

Beef customer satisfaction: USDA quality grade and marination effects on consumer evaluations of top round steaks¹

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ABSTRACT: An in-home beef study evaluated consumer ratings of top round steaks (semimembranosus) as influenced by USDA quality grade (top Choice or high Select), city (Chicago or Philadelphia), consumer segment (beef loyalists = heavy consumers of beef; budget rotators = cost-driven and split meat consumption between beef and chicken; and variety rotators = higher incomes and education and split meat consumption among beef, poultry, and other foods), degree of doneness, cooking method, and marination. Consumers evaluated each steak for overall like, tenderness, juiciness, flavor like, and flavor amount using 10-point scales (1 = dislike extremely, not at all tender, not at all juicy, dislike extremely, and none at all to 10 = like extremely, extremely tender, extremely juicy, like extremely, and an extreme amount of flavor, respectively). Quality grade affected several consumer sensory traits, with top Choice receiving higher ($P < 0.004$) tenderness, juiciness, and flavor like scores than high Select. Consumers in Chicago rated steaks cooked "medium and less" higher for overall like, tenderness, juiciness, flavor like, and flavor amount than those in Phila-

delphia (city \times degree of doneness; $P \leq 0.020$). Steaks braised by customers in Philadelphia received among the highest scores for overall like, tenderness, juiciness, flavor like, and flavor amount compared with any cooking method used by customers in Chicago (cooking method \times city; $P \leq 0.026$). Overall like and flavor amount ratings were least ($P < 0.05$) for steaks that were marinated and cooked to "medium and less" degree of doneness (marination \times degree of doneness; $P \leq 0.014$). Braised steaks received among the highest values for overall like, tenderness, juiciness, flavor like, and flavor amount when cooked to "medium and less" or "medium well and more" (cooking method \times degree of doneness; $P \leq 0.008$). Correlation and stepwise regression analysis indicated that flavor like was pivotal in customers' satisfaction with top round steaks, and was the sensory trait most highly correlated to overall like, followed by tenderness, flavor amount, and juiciness. Preparation of top round steaks was crucial in consumers' likes and dislikes, and by improving flavor, higher consumer satisfaction may be achieved.

Key Words: Beef, Consumer Preference, Cookery Method, Degree of Doneness, Market Research, Meat Grades

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J. Anim. Sci. 2005. 83:662–670

Introduction

There is a continuing need to examine consumers' preferences for different beef cuts to properly develop and use those muscles as the industry strives to provide consumers with easy and convenient meats. Savell et

al. (1987, 1989) reported some of the first information on consumer practices and preferences in the National Consumer Retail Beef Studies. Additional studies have demonstrated regional differences, and their profound effect on consumers (Neely et al., 1998, 1999; Lorenzen et al., 1999).

Development of a consumer target based on sound consumer preference information is critical when devel-

¹Technical article from the Texas Agric. Exp. Stn. This project was funded in part by beef and veal producers and importers through their \$1.00/animal beef check-off, and was produced for the Cattlemen's Beef Board and state beef councils by the National Cattlemen's Beef Association. Special recognition is given to S. M. Courington from Wirthlin Worldwide.

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Received January 23, 2004.

Accepted December 5, 2004.

oping beef marketing and production strategies (Branson et al., 1986). As we continue to identify new value-added cuts, we must be able to correctly identify the proper cooking recommendations for consumers' ultimate satisfaction.

The top round steak has continued to be marketed in different ways. Through better understanding of consumers' preparation of cuts, such as the top round, we will be better prepared to correctly identify the proper cooking method and label accordingly. Therefore, the objective of this study was to evaluate two major cities and their response to top round steaks based on their preferred cooking method, as well as to provide insight on the effect of USDA quality grade (top Choice and high Select), consumer segment, degree of doneness, and marination on consumer sensory ratings and overall customer satisfaction with top round steaks.

Materials and Methods

Beef Selection

Carcasses (n = 200) were selected from the Excel Corp. (Schuyler, NE) beef processing facility as described by Goodson et al. (2002). Carcasses were graded by a USDA, Standardization Branch representative and were selected to equally represent top Choice (Modest to Moderate degrees of marbling, n = 100) and high Select (upper half of Slight degree of marbling, n = 100). Each carcass was identified with a unique identification number that was transferred to each subprimal and its subsequent steaks. Carcasses were fabricated according to Institutional Meat Purchasing Specifications (IMPS; USDA, 1996). Top (inside) rounds (IMPS #168), including the semimembranosus and adductor muscles, were obtained from both sides of each carcass, vacuum-packaged, boxed, and shipped to Rosenthal Meat Science and Technology Center at Texas A&M University (College Station) for refrigerated storage at 2°C and further processing. Top rounds from one side of each carcass were designated for marinade application. These subprimals were weighed and passed through a multi-needle injector (model 12354, Koch Supplies, Inc., Kansas City, MO) at 48 to 72 h postmortem. Each cut was injected at 5% of the cut weight with a 200 mM calcium chloride solution (Tetra Chemicals, Houston, TX) made with cold tap water. After injection, cuts were allowed to drip for 5 min and were then reweighed.

