

# Beef Customer Satisfaction: Cooking Method and Degree of Doneness Effects on the Top Sirloin Steak<sup>1</sup>

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**ABSTRACT:** The objective of this research was to evaluate the consumer-controlled factors of cooking method and degree of doneness on Top Choice, Low Choice, High Select, and Low Select top sirloin steaks. The in-home product test was conducted in Chicago, Houston, Philadelphia, and San Francisco. Consumers ( $n = 2,212$ ) evaluated each top sirloin steak for overall like (OLIKE), tenderness (TEND), juiciness (JUIC), flavor desirability (DFLAV), and flavor intensity (IFLAV) using 23-point hedonic scales. Top sirloin steaks, regardless of city, were consistently cooked to well done or higher degrees of doneness. Dry-heat methods such as outdoor grilling, broiling, and indoor grilling were the most frequent cooking methods used. Four significant interactions existed for OLIKE: USDA quality grade  $\times$  cooking method ( $P = .02$ ), city  $\times$  cooking method ( $P = .0001$ ), city  $\times$  degree of doneness ( $P = .01$ ), and cooking method  $\times$  degree of doneness ( $P = .009$ ). Greater differences were found

between cooking methods within USDA quality grade than between USDA quality grades within cooking method. Consumers in Houston rated steaks cooked by outdoor grilling higher than those from the other cities, and steaks cooked by indoor grilling were rated the highest among all cooking methods by consumers in Chicago. In Chicago, steaks cooked to more advanced degrees of doneness tended to receive higher ratings, but few differences between degrees of doneness in the other three cities were detected. For outdoor grilling, broiling, and pan-frying, the trend was for OLIKE ratings to decline as degree of doneness increased. The lowest customer satisfaction ratings tended to be given to top sirloin steaks cooked to more advanced degrees of doneness, and consumers most frequently cooked steaks to at least the well done stage. Consumer information programs or the development of postmortem techniques that would ensure acceptable palatability of top sirloin steaks may need to be developed.

Key Words: Beef, Market Research, Meat Grades, Consumer Preferences

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## Introduction

Of the three beef cuts evaluated in the Beef Customer Satisfaction project, top sirloin steaks ranked intermediate to top loin and top round in overall ratings (Neely et al., 1998). Previous research has reported top sirloin steaks to be less tender and more variable than top loin steaks (Morgan et al., 1991; Harris et al., 1992). Variation in the tenderness

of top sirloin has been attributed to the connective tissue in this cut (Harris et al., 1992). Despite the tenderness variability problems with the top sirloin steak, it remains a popular item in the retail counter and on the menu because it is often more affordable than ribeye, top loin, or tenderloin steaks.

This article, which focuses on the palatability of top sirloin steak, is the second in a series dealing with in-home cooking methods and degree of doneness used by

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beef consumers in four cities. These consumer-controlled factors were evaluated in combination with city and USDA quality grade.

## Materials and Methods

This study is an extension of the Beef Customer Satisfaction Study; carcass selection, steak processing, and consumer recruitment followed procedures described by Neely et al. (1998). Briefly, Top Choice, Low Choice, High Select, and Low Select carcasses ( $n = 150$  each) were selected from three packing facilities in Colorado, Texas, and Nebraska, and the strip loin, top sirloin, and top (inside) round subprimals from each side were obtained. Steaks from each subprimal were cut, packaged, frozen, and shipped to consumer households ( $n = 300$  in each city) in Houston, Chicago, Philadelphia, and San Francisco. Each household had two respondents who evaluated steaks, for a total of 600 consumers in each city and 2,400 consumers in the study (2,212 consumers completed the study).

### *In-Home Product Test*

Only consumer responses for top sirloin steaks are discussed. Respondents (two per household) were asked to prepare the steaks as they would when buying the same cuts in the supermarket; no instructions were given for beef preparation. The preparer was asked how the beef was cooked and was given choices among different dry heat (outdoor grill, indoor grill, broil, oven-roast uncovered, pan-broil, pan-fry, and stir-fry), moist heat (braise and simmer and stew), and other (deep-fry) methods (National Live Stock and Meat Board, 1992).

Consumers evaluated each top sirloin steak for overall like (**OLIKE**), tenderness (**TEND**), juiciness (**JUIC**), flavor desirability (**DFLAV**), and flavor intensity (**IFLAV**) using 23-point hedonic scales (23 = like extremely, extremely tender, extremely juicy, like extremely, and an extreme amount of flavor; 1 = dislike extremely, not at all tender, not at all juicy, dislike extremely, and no flavor at all). Sample unadjusted main effect means and standard deviations for OLIKE, TEND, JUIC, DFLAV, and IFLAV by USDA quality grade, city, degree of doneness, and cooking methods are presented in Table 1. Each respondent completed separate evaluation forms and was instructed to complete the evaluation form immediately following the meal. Each evaluation form also included a question relative to the degree of doneness of the steaks at the time of consumption. Participants used the National Live Stock and Meat Board beef steak color guide as an aid and responded to this question by making one of the following choices: very rare, rare, medium rare, medium, medium well, well done, or very well done. The

questionnaire completed by the primary preparer/shopper included an additional sheet of preparation information using standardized preparation definitions (National Live Stock and Meat Board, 1992).

### *Data Analysis*

The statistical model for consumer satisfaction ratings included main effects of city, USDA quality grade, degree of doneness, and cooking method and their two-way interactions. In addition, steak location nested within cut, week nested within city, and animal nested within USDA quality grade and packing facility were included in the model.

