



**PROJECT SUMMARY**  
PRODUCT QUALITY

**BEEF**  
RESEARCH

Grilling Temperature Effects on Tenderness and Juiciness of Ribeye,  
Top Loin and Sirloin Steaks

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# Grilling Temperature Effects on Tenderness and Juiciness of Ribeye, Top Loin and Sirloin Steaks:

## Project Summary

### Background

Consumers are effectively able to distinguish tenderness without any prior information, so guaranteeing tenderness of a steak would be advantageous to the beef industry. Accordingly, tenderness has risen as a concern for consumer acceptance of steaks, and the pursuit of a guaranteed tender product has become an objective for the beef industry. Time of exposure to the grill can impact flavor development and tenderness as it pertains to degree of doneness. However, the impact of the grill surface temperature on consumer perception of tenderness has not been investigated. Research has determined steaks cooked to the same degree of doneness at increasing grilling temperatures had increased steak surface temperature at time of flip and end point. With these greater steak surface temperatures, a crust can form and change the transfer of heat and energy via water exchange. We have found the tenderness and juiciness of steaks of greater thicknesses grilled at greater surface temperatures to be liked less than those grilled at lesser surface temperatures.

### Objective

The objective of the present study was to examine the impact of grill surface temperature on the consumer perception of tenderness and juiciness. The hypothesis of this study was steaks grilled at greater surface temperatures would be tougher than those grilled at lower grill surface temperatures and would yield greater volatile compounds from the Maillard reaction.

### Methods

USDA Choice boneless ribeye rolls, boneless strip loins, and boneless top sirloin butts were purchased from a local meat supplier in Bryan, TX. The vacuum-packaged subprimals were aged 21 d post-processing date at refrigeration temperature (38°F) before being hand-cut into 1 inch-thick steaks. Steaks were cooked on a flat top grill set at 350, 400, or 450°F within a range of  $\pm 5^\circ\text{F}$  for each treatment. Steaks were turned at an internal temperature of 90°F and removed at 160°F. Panelists were trained to scale each attribute on a 16-point intensity scale (0 = none and 15 = extremely intense). Extra representative cubes from each sample, excluding the edges, were wrapped in aluminum foil, quick frozen in liquid nitrogen, and stored at -80° F for GC/MS analysis. Consumer testing was conducted in a series of four sessions with 80 consumers. Panelists were prompted to rate their opinion of each of the samples on a 9-point hedonic scale for overall juiciness, flavor, tenderness, and appearance liking. Up to six cores, ½ inch in diameter, were sheared once, perpendicular to the muscle fibers. The frozen extra cubes (1/2 inch x 1/2 inch x steak thickness) from the trained panel were weighed and placed in a 1 pint glass jar with a Teflon lid to be placed in a water bath held at 160°F, for gas chromatography (GC) analyses of volatile aroma compounds.

### Important Findings

The ribeye, strip loin, and top sirloin steaks were given similar trained sensory panel scores for bloody/serumy, fat-like, green-haylike, salty, sour aromatics, green, and overall tenderness. Burnt tended to be greater for the strip loin steaks compared to ribeye and top sirloin steaks. Bitter tended to be greater for top sirloin steaks than strip loin and ribeye steaks. Beef identification was highest for strip loin steaks, followed by ribeye steaks, and lowest for top sirloin steaks (11.0, 10.7, and 10.3, respectively). Brown/roasted was greater for ribeye and strip loin steaks than top sirloin steaks. Metallic, liver-like, and sour flavors were higher for top sirloin steaks than ribeye and strip loin steaks. Scores for umami, overall sweet, and sweet attributes were higher for ribeye and strip loin steaks than top sirloin steaks. Strip loin steaks were juicier than ribeye and top sirloin steaks (10.8, 10.5, and 10.3, respectively). The strip loin steaks tended to cook for the longest total time but did not differ in cook yield. Juiciness scores were higher for steaks grilled at 450°F than 400°F. However, no differences were detected in steaks grilled at three different surface temperatures in muscle fiber tenderness, connective tissue amount, and overall tenderness. These results were not expected. The steaks were very tender to begin with due to being aged 21 d post-processing.

Grill surface treatment had no effect on peak shear force. Greater grill surface temperatures yield a greater crust development and drier surface. The average peak shear force ranged from 5.98 to 6.14 lb. for the grill surface temperature, which are similar to the national average for shear force across meat cuts. These measurements were lower than the minimum tenderness threshold value by more than 2.2 lb. shear force and would thereby qualify the meat products for the “certified very tender” labeling.

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Consumers liking did not differ for appearance, tenderness, juiciness, flavor, and overall liking by steak type. In fact, average hedonic scores for liking numerically ranged by no more than 0.2 points for each attribute. Consumer scores for appearance, tenderness, juiciness, flavor, or overall liking also did not differ with grill surface temperature treatments.

Volatile compounds were classified by their major functional groups and included seven alcohols, 26 aldehydes, four alkanes, two furans, five ketones, 11 pyrazines, two pyrroles, five sulfur-containing compounds, and three other compounds. While 65 volatile compounds were identified during an aroma event, grilling surface temperature impacted pyrazines, produced by the Maillard reaction of an amino acid and sugar compound, to the greatest degree. The degradation of lipid is most responsible for the generation of hydrocarbons, alcohols, aldehydes and ketones, which differences were more influenced by steak type rather than grilling surface temperature.

## Industry Impact

Ribeye, strip loin and top sirloin steaks were grilled on a surface temperature of 350, 400, or 450°F. Consumer sensory panel, trained sensory panel, Warner-Bratzler shear force, and GC/MS-O were performed in order to investigate whether steaks grilled at higher temperatures yielded a tougher steak and to define differences in the Maillard reaction compounds produced. Grill surface temperature did not impact the tenderness of ribeye, strip loin, or top sirloin steaks aged 21 d post-processing. Consumers' liking scores did not differ amongst steaks grilled at a particular grill surface temperature. However, grill surface temperature did change the flavor and corresponding volatile compounds of steaks. With increasing grill surface temperature, the production of pyrazines increased; therefore, greater grill surface temperatures yielded greater Maillard reaction products. Although a consumer preference for grill surface temperature was not detected in this study, consumers still had a preference for how their steaks were prepared. A difference in grill surface temperature generated different flavor attributes in steaks, which should be investigated further to determine the optimal grilling temperature for favorable flavor production when steak tenderness is below the tenderness threshold. Additionally, grill surface temperature may have an impact on the tenderness of steaks aged less than 21 d post-processing.



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