Steak Processing and Packaging

Following an aging period of 14 to 21 d, mirror-image steaks were removed simultaneously from the right and left subprimals of each carcass using two band saws. Five, 1.59-cm-thick top round steaks (adductor removed, IMPS #1168; USDA, 1996) were cut from each subprimal. The first steak, beginning at the anterior end of the top round, was assigned for Warner-Bratzler shear force determination. The remaining four steaks

were paired with their mirrored, marinated steaks from the opposite side subprimal of the same carcass and used for in-home consumer evaluations. All steaks were trimmed free of subcutaneous fat. Steaks were individually vacuum-packaged on an American National Can Bivac machine using roll stock oxygen barrier film (American National Can, Chicago, IL) and blast frozen at -40°C. Steaks remained frozen through delivery to consumers.

Steak Distribution

Paired top round steaks were supplied to the same household. Each participant was provided a top round steak from top Choice and high Select carcasses, as well as an injected and noninjected top round steak (four steaks per household). Sample packets were prepared for each household and distributed as reported by Goodson et al. (2002).

Consumer Recruitment

Consumers in Chicago, IL, and Philadelphia, PA, were recruited as reported by Goodson et al. (2002). Wirthlin Worldwide (Chicago, IL) analyzed this information using an in-house cluster analysis algorithm, which assigned households to one of three beef consuming segments: 1) beef loyalists, who are heavy consumers of beef, 2) budget rotators, who are cost driven and split meat consumption between beef and chicken, and 3) variety rotators, who have higher incomes and education level, and split their consumption among beef, poultry, and other foods.

Customer Satisfaction Evaluation

Guidelines for safe handling and storage of meat were provided to all participants. Respondents were asked to prepare the steaks as they would when buying the same cut in the supermarket. Consumers evaluated each steak for overall satisfaction (overall like), tenderness, juiciness, flavor desirability (flavor like), and flavor intensity (flavor amount) using a 10-point scale (10 = like extremely, extremely tender, extremely juicy, like extremely, and an extreme amount of flavor to 1 = dislike extremely, not at all tender, not at all juicy, dislike extremely, and none at all). Each evaluation form also asked participants to determine degree of doneness of the beef at the time of consumption as compared with the National Live Stock and Meat Board beef steak color guide (Lorenzen et al., 1999). Participants 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. Meal preparers also were asked to indicate cooking methods, including outdoor-grilled, indoor-grilled, broiled, oven-roasted, pan-broiled, pan-fried/sautéed, stir-fried, deep-fried, braised, poached, simmered and stewed, and other (NLSMB, 1992). Respondents were instructed to complete the evaluation forms immediately following

the meal and only consumer households completing the entire study were included in the analyses.

Warner-Bratzler Shear Force Determination

Warner-Bratzler shear force determination was conducted according to the procedure of Goodson et al. (2002). Steaks were thawed at 2°C and cooked on Farberware open hearth electric broilers (Kidde, Inc., Bronx, NY) to an internal temperature of 70°C, allowed to cool to room temperature, and then six 1.3-cm-diameter cores were removed parallel to the muscle fibers of the steak. Cores were sheared perpendicular to the muscle fibers using a Warner-Bratzler shear force device (Chatillon and Sons, New York, NY), and the mean of six cores was used for statistical analyses.

Data Analyses

Statistical analyses were performed using GLM procedure of SAS (SAS Inst., Inc., Cary, NC), and the model for customer satisfaction ratings for top round steaks included the main effects of quality grade, city, segment, degree of doneness, marination, cooking method, and all two-way interactions. Only significant terms ($P < 0.05$) were retained in the model. Least squares means were generated, and separated using pairwise t -tests (PDIF option). Pair-wise correlation coefficients (Proc Corr) were generated among consumer ratings to determine the relationship of palatability attributes (tenderness, juiciness, and flavor) to overall like ratings. Step-wise regression analysis (Proc Reg) was performed to develop equations involving those sensory traits that most contributed to overall like ratings. Frequency distributions for cooking method and degree of doneness within city were generated using Proc Freq of SAS.

Results

For cooking method, outdoor-grilled and indoor-grilled were combined into grilled; broiled, oven roasted, and pan-broiled were classified as broiled; deep-fried, pan-fried/sautéed, and stir-fried were combined into fried; and braised, poached, and simmered and stewed were grouped as braised. For degree of doneness, medium, medium rare, rare, and very rare were combined into the category of “medium and less,” whereas medium well, well done, and very well done were categorized into “medium well and more.”

The predominant cooking method used for preparing top round steaks was grilling (Figure 1). Consumers in Philadelphia tended ($P < 0.10$) to cook steaks by grilling more frequently than consumers in Chicago, whereas broiled, fried, and braised were used by consumers in similar frequencies. The most preferred degree of doneness was “medium well and more” in both cities ($P < 0.05$; Figure 2).