Statistical analyses were performed using SAS (1991). For all data, Box-Cox transformations (Neter et al., 1989) were used to produce normally distributed errors. Least squares means were generated and tested for significance ( $P < .05$ ) using Bonferoni's procedure (Lentner and Bishop, 1993). Dependent variables were tested for significance by ANOVA using the GLM procedure of SAS (1991). Only significant terms ( $P < .05$ ) were retained in the model. Frequency distributions were generated for degree of doneness and cookery method within city for top sirloin steaks.

## Results

Frequency distributions of degree of doneness and cookery method by city are presented in Figures 1 and 2. Because not all cooking methods and degrees of doneness were used frequently, some categories were combined. "Other" cookery methods included oven-roasted uncovered, pan-broil, braise, and deep-fry. Consumers in all cities most frequently cooked the steaks well done or to a higher degree of doneness (Figure 1). However, medium degree of doneness was used more often than medium rare or less or medium well degrees of doneness. Consumers in Houston tended to cook steaks to more advanced degrees of doneness, and consumers in San Francisco tended to cook steaks to less advanced degrees of doneness. For all cities, outdoor grilling was the most popular cooking method, followed by broiling and pan-frying (Figure 2).

### *Consumer Overall Like Ratings*

Four significant interactions existed for OLIKE: cooking method  $\times$  degree of doneness ( $P = .009$ ), city  $\times$  cooking method ( $P = .0001$ ), USDA quality grade  $\times$  cooking method ( $P = .02$ ), and city  $\times$  degree of doneness ( $P = .01$ ). For outdoor grilling and pan-frying, the trend was for OLIKE ratings to decline as degree of doneness increased (Table 2). For indoor grilling, broiling, and simmer and stewing, degree of doneness did not affect OLIKE ratings. For stir-frying,

OLIKE ratings increased with increased degree of doneness.

City × cooking method effects on OLIKE ratings are given in Table 3. In Chicago, top sirloin steaks cooked by indoor grilling and other methods were rated considerably higher than those cooked by other methods. In Houston, steaks cooked by pan-frying, outdoor grilling, indoor grilling, simmer and stewing, and other methods were rated the highest. Those

cooked by stir-frying were rated the lowest. In Philadelphia, few differences were found among cooking methods. However, the trend was for indoor and outdoor grilling to result in the highest ratings, and stir-frying resulted in the lowest. In San Francisco, indoor grilling produced higher ratings than broiling, and the other methods produced intermediate ratings.

No significant USDA quality grade effects were found for steaks cooked by outdoor grilling, broiling, or

Table 1. Consumer rating means (standard deviations) within USDA quality grade, city, degree of doneness, and cooking method

	Consumer rating <sup>a</sup>				
	OLIKE	TEND	JUIC	DFLAV	IFLAV
USDA quality grade					
Top Choice	17.4 (4.2)	17.3 (4.4)	17.1 (4.5)	17.8 (4.2)	17.9 (4.0)
Low Choice	17.4 (4.3)	17.2 (4.5)	17.0 (4.6)	17.7 (4.4)	17.8 (4.1)
High Select	17.2 (4.4)	16.9 (4.7)	16.6 (4.8)	17.4 (4.5)	17.5 (4.4)
Low Select	17.4 (4.3)	17.0 (4.7)	16.8 (4.8)	17.6 (4.3)	17.7 (4.2)
City					
Chicago	17.2 (4.4)	17.0 (4.7)	16.8 (4.8)	17.5 (4.5)	17.6 (4.3)
Houston	18.3 (3.8)	18.0 (4.1)	17.6 (4.4)	18.5 (3.9)	18.5 (3.8)
Philadelphia	17.1 (4.4)	16.9 (4.6)	16.8 (4.6)	17.5 (4.3)	17.6 (4.2)
San Francisco	16.9 (4.4)	16.7 (4.7)	16.3 (4.7)	17.2 (4.6)	17.3 (4.3)
Degree of doneness					
Medium rare or less	17.7 (4.2)	17.5 (4.3)	18.0 (4.0)	18.0 (4.2)	18.0 (4.0)
Medium	17.3 (4.4)	17.1 (4.5)	17.2 (4.3)	17.5 (4.4)	17.6 (4.3)
Medium well	17.1 (4.3)	16.9 (4.5)	16.5 (4.5)	17.3 (4.4)	17.5 (4.1)
Well done or more	17.3 (4.4)	17.0 (4.3)	16.0 (5.2)	17.7 (4.4)	17.8 (4.3)
Cooking method					
Outdoor grill	17.4 (4.3)	17.1 (4.6)	17.0 (4.5)	17.7 (4.3)	17.8 (4.1)
Broil	16.8 (4.6)	16.5 (4.8)	16.4 (4.9)	17.0 (4.7)	17.2 (4.5)
Indoor grill	18.3 (4.1)	17.8 (4.4)	17.7 (4.5)	18.6 (4.2)	18.5 (4.1)
Pan-fry	17.4 (4.2)	17.0 (4.6)	16.7 (4.9)	17.7 (4.2)	17.7 (4.2)
Stir-fry	17.3 (4.2)	17.2 (4.4)	16.6 (4.7)	17.5 (4.3)	17.5 (4.2)
Simmer and stew	17.4 (4.3)	17.8 (4.4)	16.4 (4.9)	17.9 (4.1)	17.8 (4.1)
Other <sup>b</sup>	18.0 (3.9)	17.9 (4.1)	17.3 (4.5)	18.4 (3.9)	18.5 (3.7)

<sup>a</sup>OLIKE = overall like, TEND = tenderness, JUIC = juiciness, DFLAV = flavor desirability, and IFLAV = flavor intensity. Consumers used a 23-point hedonic scale: 23 = like extremely, extremely tender, extremely juicy, like extremely, and an extreme amount of flavor; 1 = dislike extremely, not at all tender, not at all juicy, dislike extremely, and no flavor at all.

