Project Title: Do market-driven storage conditions (fresh versus frozen) of subprimals and steaks impact beef tenderness and consumer acceptability?

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Background

Purchasing decisions across all sectors of the beef industry can often be correlated to market signals and/or pressures. The cause of changing marketing conditions is sometimes predictable (drought, other agricultural impacts, global shifts in consumer trends, seasonality and holidays, etc.), while other shifts in price and available inventory may be less understood or expected. A response from purveyors, retailers, and/or foodservice operators to these changing market conditions would be to purchase reasonably priced subprimals in a higher quantity than needed and store them for subsequent use. Therefore, a better understanding of the impact of various storage conditions on tenderness, color, and consumer acceptance will aid decision making for storage strategies, inventory management, and balancing changing marketing conditions to achieve optimal consumer acceptance. While studies have examined effects of storage temperature on tenderness, a cohesive effort to evaluate the compound effect of subprimal and steak storage conditions on consumer acceptance and quality attributes was not addressed. Therefore, this study was designed to determine if various combinations of fresh and frozen storage of subprimals and steaks impact product tenderness, color, purge, and overall consumer acceptability. The objective of this study was to determine if tenderness and consumer acceptability of beef steaks are influenced by storage conditions (fresh versus frozen).

Methodology

USDA Choice boneless ribeye rolls (n = 40) and top sirloin butts (n = 40) were vacuum packaged, aged under refrigeration for 21 days, and then assigned to one of four treatment groups: Treatment 1 both subprimals and steaks were frozen and thawed; Treatment 2 subprimals were frozen and thawed, but steaks were not frozen; Treatment 3 subprimals were not frozen, but steaks were frozen and thawed; and Treatment 4 subprimals and steaks were never frozen. For all treatments, purge was quantified for both subprimals and steaks.

Subprimals were trimmed and cut into steaks following normal industry practices. Upon completion of steak cutting for all treatments, steaks (n = 160 ribeyes and 160 top sirloins) were assigned to consumer sensory panels or Warner-Bratzler shear (WBS) force and stored under refrigeration for no longer than 7 days.

On the day of assessment, objective color measurements were conducted on all steaks after a 30 min bloom time. Then, steaks were cooked on one of two Star International commercial flat-top grills to a final internal temperature of 70 °C. In-package weight, raw out-ofpackage weight, initial internal steak temperature, grill temperature, time on, final internal temperature, time off, and final cooked weight were collected for every steak. Cooked yield and total cook time were calculated. Cooked steaks assigned for WBS force

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evaluation were placed onto plastic trays in a single layer, covered with plastic film, and stored at 2 to 4 °C for approximately 12 to 16 h. Steaks assigned to consumer panels were held in an Alto-Shaam oven set at 60 °C (Alto-Shaam Inc., Menomnee Falls, WI) for no more than 20 min before serving. One steak from each subprimal was used for WBS force evaluation, (n = 40 steaks, per subprimal type). Cooked and chilled steaks (n = 80, total) were allowed to equilibrate to room temperature (approximately 1.5 h) then trimmed of visible connective tissue to expose muscle fiber orientation. From each steak, at least six 1.3-cm cores were removed from the M. longissimus thoracsis and M. gluteus medius parallel to the muscle fibers using a hand-held coring device. Cores were removed to avoid excess fat or connective tissue and were sheared once, perpendicular to the muscle fibers, on a TMS-Pro Texture Analyzer.

Consumer sensory panel steaks (n = 160) were cooked as described previously, cut into cuboidal portions and served warm to panelists seated in individually partitioned spaces with red lighting to prevent panelist bias for degree of doneness. Consumer sensory panels were completed in four sessions and designed to have five groups of four panelists per session. Each panelist assessed eight samples (one from each treatment and steak type combination), and each sample was evaluated by four panelists. Panelists (n = 80) evaluated samples using 9-point scales (1 = dislike extremely; 9 = like extremely) for overall liking, flavor liking, tenderness liking, and juiciness liking.

Findings

Treatment 1 ribeye steaks had the highest numerical mean WBS force value, which differed from Treatments 3 and 4 (P = 0.0040; Table 1); this trend was not reflected by consumers' tenderness liking scores (Table 2). These data indicate that consumer acceptability of ribeye steaks was not impacted by storage treatment. WBS values for top sirloin steaks were similar among treatments; however, storage treatment did impact yield, color, and consumer score data, especially for frozen and thawed steaks that were cut from previously frozen and thawed subprimals (Treatment 1). Therefore, to optimize yield and color of top sirloins without impacting consumer acceptability, we recommend the use of fresh top sirloin subprimals; however, flexibility in steak handling (fresh or frozen) can be utilized without negatively impacting yield or palatability.