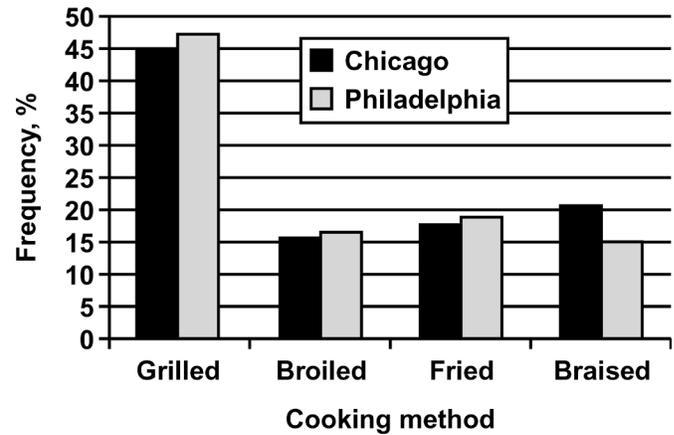


Figure 1. Cooking method frequency distributions for top round steaks stratified by city. Grilled combined the methods of outdoor- and indoor-grilled; broiled represents the combined cooking methods of broiled, oven-roasted, and pan-broiled; fried encompasses the cookery methods of deep-frying, pan-frying/sautéed, and stir-frying; and braised category includes the methods of braising, poaching, and simmering/stewing.

Consumer Evaluation of Top Round Steaks

Main Effect of Quality Grade Classification. Steaks from top Choice carcasses received higher ($P < 0.05$) ratings for overall like, tenderness, juiciness, and flavor like than steaks from high Select carcasses (Table 1). These results clearly demonstrate that quality grade group was an important factor affecting consumer likes and dislikes.

City \times Degree of Doneness Interactions. In Chicago, top round steaks cooked to “medium well and more” received higher ($P < 0.05$) overall likeness ratings than “medium and less”; however, in Philadelphia, there were no differences ($P > 0.24$) between degrees of doneness for sensory traits other than juiciness (Table 2).

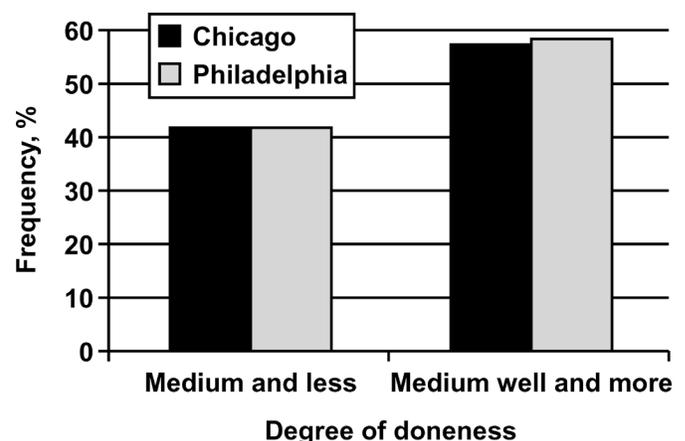


Figure 2. Degree of doneness frequency distributions for top round steaks stratified by city.

Table 1. Effect of quality grade category on in-home sensory evaluations of top round steaks

Sensory trait	Quality grade category ^a		P-value
	Top Choice	High Select	
Overall like ^b	6.59	6.13	<0.001
Tenderness ^c	6.15	5.71	0.004
Juiciness ^d	5.92	5.55	0.003
Flavor like ^b	6.45	6.04	<0.001

^aTop Choice = Modest and Moderate degrees of marbling, and high Select = upper half of Slight degree of marbling.

^b10 = like extremely to 1 = dislike extremely.

^c10 = very tender to 1 = not at all tender.

^d10 = very juicy to 1 = not at all juicy.

Moreover, tenderness ratings were higher ($P < 0.05$) in Chicago for those top rounds that were cooked to “medium well and more” compared with those cooked to “medium and less,” despite no differences ($P = 0.95$) between degree of doneness in Philadelphia (Table 2). In Philadelphia, steaks cooked to “medium and less” received the highest ($P < 0.05$) juiciness ratings compared with any other city combinations (Table 2). Conversely, in Chicago, top round steaks cooked to “medium and less” received the lowest ($P < 0.05$) flavor like ratings compared with the other city \times degree of doneness combinations (Table 2). Additionally, Chicago consumers rated top round steaks cooked to “medium and less” the lowest ($P < 0.05$) in flavor amount compared with Philadelphia consumers, regardless of degree of done-

Table 2. City \times degree of doneness interactive effects on sensory evaluations of top round steaks