<sup>b</sup>Other cooking methods included oven-roasted uncovered, pan-broil, braise, and deep-fry. These cooking methods were used infrequently by the consumers in this study.

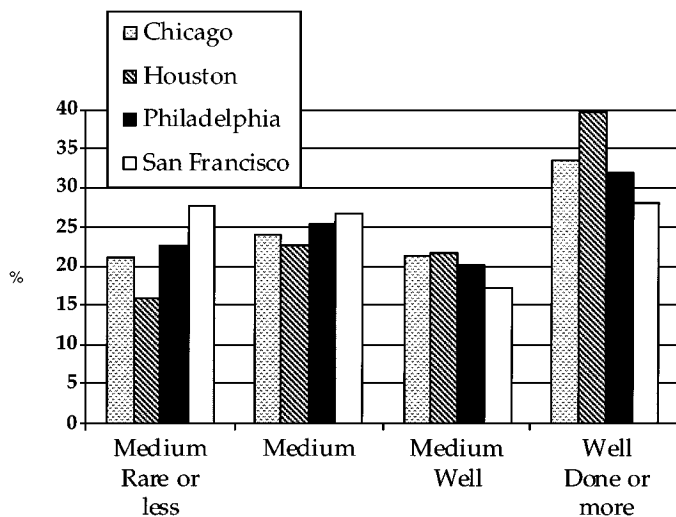


Figure 1. Degree of doneness frequency distributions for beef top sirloin steaks stratified by city.

pan-frying (Table 4). Top Choice top sirloin steaks cooked by indoor grilling received the highest ratings, and Low Select steaks cooked by stir-frying were among the lowest rated.

Degree of doneness  $\times$  city effects for OLIVE are presented in Table 5. In Chicago, steaks cooked to more advanced degrees of doneness tended to receive higher ratings. In Houston and San Francisco, OLIVE ratings were not influenced by degree of doneness. In Philadelphia, the trend was for higher ratings to be given to steaks cooked medium rare or less or well done or more; steaks cooked medium or medium well were rated intermediate.

### Consumer Tenderness Ratings

High Select steaks were rated as less tender ( $P < .05$ ) than Low Choice and Top Choice steaks (Table 6). However, Low Select steaks did not differ ( $P >$

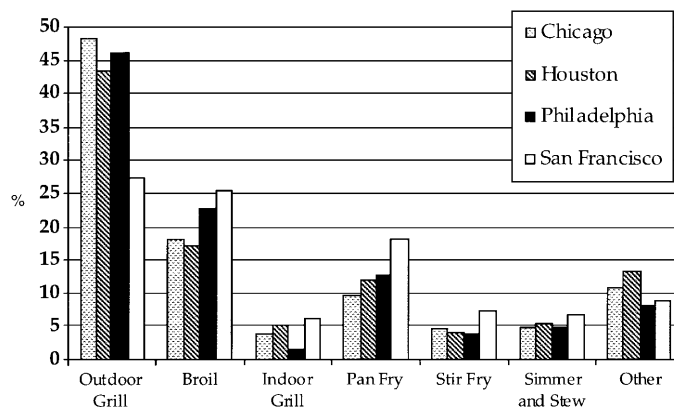


Figure 2. Cooking method frequency distributions for beef top sirloin steaks stratified by city. Other cooking methods included oven-roasted uncovered, pan-broil, braise, and deep fry. These methods were used infrequently by the consumers in this study.

.05) from High Select or Low Choice and Top Choice steaks for TEND ratings. There was a city effect on TEND ratings (Table 7); consumers in Houston rated top sirloin steaks to be the most tender, followed by consumers in Chicago, Philadelphia, and San Francisco ( $P < .05$ ).

Only one interaction was significant for TEND ratings: cooking method  $\times$  degree of doneness ( $P = .002$ , Table 8). For outdoor grilling, broiling, and pan-frying, TEND ratings were higher at lower degrees of doneness ( $P < .05$ ). For top sirloin steaks that were simmered and stewed, TEND ratings increased with increased degree of doneness ( $P < .05$ ).

### Consumer Juiciness Ratings

Three interactions were found for JUIC ratings: USDA quality grade  $\times$  cooking method ( $P = .002$ ), city  $\times$  cooking method ( $P = .002$ ), and cooking method  $\times$

Table 2. Least squares means for cooking method  $\times$  degree of doneness effect on overall like ratings (23 = like extremely; 1 = dislike extremely)

Cooking method	Degree of doneness			
	Medium rare or less	Medium	Medium well	Well done or more
Outdoor grill	18.4 <sup>abc</sup>	18.1 <sup>cd</sup>	17.9 <sup>cd</sup>	17.7 <sup>de</sup>
Broil	18.1 <sup>bcd</sup>	17.6 <sup>de</sup>	17.1 <sup>de</sup>	17.3 <sup>de</sup>
Indoor grill	19.0 <sup>a</sup>	18.2 <sup>abcd</sup>	18.7 <sup>abc</sup>	19.1 <sup>ab</sup>
Pan-fry	18.4 <sup>abc</sup>	18.2 <sup>abcd</sup>	17.7 <sup>cd</sup>	17.8 <sup>cd</sup>
Stir-fry	15.7 <sup>e</sup>	17.3 <sup>de</sup>	17.9 <sup>cd</sup>	18.4 <sup>abc</sup>
Simmer and stew	17.0 <sup>de</sup>	18.3 <sup>abcd</sup>	17.6 <sup>de</sup>	18.0 <sup>bcd</sup>
Other <sup>f</sup>	18.9 <sup>ab</sup>	17.7 <sup>cde</sup>	18.3 <sup>abcd</sup>	18.5 <sup>abc</sup>

a,b,c,d,e Means lacking a common superscript letter differ ( $P < .05$ ).

