at -5°F. FRAGE Strip Loins were thawed in large gondolas full of circulating 57°F water for six hours then placed on aging racks at 33°F. All Strip Loins were aged for 14 days after FRAGE Strip Loins were thawed.

Measurements. After Strip Loins were aged for the appropriate time, they were unpackaged and weighed for purge loss and then cut into one-inch thick steaks and assigned to slice shear force evaluation, color evaluation, or simulated retail display at four times. Display steaks were weighed after cutting and after the designated display time to determine purge loss as a steak in a retail package.

Steaks were cooked to a medium degree of doneness and slice shear force (SSF) evaluation was conducted as the measure of tenderness.

To simulate retail display, steaks were packaged on trays with typical overwrap film. Steaks were subjected to continuous fluorescent lighting in a refrigerated room and instrumental color readings were taken on each steak on day zero, one, four, seven, and 11 days.



Findings

In Experiment 1, steaks from FRAGE Strip Loins were more tender than steaks from the control group regardless of post-mortem aging. Post-mortem aging also reduced SSF values regardless of freezing treatment. The FRAGE treatment increased purge by an average of 1.73% across all aging periods compared to control Strip Loins, as control Strip Loins averaged 0.79% purge loss compared to 2.52% for FRAGE Strip Loins. Steaks in the simulated retail display had increased purge as display time increased. FRAGE steaks purged almost twice as much during display as control steaks. Color deterioration was greater in FRAGE steaks than control steaks during simulated retail display.

The project goal was to apply rapid freezing to minimize ice crystal formation/damage (two hours at -40°F). In retrospect, the attempt to minimize freezing time may have resulted in a freezing end point that fell short of complete freezing throughout the Strip Loin that resulted in significant ice crystal damage and excessive purge losses in the thawed Strip Loins and the subsequent steaks during display. Experiment 2 addressed this shortcoming by utilizing dry ice freezing and thawing in circulating water. This freezing/thawing process from Experiment 2 also significantly improved tenderness (12.8 vs 16.0 kg SSF) and greatly reduced the amount of purge losses relative to Experiment 1 (1.6 vs 0.6%); however, color stability during display was still problematic.

The results indicate that the combination freezing, thawing, and aging of beef subprimals improved tenderness by approximately 10-15% compared to fresh, never frozen counterparts with the same DPM aging. However, the negative effects of this tenderization approach were slightly increased purge loss in both intact subprimals as well as the steaks compared to fresh, never frozen steaks and more rapid deterioration of color during display.

Industry Impact

Despite identifying freeze/thawing parameters that gave significant improvements in tenderness and minimized purge losses to a reasonable level, color stability reduction will likely limit the application of this process for product destined for retail display. It might be a viable option for wholesale club distribution of whole subprimals. However, the most useful application of freezing to improve tenderness might be the foodservice segment where fresh shelf-life and color stability do not play a large role. Many companies already practice seasonal price fluctuation management by buying during lower cost time periods and freezing product to use during higher cost periods. Further investigation is warranted to determine how this process could be used to improve tenderness in the foodservice segment of the industry.

Graphs/Charts

Table 1. Trial 2 meat characteristics of Control and FRAGE.

Trait	Control	FRAGE
Slice shear force, kg	16.0 ^a	12.8 ^b
Strip loin purge, %	0.6 ^b	1.6 ^a
Cooking losses, %	16.6 ^b	17.5 ^a
Steak Purge, %		
1 d	0.9 ^b	1.5 ^a
4 d	2.0 ^b	3.5 ^a
7 d	2.6 ^b	4.1 ^a
11 d	2.9 ^b	4.5 ^a

Photos



Figure 1. Strip Loins thawing in water.



Figure 2. Steaks in simulated retail display.