Sensory trait/city	Degree of doneness ^a		P-value
	Medium and less	Medium well and more	
Overall like ^b			<0.001
Chicago	5.73 ^h	6.72 ^g	
Philadelphia	6.55 ^g	6.44 ^g	
Tenderness ^c			0.003
Chicago	5.40 ^h	6.21 ^g	
Philadelphia	6.06 ^g	6.05 ^g	
Juiciness ^d			0.020
Chicago	5.71 ^h	5.39 ^h	
Philadelphia	6.38 ^g	5.46 ^h	
Flavor like ^b			<0.001
Chicago	5.69 ^h	6.52 ^g	
Philadelphia	6.48 ^g	6.30 ^g	
Flavor amount ^e			<0.001
Chicago	5.82 ^h	6.50 ^g	
Philadelphia	6.60 ^g	6.24 ^g	

^aThe Medium and less category includes the degrees of doneness of very rare, rare, medium rare, and medium, whereas the Medium well and more category includes medium well, well done, and very well done degrees of doneness.

^b10 = like extremely to 1 = dislike extremely.

^c10 = very tender to 1 = not at all tender.

^d10 = very juicy to 1 = not at all juicy.

^e10 = an extreme amount to 1 = none at all.

^{g,h}Within a sensory trait, least squares means that do not have a common superscript letter differ, $P < 0.05$.

Table 3. Cooking method \times city interactive effects on in-home sensory evaluations of top round steaks

Sensory trait/ cooking method	City		P-value
	Chicago	Philadelphia	
Overall like ^a			<0.001
Grilled ^b	6.37 ^{kl}	5.70 ^m	
Broiled ^c	6.03 ^{lm}	6.26 ^{klm}	
Fried ^d	6.06 ^{lm}	6.70 ^{jk}	
Braised ^e	6.43 ^k	7.31 ^j	
Tenderness ^f			<0.001
Grilled ^b	5.76 ^l	5.16 ^m	
Broiled ^c	5.37 ^{lm}	5.63 ^{lm}	
Fried ^d	5.59 ^{lm}	6.11 ^{kl}	
Braised ^e	6.49 ^k	7.33 ^j	
Juiciness ^g			0.026
Grilled ^b	6.40 ^{kl}	5.67 ^m	
Broiled ^c	6.02 ^{lm}	6.00 ^{lm}	
Fried ^d	5.81 ^m	6.80 ^{jk}	
Braised ^e	6.19 ^{klm}	7.08 ^j	
Flavor like ^a			<0.001
Grilled ^b	6.40 ^{kl}	5.67 ^m	
Broiled ^c	6.02 ^{lm}	6.00 ^{lm}	
Fried ^d	5.81 ^m	6.80 ^{jk}	
Braised ^e	6.19 ^{klm}	7.08 ^j	
Flavor amount ^h			<0.001
Grilled ^b	6.47 ^{jk}	5.80 ^l	
Broiled ^c	6.22 ^{kl}	6.26 ^{kl}	
Fried ^d	5.71 ^l	6.65 ^{jk}	
Braised ^e	6.24 ^{kl}	6.96 ^j	

^a10 = like extremely to 1 = dislike extremely.

^bGrilled included outdoor grilled and indoor grilled.

^cBroiled included broiled, oven roasted, and pan-broiled.

^dFried included deep fried, pan-fried/sautéed, and stir fried.

^eBraised included braised, poached, and simmered and stewed.

^f10 = very tender to 1 = not at all tender.

^g10 = very juicy to 1 = not at all juicy.

^h10 = an extreme amount to 1 = none at all.

^{j,k,l,m}Within a sensory trait, least squares means that do not have a common superscript letter differ, $P < 0.05$.

ness, or consumers in Chicago who cooked steaks to “medium well and more.”

Cooking Method \times City Interactions. In Philadelphia, steaks that were braised received among the highest overall like ratings, and were rated higher ($P < 0.05$) than steaks braised in Chicago (Table 3). Grilled steaks were rated lower ($P < 0.05$) for overall like in Philadelphia than in Chicago, whereas consumers in Chicago rated fried steaks lower in overall like than consumers in Philadelphia.

For the cooking method \times city interaction (Table 3), top round steaks that were braised were rated highest ($P < 0.05$) for tenderness in both Chicago and Philadelphia compared with other cooking methods. Consumers in Philadelphia rated braised top round steaks higher ($P < 0.05$) in tenderness than did consumers in Chicago. Grilled top round steaks in Philadelphia were rated among the lowest for tenderness among cooking methods, and tenderness scores of grilled steaks were lower ($P < 0.05$) in Philadelphia than Chicago.

Steaks that were grilled, fried, or braised received lower ($P < 0.05$) juiciness ratings in Chicago than in

Table 4. Marination \times degree interactive effects on in-home sensory evaluations of top round steaks

Sensory trait/marination treatment	Degree of doneness ^a		P-value
	Medium and less	Medium well and more	
Overall like ^b			0.014
Marination	5.95 ^e	6.68 ^d	
No marination	6.33 ^d	6.48 ^d	
Flavor amount ^c			0.008
Marination	6.05 ^e	6.53 ^d	
No marination	6.36 ^{de}	6.21 ^e	

^aThe Medium and less category includes the degrees of doneness of very rare, rare, medium rare, and medium, whereas the Medium well and more category includes medium well, well done, and very well done degrees of doneness.