<sup>f</sup>Other cooking methods included oven-roasted uncovered, pan-broil, braise, and deep-fry. These cooking methods were used infrequently by the consumers in this study.

Table 3. Least squares means for cooking method × city effect on overall like ratings (23 = like extremely; 1 = dislike extremely)

Cooking Method	City			
	Chicago	Houston	Philadelphia	San Francisco
Outdoor grill	17.7 <sup>cd</sup>	18.7 <sup>a</sup>	17.9 <sup>c</sup>	17.7 <sup>cd</sup>
Broil	17.7 <sup>cd</sup>	18.5 <sup>b</sup>	17.4 <sup>cd</sup>	16.5 <sup>d</sup>
Indoor grill	19.4 <sup>a</sup>	18.8 <sup>a</sup>	18.4 <sup>c</sup>	18.4 <sup>c</sup>
Pan-fry	17.3 <sup>cd</sup>	19.2 <sup>a</sup>	17.8 <sup>cd</sup>	17.8 <sup>cd</sup>
Stir-fry	17.2 <sup>cd</sup>	18.1 <sup>c</sup>	16.8 <sup>d</sup>	17.3 <sup>cd</sup>
Simmer and stew	17.7 <sup>cd</sup>	18.7 <sup>a</sup>	17.3 <sup>cd</sup>	17.2 <sup>cd</sup>
Other <sup>e</sup>	19.0 <sup>a</sup>	19.1 <sup>a</sup>	17.3 <sup>cd</sup>	18.1 <sup>c</sup>

<sup>a,b,c,d</sup>Means lacking a common superscript letter differ ( $P < .05$ ).

<sup>e</sup>Other cooking methods included oven-roasted uncovered, pan-broil, braise, and deep-fry. These cooking methods were used infrequently by the consumers in this study.

degree of doneness ( $P = .0001$ ). Steaks that were grilled outdoors, broiled, grilled indoors, pan-fried, or prepared by “other” cooking methods had higher ( $P < .05$ ) JUIC ratings at lower degrees of doneness (Table 9). Consumer JUIC ratings for steaks that were stir-fried or simmered and stewed were not affected ( $P > .05$ ) by degree of doneness.

Effects of cooking method and USDA quality grade on JUIC ratings are presented in Table 10. Choice steaks cooked by either outdoor grilling or indoor grilling tended to have higher JUIC ratings than Select steaks. The USDA quality grade had no effect ( $P > .05$ ) on JUIC scores if steaks were broiled or pan-fried.

Regardless of cooking method, consumers from Houston tended to give higher JUIC ratings than those from the other three cities (Table 11). Indoor grilling in Chicago and pan-frying in Houston

Table 4. Least squares means for cooking method × USDA quality grade effect on overall like ratings (23 = like extremely; 1 = dislike extremely)

Cooking method	USDA quality grade			
	Top Choice	Low Choice	High Select	Low Select
Outdoor grill	18.2 <sup>bcde</sup>	17.9 <sup>bcdef</sup>	17.8 <sup>cdef</sup>	18.0 <sup>bcdef</sup>
Broil	17.5 <sup>efg</sup>	17.7 <sup>defg</sup>	17.3 <sup>fg</sup>	17.7 <sup>cdef</sup>
Indoor grill	19.4 <sup>a</sup>	18.6 <sup>ab</sup>	18.4 <sup>bcd</sup>	18.6 <sup>abc</sup>
Pan-fry	17.6 <sup>defg</sup>	18.4 <sup>bcd</sup>	18.1 <sup>bcde</sup>	18.1 <sup>bcde</sup>
Stir-fry	17.4 <sup>efg</sup>	18.1 <sup>bcdef</sup>	17.4 <sup>efg</sup>	16.6 <sup>g</sup>
Simmer and stew	17.5 <sup>defg</sup>	18.2 <sup>bcde</sup>	17.8 <sup>bcdefg</sup>	17.5 <sup>efg</sup>
Other <sup>h</sup>	18.1 <sup>bcde</sup>	18.3 <sup>bcd</sup>	18.6 <sup>ab</sup>	18.4 <sup>bcd</sup>

<sup>a,b,c,d,e,f,g</sup>Means lacking a common superscript letter differ ( $P < .05$ ).

<sup>h</sup>Other cooking methods included oven-roasted uncovered, pan-broil, braise, and deep-fry. These cooking methods were used infrequently by the consumers in this study.

Table 5. Least squares means for degree of doneness × city effect on overall like ratings (23 = like extremely; 1 = dislike extremely)

Degree of doneness	City			
	Chicago	Houston	Philadelphia	San Francisco
Medium rare or less	17.6 <sup>efg</sup>	18.9 <sup>ab</sup>	17.7 <sup>defg</sup>	17.8 <sup>defg</sup>
Medium	18.2 <sup>cd</sup>	18.5 <sup>abc</sup>	17.4 <sup>efg</sup>	17.6 <sup>efg</sup>
Medium well	18.0 <sup>cde</sup>	18.9 <sup>a</sup>	17.3 <sup>g</sup>	17.4 <sup>fg</sup>
Well done or more	18.3 <sup>bc</sup>	18.7 <sup>ab</sup>	17.9 <sup>def</sup>	17.6 <sup>efg</sup>

<sup>a,b,c,d,e,f,g</sup>Means lacking a common superscript letter differ ( $P < .05$ ).

produced the highest JUIC ratings, and stir-frying and simmering and stewing in San Francisco produced the lowest ratings.