Implications

With market conditions having the potential to fluctuate, findings from this study can be utilized to develop best practices for product handling and storage conditions to optimize time, space, and financial considerations without adverse effects on tenderness or consumer acceptability.

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Tables/Figures

Table 1. Least squares means of Warner-Bratzler Shear force values (N) for ribeye and top sirloin steaks stratified by subprimal type and storage treatment [a].

	Ribeye Steaks		Top Sirloin Steaks	
Treatment	*n*	Mean (N)	*n*	Mean (N)
1	10	28.09[a]	10	23.57
2	10	25.28[ab]	10	25.52
3	10	22.31[bc]	10	24.75
4	10	20.68[c]	10	24.98
SEM		1.425		1.484
P-value		0.0040		0.8188

Means within subprimal type lacking common superscript letters differ (P < 0.05).

[a] Treatment: Treatment 1 ("frozen/frozen") subprimals were frozen (approximately -28.9 °C) for 30 days, thawed for seven days under refrigerated conditions (approximately -1.1 °C), portioned into steaks, and steaks were placed in frozen storage (approximately -15.2 °C) for 30 days. After 30 days in frozen storage, steaks were thawed for two days under refrigerated conditions (approximately -1.1 °C) and were evaluated within seven days of thaw, totaling no more than 98 days of storage. Treatment 2 ("frozen/fresh") subprimals were frozen (approximately -28.9 °C) for 30 days, thawed for 7 days under refrigerated conditions (approximately -1.1 °C), portioned into steaks, and were evaluated within 7 days of cutting, totaling no more than 65 days of storage. Treatment 3 ("fresh/frozen") subprimals were portioned into steaks, and steaks were frozen (approximately -28.9 °C) for 30 days. Then, steaks were thawed for two days under refrigerated conditions (approximately -1.1 °C) and were evaluated within seven days of thaw, totaling no more than 65 days of storage. Treatment 4 ("fresh/fresh") subprimals were portioned into steaks and steaks were evaluated within 7 days of cutting, totaling no more than 28 days of storage.

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Table 2. Least squares means of consumer panelists' scores for attributes of ribeye and top sirloin steaks stratified by treatment[a].

	n	Overall Liking	*Flavor Liking*	*Tenderness Liking*	Juiciness Liking
Ribeye Steaks					
Treatment 1	10	6.10	6.25	5.71	5.85
Treatment 2	10	5.90	6.30	5.41	5.14
Treatment 3	10	6.89	6.86	6.58	6.14
Treatment 4	10	6.73	6.46	6.64	6.44
SEM		0.29	0.23	0.39	0.37
P-value		0.0579	0.2396	0.0715	0.0915
Top Sirloin Steaks					
Treatment 1	10	5.16[b]	5.48[b]	4.86[b]	4.55[b]
Treatment 2	10	6.26[a]	6.40[a]	6.19[a]	5.90[a]
Treatment 3	10	5.99[a]	6.21[a]	5.66[ab]	6.03[a]
Treatment 4	10	6.19[a]	6.14[a]	5.68[ab]	6.01[a]
SEM		0.22	0.22	0.30	0.28
P-value		0.0039	0.0259	0.0307	0.0010

Means within subprimal type lacking common superscript letters differ ($P < 0.05$).

[a] Treatment: Treatment 1 ("frozen/frozen") subprimals were frozen (approximately -28.9 °C) for 30 days, thawed for seven days under refrigerated conditions (approximately -1.1 °C), portioned into steaks, and steaks were placed in frozen storage (approximately -15.2 °C) for 30 days. After 30 days in frozen storage, steaks were thawed for two days under refrigerated conditions (approximately -1.1 °C) and were evaluated within seven days of thaw, totaling no more than 98 days of storage. Treatment 2 ("frozen/fresh") subprimals were frozen (approximately -28.9 °C) for 30 days, thawed for 7 days under refrigerated conditions (approximately -1.1 °C), portioned into steaks, and were evaluated within 7 days of cutting, totaling no more than 65 days of storage. Treatment 3 ("fresh/frozen") subprimals were portioned into steaks, and steaks were frozen (approximately -28.9 °C) for 30 days. Then, steaks were thawed for two days under refrigerated conditions (approximately -1.1 °C) and were evaluated within seven days of thaw, totaling no more than 65 days of storage. Treatment 4 ("fresh/fresh") subprimals were portioned into steaks and steaks were evaluated within 7 days of cutting, totaling no more than 28 days of storage.

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