^b10 = like extremely to 1 = dislike extremely.

^c10 = an extreme amount to 1 = none at all.

^{d,e}Within a sensory trait, least squares means that do not have a common superscript letter differ, $P < 0.05$.

Philadelphia (Table 3). Furthermore, consumers in Philadelphia rated steaks that were fried or braised juicier ($P < 0.05$) than the other cooking methods, whereas consumers in Chicago rated grilled steaks juicier ($P < 0.05$) than fried steaks.

In Philadelphia, fried and braised steaks received higher ($P < 0.05$) flavor like ratings than those that were grilled and broiled (Table 3). Moreover, fried steaks prepared in Philadelphia received higher ($P < 0.05$) flavor like ratings than fried steaks in Chicago. Interestingly, steaks that were grilled were rated higher for flavor amount in Chicago than in Philadelphia, yet fried or braised steaks were perceived to have more ($P < 0.05$) flavor by consumers in Philadelphia than those in Chicago.

Marination \times Degree of Doneness Interactions. Marinated steaks received the lowest ($P < 0.05$) overall like ratings when cooked to “medium and less” degree of doneness compared with all other marination \times degree of doneness combinations (Table 4). Moreover, when cooked to “medium and less,” marinated steaks received lower ($P < 0.05$) flavor amount ratings than marinated steaks cooked to higher degrees of doneness. Additionally, marinated steaks cooked to “medium well and more” were rated higher ($P < 0.05$) in flavor amount than unmarinated steaks. Marinade in the current study did not affect ($P = 0.36$) tenderness ratings, but was involved in main effect interactions on flavor amount ratings.

Cooking Method \times Degree of Doneness Interactions. Top round steaks that were fried to “medium well and more” received higher ($P < 0.05$) overall like ratings than steaks cooked to “medium and less” (Table 5). When cooked to “medium well and more,” fried and broiled steaks received higher ($P < 0.05$) overall like ratings than grilled or broiled steaks.

When cooked to “medium and less,” braised steaks were rated tenderer ($P < 0.05$) than fried, broiled or grilled steaks (Table 5). Steaks that were braised to

Table 5. Cooking method \times degree of doneness interactive effects on in-home sensory evaluations of top round steaks

Sensory trait/cooking method	Degree of doneness ^a		P-value
	Medium and less	Medium well and more	
Overall like ^b			< 0.001
Grilled ^c	6.13 ^{lm}	5.95 ^m	
Broiled ^d	6.03 ^{lm}	6.26 ^{lm}	
Fried ^e	5.66 ^m	7.09 ^k	
Braised ^f	6.73 ^{kl}	7.02 ^k	
Tenderness ^g			< 0.001
Grilled ^c	5.59 ^m	5.32 ^m	
Broiled ^d	5.43 ^m	5.57 ^m	
Fried ^e	5.22 ^m	6.48 ^l	
Braised ^f	6.69 ^{kl}	7.15 ^k	
Juiciness ^h			0.002
Grilled ^c	5.92 ^l	4.97 ^m	
Broiled ^d	5.79 ^l	4.68 ^m	
Fried ^e	5.75 ^l	6.02 ^{kl}	
Braised ^f	6.72 ^k	6.02 ^{kl}	
Flavor like ^b			0.001
Grilled ^c	6.10 ^l	5.91 ^l	
Broiled ^d	6.04 ^l	5.98 ^l	
Fried ^e	5.79 ^l	6.82 ^k	
Braised ^f	6.34 ^l	6.93 ^k	
Flavor amount ⁱ			0.008
Grilled ^c	6.26 ^{kl}	6.02 ^l	
Broiled ^d	6.30 ^{kl}	6.18 ^{kl}	
Fried ^e	5.74 ^l	6.62 ^k	
Braised ^f	6.54 ^{kl}	6.66 ^k	

^aMedium and less category includes the degrees of doneness of very rare, rare, medium rare, and medium, whereas Medium well and more includes medium well, well done, and very well done degrees of doneness.

^b10 = like extremely to 1 = dislike extremely.

^cGrilled included outdoor grilled and indoor grilled.

^dBroiled included broiled, oven roasted, and pan-broiled.

^eFried included deep fried, pan-fried/sautéed, and stir fried.

^fBraised included braised, poached, and simmered and stewed.

^g10 = very tender to 1 = not at all tender.

^h10 = very juicy to 1 = not at all juicy.

ⁱ10 = an extreme amount to 1 = none at all.

^{k,l,m}Within a sensory trait, least squares means that do not have a common superscript letter differ, $P < 0.05$.