### Consumer Flavor Desirability Ratings

There were three interactions for DFLAV ratings: USDA quality grade × cooking method ( $P = .03$ ), city × cooking method ( $P = .0002$ ), and cooking method × degree of doneness ( $P = .009$ ). Flavor desirability ratings were higher at lower degrees of doneness for broiling and pan-frying (Table 12). Advanced degrees of doneness tended to produce higher DFLAV ratings for the cooking methods of stir-frying and simmering and stewing. Degree of doneness did not affect ( $P > .05$ ) DFLAV ratings when outdoor grilling was the cooking method used.

Effects of cooking method × city are presented in Table 13. For all cooking methods, Houston tended to rate DFLAV higher than the other cities. Chicago rated DFLAV the lowest ( $P < .05$ ) for outdoor grilling.

The USDA quality grade did not affect ( $P > .05$ ) DFLAV ratings for top sirloin steaks cooked by outdoor grilling, broiling, pan-frying, or “other” cooking methods (Table 14). Top Choice steaks were rated higher ( $P < .05$ ) than Low Choice or Low Select steaks when steaks were prepared by indoor grilling.

### Consumer Flavor Intensity Ratings

There were three interactions for IFLAV ratings: USDA quality grade × cooking method ( $P = .02$ ), city

Table 6. Least squares means for quality grade effect on tenderness ratings (23 = extremely tender; 1 = not at all tender)

Top Choice	Low Choice	High Select	Low Select
17.9 <sup>a</sup>	17.8 <sup>a</sup>	17.6 <sup>b</sup>	17.7 <sup>ab</sup>

<sup>a,b</sup>Means lacking a common superscript letter differ ( $P < .05$ ).

Table 7. Least squares means for city effect on tenderness ratings (23 = extremely tender; 1 = not at all tender)

Chicago	Houston	Philadelphia	San Francisco
17.8 <sup>b</sup>	18.5 <sup>a</sup>	17.5 <sup>c</sup>	17.3 <sup>d</sup>

<sup>a,b,c,d</sup>Means lacking a common superscript letter differ ( $P < .05$ ).

× degree of doneness ( $P = .003$ ), and cooking method × degree of doneness ( $P = .0002$ ). Degree of doneness × cooking method effects are presented in Table 15. Flavor tended to be more intense when steaks were cooked by outdoor grilling, broiling, or pan-frying to lower degrees of doneness. However, IFLAV ratings tended to be higher at higher degrees of doneness for steaks that were stir-fried or simmered and stewed.

City × cooking method effects are presented in Table 16. Ratings for IFLAV tended to be higher in Houston, regardless of cooking method, than in the other three cities.

The USDA quality grade × cooking method effects are presented in Table 17. The USDA quality grade did not affect ( $P > .05$ ) IFLAV ratings for the cooking methods of outdoor grilling, broiling, indoor grilling, simmering and stewing, or pan-frying.

### Discussion

#### USDA Quality Grade

Neely et al. (1998) reported no quality grade effect on OLIVE ratings for top sirloin steaks. By including degree of doneness and cooking method in the model, USDA quality grade had very little effect on attributes of the meat, especially for steaks cooked by the two most frequently used methods. This finding is in

Table 8. Least squares means for cooking method × degree of doneness effect on tenderness ratings (23 = extremely tender; 1 = not at all tender)

Cooking method	Degree of doneness			
	Medium rare or less	Medium	Medium well	Well done or more
Outdoor grill	18.2 <sup>ab</sup>	17.8 <sup>b</sup>	17.6 <sup>bc</sup>	17.2 <sup>cd</sup>
Broil	17.9 <sup>ab</sup>	17.4 <sup>c</sup>	16.8 <sup>d</sup>	16.8 <sup>d</sup>
Indoor grill	18.4 <sup>ab</sup>	18.0 <sup>ab</sup>	18.2 <sup>ab</sup>	18.3 <sup>ab</sup>
Pan-fry	18.5 <sup>a</sup>	17.8 <sup>bc</sup>	17.5 <sup>bc</sup>	17.6 <sup>bc</sup>
Stir-fry	16.1 <sup>d</sup>	17.1 <sup>cd</sup>	18.0 <sup>ab</sup>	18.2 <sup>ab</sup>
Simmer and stew	17.1 <sup>cd</sup>	17.9 <sup>ab</sup>	17.8 <sup>bc</sup>	18.5 <sup>a</sup>
Other <sup>e</sup>	18.7 <sup>a</sup>	17.5 <sup>bc</sup>	18.1 <sup>ab</sup>	18.3 <sup>ab</sup>

<sup>a,b,c,d</sup>Means lacking a common superscript letter differ ( $P < .05$ ).

<sup>e</sup>Other cooking methods included oven-roasted uncovered, pan-broil, braise, and deep-fry. These cooking methods were used infrequently by the consumers in this study.