“medium well and more” received the highest ($P < 0.05$) tenderness ratings, whereas steaks fried to “medium well and more” were rated tenderer ($P < 0.05$) than broiled or grilled steaks.

When cooked to “medium well or more,” grilled and broiled steaks had the lowest ($P < 0.05$) juiciness ratings among all other combinations. Additionally, braised steaks were rated juicier ($P < 0.05$) than the other cooking methods when cooked to “medium and less.”

Steaks fried or braised to “medium well and more” received higher ($P < 0.05$) flavor like ratings than all other cooking method \times degree of doneness combinations (Table 5). Moreover, fried steaks were rated higher ($P < 0.05$) for flavor amount when cooked to “medium well and more.”

Cooking Method \times Segment Interactions. Beef loyalists rated grilled round steaks higher ($P < 0.05$) in overall

Table 6. Cooking method × segment interactive effects on in-home sensory evaluations of top round steaks

Sensory trait/cooking method	Segment ^a			P-value
	Beef loyalists	Budget rotators	Variety rotators	
Overall like ^b				0.007
Grilled ^c	6.70 ^j	5.56 ^l	5.85 ^{kl}	
Broiled ^d	6.89 ^j	5.48 ^l	6.07 ^{kl}	
Fried ^e	6.10 ^{ijkl}	6.79 ^j	6.25 ^{jk}	
Braised ^f	6.89 ^j	6.96 ^j	6.77 ^j	
Juiciness ^g				0.008
Grilled ^c	5.81 ^{kl}	5.34 ^{lm}	5.18 ^m	
Broiled ^d	5.45 ^{klm}	4.83 ^m	5.42 ^{lm}	
Fried ^e	5.45 ^{lm}	6.38 ^{jk}	5.83 ^{kl}	
Braised ^f	6.98 ^j	6.21 ^{ijkl}	5.93 ^{kl}	
Flavor like ^b				0.033
Grilled ^c	6.62 ^{ijkl}	5.64 ⁿ	5.84 ^{mn}	
Broiled ^d	6.55 ^{ijklm}	5.38 ⁿ	6.11 ^{lmn}	
Fried ^e	6.01 ^{lmn}	6.77 ^{jk}	6.14 ^{ijklmn}	
Braised ^f	6.80 ^j	6.38 ^{ijklmn}	6.73 ^{jk}	
Flavor amount ^h				0.014
Grilled ^c	6.87 ^j	5.67 ^m	5.88 ^{lm}	
Broiled ^d	6.62 ^{ijkl}	5.73 ^{lm}	6.37 ^{ijkl}	
Fried ^e	6.00 ^{lm}	6.50 ^{ijkl}	6.05 ^{lm}	
Braised ^f	6.67 ^{jk}	6.49 ^{ijkl}	6.64 ^{jk}	

^aBeef loyalists = heavy consumers of beef; Budget rotators = cost-driven and split meat consumption between beef and chicken; and Variety rotators = higher incomes and education and split meat consumption among beef, poultry, and other foods.

^b10 = like extremely to 1 = dislike extremely.

^cGrilled included outdoor grilled and indoor grilled.

^dBroiled included broiled, oven roasted, and pan-broiled.

^eFried included deep fried, pan-fried/sautéed, and stir fried.

^fBraised included braised, poached, and simmered and stewed.

^g10 = very juicy to 1 = not at all juicy.

^h10 = an extreme amount to 1 = none at all.

^{j,k,l,m,n}Within a sensory trait, least squares means that do not have a common superscript letter differ, $P < 0.05$.

like than the budget or variety rotators (Table 6). Conversely, budget rotators rated steaks cooked by dry-heat (grilled and broiled) methods lower ($P < 0.05$) in overall like than moist-heat (fried and braised) methods.

Beef loyalists rated braised steaks higher in juiciness ($P < 0.05$) compared with the other cooking methods; however, budget rotators found steaks that had been fried or braised to be juicier ($P < 0.05$) than steaks that had been broiled (Table 6). Moreover, grilled and broiled steaks were generally rated lower ($P < 0.05$) for juiciness by budget and variety rotators than either braised or fried steaks.

Budget rotators that fried top round steaks reported the highest ($P < 0.05$) flavor like ratings, whereas beef loyalists gave fried steaks the lowest ($P < 0.05$) flavor like ratings (Table 6). Beef loyalists gave braised steaks the highest ($P < 0.05$) flavor like ratings when compared with other cooking methods by beef loyalists.

Grilled top round steaks received higher ($P < 0.05$) flavor amount ratings from beef loyalists than the other segments (Table 6). Also, beef loyalists rated flavor amount of fried steaks lower ($P < 0.05$) than that of grilled and braised steaks, whereas budget rotators

Table 7. City × segment interactive effects on in-home tenderness ratings (10 = very tender; 1 = not at all tender) of top round steaks

City	Segment ^a			P-value
	Beef loyalists	Budget rotators	Variety rotators	
Chicago	6.44 ^b	5.51 ^{de}	5.46 ^e	0.032
Philadelphia	6.15 ^{bc}	6.04 ^{bcd}	5.98 ^{cd}	

^aBeef loyalists = heavy consumers of beef; Budget rotators = cost-driven and split meat consumption between beef and chicken; and Variety rotators = higher incomes and education and split meat consumption among beef, poultry, and other foods.

^{b,c,d,e}Least squares means that do not have a common superscript letter differ, $P < 0.05$.

gave steaks that were fried or braised higher ($P < 0.05$) flavor amount ratings than grilled steaks.

City × Segment Interaction. Variety rotators in Philadelphia rated top round steaks tenderer ($P < 0.05$) than those in Chicago (Table 7). Nonetheless, in Chicago, beef loyalists gave higher ($P < 0.05$) tenderness ratings to steaks than did budget rotators and variety rotators.

Correlations and Regression of Consumer Attributes of Top Round Steaks. Simple correlations among the sensory traits for top round steaks were highly correlated to one another (Table 8). Flavor like was the sensory trait that was the most highly correlated with overall like, followed by tenderness, flavor amount, and juiciness.

For beef loyalists, flavor like was more highly correlated to overall like than was tenderness (Table 9). Moreover, for budget rotators, the correlation of flavor like to overall like was the highest with the correlations of tenderness or flavor amount to overall like being similar in magnitude. The primary difference between the variety rotators and beef loyalists was that correlations among tenderness, juiciness, flavor like, and flavor amount to overall like were higher in beef loyalists than variety rotators.

During regression analysis, flavor like was the first variable predicting overall like (Table 10). The second variable was tenderness and followed by flavor amount. Juiciness was the last variable to enter and the b -value

Table 8. Simple correlations of consumer ratings for top round steaks

Item	Overall like ^a	Tenderness ^b	Juiciness ^c	Flavor like ^a
Tenderness	0.81***			
Juiciness	0.70***	0.76***		
Flavor like	0.87***	0.77***	0.75***	
Flavor amount	0.80***	0.71***	0.72***	0.87***

*** $P < 0.001$.

^a10 = like extremely to 1 = dislike extremely.

^b10 = very tender to 1 = not at all tender.

^c10 = very juicy to 1 = not at all juicy.

Table 9. Simple correlations of overall like ratings with the other consumer ratings for top round steaks stratified by segment^a

Segment ^b	Tenderness ^c	Juiciness ^d	Flavor like ^a	Flavor amount ^e
Beef loyalists	0.83***	0.77***	0.88***	0.82***
Budget rotators	0.86***	0.81***	0.91***	0.86***
Variety rotators	0.79***	0.63***	0.85***	0.73***

*** $P < 0.001$.

^a10 = like extremely to 1 = dislike extremely.

^bBeef loyalists = heavy consumers of beef; Budget rotators = cost-driven and split meat consumption between beef and chicken; and Variety rotators = higher incomes and education and split meat consumption among beef, poultry, and other foods.

^c10 = very tender to 1 = not at all tender.

^d10 = very juicy to 1 = not at all juicy.

^e10 = like extremely to 1 = dislike extremely.

(slope) was negative, indicating that lower (not higher) juiciness ratings were related to overall like.

Warner-Bratzler Shear Force Determination

No differences in shear force were detected between quality grade ($P = 0.14$) or marination treatment ($P = 0.40$; Figure 3). These values were not unexpected for top round steaks, and were below the threshold established for round cuts (Shackelford et al., 1991).

Discussion

Flavor, not tenderness, was most highly correlated with overall like of top round steaks due to the low variability in tenderness. Goodson et al. (2002) reported that flavor was highly correlated with overall like in beef shoulder clods steaks. It is interesting that all consumer sensory traits were highly correlated to overall like. It is important to note that consumers take all sensory traits into account when estimating their overall like. The greater flavor ratings of steaks may have compensated for some of the less tender aspects associated with this product, resulting in higher overall palatability ratings. Other consumer studies have re-

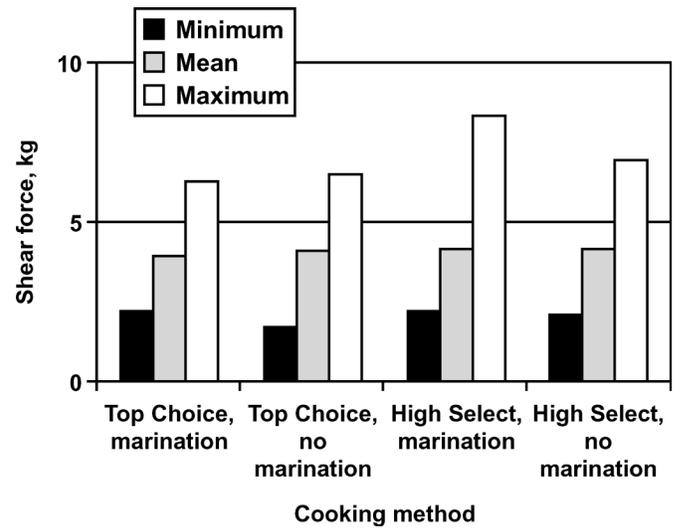


Figure 3. Means, and minimum and maximum Warner-Bratzler shear force values for top round steaks from different grade \times marination treatment combinations.

ported the importance of flavor in determining acceptability (Miller et al., 1995a,b; Huffman et al., 1996).