Table 9. Least squares means for cooking method × degree of doneness effect on juiciness ratings (23 = extremely juicy; 1 = not at all juicy)

Cooking method	Degree of doneness			
	Medium rare or less	Medium	Medium well	Well done or more
Outdoor grill	18.4 <sup>b</sup>	17.8 <sup>cd</sup>	17.1 <sup>de</sup>	16.2 <sup>ef</sup>
Broil	18.6 <sup>b</sup>	17.4 <sup>cde</sup>	16.4 <sup>ef</sup>	15.9 <sup>f</sup>
Indoor grill	18.8 <sup>ab</sup>	17.9 <sup>bcd</sup>	17.8 <sup>cde</sup>	18.1 <sup>bc</sup>
Pan-fry	19.3 <sup>a</sup>	18.0 <sup>bc</sup>	17.2 <sup>cde</sup>	16.5 <sup>ef</sup>
Stir-fry	16.0 <sup>ef</sup>	16.3 <sup>ef</sup>	17.4 <sup>cde</sup>	17.5 <sup>cde</sup>
Simmer and stew	17.0 <sup>def</sup>	17.8 <sup>cde</sup>	16.7 <sup>ef</sup>	16.8 <sup>ef</sup>
Other <sup>g</sup>	18.8 <sup>ab</sup>	17.2 <sup>cde</sup>	17.7 <sup>cde</sup>	17.5 <sup>cde</sup>

<sup>a,b,c,d,e,f</sup>Means lacking a common superscript letter differ ( $P < .05$ ).

<sup>g</sup>Other cooking methods included oven-roasted uncovered, pan-broil, braise, and deep-fry. These cooking methods were used infrequently by the consumers in this study.

Table 10. Least squares means for cooking method × USDA quality grade effect on juiciness ratings (23 = extremely juicy; 1 = not at all juicy)

Cooking method	USDA quality grade			
	Top Choice	Low Choice	High Select	Low Select
Outdoor grill	17.8 <sup>bcd</sup>	17.4 <sup>cde</sup>	17.0 <sup>def</sup>	17.4 <sup>cdef</sup>
Broil	17.1 <sup>cdef</sup>	17.2 <sup>cdef</sup>	16.8 <sup>ef</sup>	17.3 <sup>cdef</sup>
Indoor grill	18.9 <sup>a</sup>	18.4 <sup>ab</sup>	17.9 <sup>abc</sup>	17.4 <sup>cdef</sup>
Pan-fry	17.6 <sup>bcd</sup>	18.1 <sup>ab</sup>	17.8 <sup>bcd</sup>	17.6 <sup>bcd</sup>
Stir-fry	16.4 <sup>f</sup>	17.5 <sup>bcd</sup>	16.9 <sup>def</sup>	16.4 <sup>f</sup>
Simmer and stew	16.7 <sup>ef</sup>	18.0 <sup>abc</sup>	16.7 <sup>ef</sup>	17.1 <sup>cdef</sup>
Other <sup>g</sup>	17.8 <sup>bcd</sup>	17.3 <sup>cdef</sup>	18.3 <sup>ab</sup>	17.8 <sup>bc</sup>

<sup>a,b,c,d,e,f</sup>Means lacking a common superscript letter differ ( $P < .05$ ).

<sup>g</sup>Other cooking methods included oven-roasted uncovered, pan-broil, braise, and deep-fry. These cooking methods were used infrequently by the consumers in this study.

Table 11. Least squares means for cooking method × city effect on juiciness ratings (23 = extremely juicy; 1 = not at all juicy).

Cooking method	City			
	Chicago	Houston	Philadelphia	San Francisco
Outdoor grill	17.2 <sup>de</sup>	18.1 <sup>bc</sup>	17.4 <sup>cde</sup>	16.9 <sup>def</sup>
Broil	17.3 <sup>cde</sup>	18.1 <sup>abc</sup>	17.0 <sup>def</sup>	16.0 <sup>f</sup>
Indoor grill	18.9 <sup>a</sup>	18.3 <sup>abc</sup>	18.0 <sup>bcd</sup>	17.3 <sup>cde</sup>
Pan-fry	17.4 <sup>cde</sup>	18.7 <sup>a</sup>	17.7 <sup>cd</sup>	17.3 <sup>cde</sup>
Stir-fry	16.8 <sup>def</sup>	17.1 <sup>def</sup>	17.0 <sup>def</sup>	16.3 <sup>f</sup>
Simmer and stew	17.5 <sup>cde</sup>	18.3 <sup>abc</sup>	16.3 <sup>ef</sup>	16.2 <sup>f</sup>
Other <sup>g</sup>	18.6 <sup>ab</sup>	18.2 <sup>abc</sup>	17.1 <sup>def</sup>	17.4 <sup>cde</sup>

<sup>a,b,c,d,e,f</sup>Means lacking a common superscript letter differ ( $P < .05$ ).

<sup>g</sup>Other cooking methods included oven-roasted uncovered, pan-broil, braise, and deep-fry. These cooking methods were used infrequently by the consumers in this study.

Table 12. Least squares means for cooking method × degree of doneness effect on flavor desirability ratings (23 = like extremely; 1 = dislike extremely)

Cooking method	Degree of doneness			
	Medium rare or less	Medium	Medium well	Well done or more
Outdoor grill	18.7 <sup>bc</sup>	18.4 <sup>cd</sup>	18.2 <sup>cd</sup>	18.2 <sup>cd</sup>
Broil	18.5 <sup>bc</sup>	17.9 <sup>cd</sup>	17.5 <sup>d</sup>	17.6 <sup>d</sup>
Indoor grill	19.4 <sup>a</sup>	18.5 <sup>bc</sup>	19.0 <sup>ab</sup>	19.6 <sup>a</sup>
Pan-fry	19.3 <sup>a</sup>	18.6 <sup>bc</sup>	17.9 <sup>cd</sup>	18.2 <sup>c</sup>
Stir-fry	16.0 <sup>d</sup>	18.4 <sup>bc</sup>	18.4 <sup>bc</sup>	18.6 <sup>bc</sup>
Simmer and stew	17.3 <sup>d</sup>	18.6 <sup>bc</sup>	17.8 <sup>cd</sup>	18.7 <sup>b</sup>
Other <sup>e</sup>	19.2 <sup>ab</sup>	18.4 <sup>bc</sup>	18.6 <sup>bc</sup>	18.9 <sup>ab</sup>

<sup>a,b,c,d</sup>Means lacking a common superscript letter differ ( $P < .05$ ).

<sup>e</sup>Other cooking methods included oven-roasted uncovered, pan-broil, braise, and deep-fry. These cooking methods were used infrequently by the consumers in this study.

agreement with Luchak et al. (1998) that USDA quality grade did not affect palatability of top sirloin steaks.

City

Consumers in Houston continually rated top sirloin steaks higher for all consumer attributes. This was evident especially in tenderness ratings; consumers in Houston rated the steaks highest, followed by those in Chicago, Philadelphia, and San Francisco.

Degree of Doneness

Cooking method played an important role in how consumers rated steaks based on degree of doneness. For some cooking methods, as steaks were cooked to more advanced degrees of doneness palatability ratings declined. For other cooking methods, steaks cooked to well done or higher degrees of doneness

Table 13. Least squares means for cooking method × city effect on flavor desirability ratings (23 = like extremely; 1 = dislike extremely)

Cooking method	City			
	Chicago	Houston	Philadel-phia	San Francisco
Outdoor grill	18.2 <sup>c</sup>	18.9 <sup>ab</sup>	18.2 <sup>b</sup>	18.1 <sup>b</sup>
Broil	18.0 <sup>b</sup>	18.9 <sup>ab</sup>	17.8 <sup>bc</sup>	16.8 <sup>c</sup>
Indoor grill	19.7 <sup>a</sup>	19.0 <sup>ab</sup>	19.0 <sup>ab</sup>	18.8 <sup>ab</sup>
Pan-fry	18.1 <sup>b</sup>	19.4 <sup>a</sup>	18.3 <sup>b</sup>	18.2 <sup>b</sup>
Stir-fry	18.0 <sup>b</sup>	18.2 <sup>b</sup>	17.6 <sup>bc</sup>	17.6 <sup>bc</sup>
Simmer and stew	18.2 <sup>b</sup>	18.7 <sup>ab</sup>	17.8 <sup>bc</sup>	17.8 <sup>bc</sup>
Other <sup>d</sup>	19.3 <sup>a</sup>	19.3 <sup>a</sup>	18.1 <sup>b</sup>	18.3 <sup>b</sup>

<sup>a,b,c</sup>Means lacking a common superscript letter differ ( $P < .05$ ).

<sup>d</sup>Other cooking methods included oven-roasted uncovered, pan-broil, braise, and deep-fry. These cooking methods were used infrequently by the consumers in this study.

Table 14. Least squares means for cooking method × USDA quality grade effect on flavor desirability ratings (23 = like extremely; 1 = dislike extremely)

Cooking method	USDA quality grade			
	Top Choice	Low Choice	High Select	Low Select
Outdoor grill	18.4 <sup>bc</sup>	18.4 <sup>c</sup>	18.1 <sup>cd</sup>	18.4 <sup>c</sup>
Broil	18.0 <sup>d</sup>	18.0 <sup>cd</sup>	17.5 <sup>d</sup>	18.1 <sup>cd</sup>
Indoor grill	19.8 <sup>a</sup>	18.9 <sup>bc</sup>	19.1 <sup>ab</sup>	18.6 <sup>bc</sup>
Pan-fry	18.3 <sup>cd</sup>	18.8 <sup>bc</sup>	18.5 <sup>bc</sup>	18.5 <sup>bc</sup>
Stir-fry	18.0 <sup>cd</sup>	18.5 <sup>bc</sup>	17.7 <sup>d</sup>	17.3 <sup>d</sup>
Simmer and stew	17.6 <sup>d</sup>	18.6 <sup>bc</sup>	18.0 <sup>cd</sup>	18.2 <sup>cd</sup>
Other <sup>e</sup>	18.7 <sup>bc</sup>	18.6 <sup>bc</sup>	19.0 <sup>b</sup>	18.7 <sup>bc</sup>

<sup>a,b,c,d</sup>Means lacking a common superscript letter differ ( $P < .05$ ).

<sup>e</sup>Other cooking methods included oven-roasted uncovered, pan-broil, braise, and deep-fry. These cooking methods were used infrequently by the consumers in this study.

Table 15. Least squares means for cooking method × degree of doneness effect on flavor intensity ratings (23 = extreme amount; 1 = none at all)

Cooking method	Degree of doneness			
	Medium rare or less	Medium	Medium well	Well done or more
Outdoor grill	18.6 <sup>bcd</sup>	18.4 <sup>cde</sup>	18.4 <sup>cdef</sup>	18.2 <sup>defg</sup>
Broil	18.7 <sup>bcd</sup>	17.9 <sup>efgh</sup>	17.6 <sup>gh</sup>	17.8 <sup>fgh</sup>
Indoor grill	19.2 <sup>ab</sup>	18.7 <sup>bcd</sup>	19.0 <sup>abcd</sup>	19.8 <sup>a</sup>
Pan-fry	19.1 <sup>ab</sup>	18.4 <sup>cde</sup>	18.3 <sup>cdefg</sup>	18.2 <sup>defg</sup>
Stir-fry	15.7 <sup>h</sup>	18.0 <sup>defgh</sup>	18.3 <sup>cdefg</sup>	18.5 <sup>bcd</sup>
Simmer and stew	17.2 <sup>gh</sup>	18.1 <sup>defgh</sup>	17.8 <sup>fgh</sup>	18.6 <sup>bcd</sup>
Other <sup>i</sup>	19.0 <sup>abc</sup>	18.4 <sup>cdef</sup>	18.6 <sup>bcd</sup>	19.1 <sup>ab</sup>

<sup>a,b,c,d,e,f,g,h</sup>Means lacking a common superscript letter differ ( $P < .05$ ).

<sup>i</sup>Other cooking methods included oven-roasted uncovered, pan-broil, braise, and deep-fry. These cooking methods were used infrequently by the consumers in this study.

Table 16. Least squares means for cooking method × city effect on flavor intensity ratings (23 = extreme amount; 1 = none at all)

Cooking method	City			
	Chicago	Houston	Philadel-phia	San Francisco
Outdoor grill	18.2 <sup>cdef</sup>	19.0 <sup>abcd</sup>	18.3 <sup>cde</sup>	18.2 <sup>cdef</sup>
Broil	18.2 <sup>cdef</sup>	18.9 <sup>abcd</sup>	17.8 <sup>efg</sup>	17.2 <sup>g</sup>
Indoor grill	19.6 <sup>a</sup>	19.1 <sup>abcd</sup>	19.3 <sup>abc</sup>	18.7 <sup>bcd</sup>
Pan-fry	18.0 <sup>defg</sup>	19.3 <sup>ab</sup>	18.5 <sup>cd</sup>	18.2 <sup>cde</sup>
Stir-fry	17.7 <sup>efg</sup>	18.1 <sup>cdefg</sup>	17.4 <sup>efg</sup>	17.5 <sup>efg</sup>
Simmer and stew	18.1 <sup>cdef</sup>	18.4 <sup>cde</sup>	17.8 <sup>efg</sup>	17.4 <sup>fg</sup>
Other <sup>h</sup>	19.3 <sup>abc</sup>	19.3 <sup>ab</sup>	18.2 <sup>cdef</sup>	18.3 <sup>cde</sup>

<sup>a,b,c,d,e,f,g</sup>Means lacking a common superscript letter differ ( $P < .05$ ).

<sup>h</sup>Other cooking methods included oven-roasted uncovered, pan-broil, braise, and deep-dry. These cooking methods were used infrequently by the consumers in this study.

Table 17. Least squares means for cooking method  $\times$  USDA quality grade effect on flavor intensity ratings (23 = extreme amount; 1 = none at all)

Cooking method	USDA quality grade			
	Low Select	High Select	Low Choice	Top Choice
Outdoor grill	18.4 <sup>cde</sup>	18.1 <sup>def</sup>	18.4 <sup>cde</sup>	18.7 <sup>bc</sup>
Broil	18.2 <sup>cdef</sup>	17.7 <sup>fg</sup>	18.2 <sup>cdef</sup>	18.0 <sup>ef</sup>
Indoor grill	19.2 <sup>ab</sup>	18.9 <sup>abc</sup>	19.0 <sup>abc</sup>	19.6 <sup>a</sup>
Pan-fry	18.4 <sup>cde</sup>	18.6 <sup>bcd</sup>	18.7 <sup>bcd</sup>	18.4 <sup>bcd</sup>
Stir-fry	16.9 <sup>g</sup>	17.5 <sup>fg</sup>	18.3 <sup>cdef</sup>	18.0 <sup>efg</sup>
Simmer and stew	18.0 <sup>efg</sup>	18.0 <sup>efg</sup>	18.3 <sup>cdef</sup>	17.4 <sup>fg</sup>
Other <sup>h</sup>	18.8 <sup>bc</sup>	19.0 <sup>ab</sup>	18.6 <sup>bcd</sup>	18.7 <sup>bcd</sup>

<sup>a,b,c,d,e,f,g</sup>Means lacking a common superscript letter differ ( $P < .05$ ).

<sup>h</sup>Other cooking methods included oven-roasted uncovered, pan-broil, braise, and deep-fry. These cooking methods were used infrequently by the consumers in this study.

received among the highest ratings. Most consumers cooked the steaks at least to the well done stage, and their satisfaction depended on the cooking method used to achieve this degree of doneness.

Because multiple cooking methods were used by consumers in our study to prepare top sirloin steaks, it is interesting to compare these findings to those for which single cooking methods were used. Luchak et al. (1998) reported more desirable trained sensory panel ratings for all attributes when top sirloin steaks were cooked to lower end point temperatures. Wulf et al. (1996) found lower shear force values at medium rare and medium degrees of doneness for sirloin steaks. Also, degree of doneness had the greatest effect on trained sensory panel juiciness ratings.

### Cooking Method

Indoor grilling resulted in the highest ratings for all attributes except JUIC. Pan-frying produced the highest juice ratings, probably because fat was retained and liquid was added during pan-frying, whereas fat was lost during grilling and broiling.

## Implications

Top sirloin steaks were consistently cooked to well done or higher degrees of doneness, regardless of geographical location. Outdoor grilling and broiling were the most frequent cooking methods used by consumers. Top sirloin steaks cooked with these methods and to well done or greater degrees of doneness generally received among the lowest consumer palatability ratings. Disseminating information to consumers and using palatability-enhancing post-mortem technologies, such as blade tenderization or calcium chloride injection, may increase consumer satisfaction ratings for top sirloin steaks.

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