Cooking methods were found to be an important, and confounding, factor in the desirability of various cuts. The way people choose to prepare their steaks heavily influenced how much they enjoyed the product at the dinner table. Although grilling seems to be an inappropriate cooking method for the top round steak, it was used to prepare a majority of the top round steaks in the study. Retailers must realize that marketing appropriate cuts for appropriate cooking methods may enhance product acceptability.

Goodson et al. (2002) reported grilling was the most used cooking method for clod steaks. Savell et al. (1989) reported that outdoor grilling was the most common cooking method used by consumers in Philadelphia. Neely et al. (1999) found similar results, as consumers in Philadelphia more often prepared top round steaks by outdoor grilling than consumers in Chicago, who preferred to use simmer and stew cookery.

Table 10. Stepwise regression for predicting overall like ratings of top round steaks with other consumer ratings^{a,b}

Equation	R ²	C _p ^c	Intercept	Flavor like ^a	Tenderness ^d	Flavor amount ^e	Juiciness ^f
1	0.76	352.21	1.06	0.84	—	—	—
2	0.80	37.02	0.85	0.58	0.32	—	—
3	0.81	12.60	0.71	0.47	0.31	0.13	—
4	0.81	5.00	0.74	0.49	0.33	0.15	-0.06

^a10 = like extremely to 1 = dislike extremely.

^bOnly variables that met the $P < 0.15$ significance level were included in the model.

^cC_p = Mallows' statistic.

^d10 = very tender to 1 = not at all tender.

^e10 = an extreme amount to 1 = none at all.

^f10 = very juicy to 1 = not at all juicy.

Neely et al. (1999) found the majority of consumers in four cities (including Chicago and Philadelphia) prepared top round steaks to "medium well and more," which supports the present study. Savell et al. (1987) found that many consumers in Philadelphia (36%) prepared strip loin steaks to more well done levels than consumers from other cities in the study. Luchak et al. (1998) reported that tenderness and juiciness of top round steaks was not influenced by quality grade, but rather by cooking method.

The degree of doneness preference is determined by the consumer, and will most likely not be influenced by the beef industry. Savell et al. (1999) found that top sirloin steaks were consistently cooked to well done or higher degrees of doneness, regardless of geographical location. However, Lorenzen et al. (1999) found that juiciness, desirable flavor, and flavor intensity were increased when steaks were cooked to lower degrees of doneness.

Marination did not improve customer satisfaction of top round steaks in this study. This may have been due to the specific marinade used. With acceptable tenderness levels of all products used in the study, perhaps neither myofibrillar nor connective tissue component differentiation could be detected by the consumers. However, previous research has shown that calcium chloride injection improves the tenderness of tougher meat cuts (Koochmaraie et al., 1988; Morgan et al., 1991; Wheeler et al., 1991). Nonetheless, the aforementioned studies infused calcium chloride prerigor, and by activating the calcium-dependent proteolytic system prerigor, there is an increase in tenderization. In the present study, calcium chloride was injected into postrigor muscle, and may have been less effective in stimulating proteolytic tenderization; however, Wheeler et al. (1993) showed that postrigor calcium chloride injection effectively improved tenderness of top round steaks.

Wulf et al. (1996) reported that calcium chloride lessened the toughening effects of heating as degree of doneness increased. Because sensory evaluation was not included in the study, it is unclear what the trend might have been for flavor amount. Neely et al. (1999) found that for overall like of top round steaks, the cooking methods of simmer and stew, braising, and stir-fry were preferred at lower temperatures. Luchak et al. (1998) reported that eye of round steaks were more palatable when braised rather than roasted. For these reasons, the American Meat Science Association recommends using moist heat cooking methods when preparing the top round (AMSA, 1978).

Several studies have been conducted to determine palatability preferences of consumers (Miller et al., 1995a; Lorenzen et al., 2003). However, many factors affect consumer palatability, originating from both the product and the consumer. Lorenzen et al. (2003) reported that there was difficulty in predicting consumer responses from laboratory procedures, such as trained sensory panels and Warner-Bratzler shear force. This

makes consumer satisfaction studies more important because they assess consumers' preferences in-home.

Implications

Geographical location is a factor that can influence marketing tactics for specific cuts, as observed in this study with top round steak. Retailers practicing a blanket, nationwide marketing technique for a specific cut may find their efforts more successful in one region than in another. Warner-Bratzler shear forces were relatively low for top round steaks, and consumers may have been able to concentrate on flavor not tenderness. Additionally, preparation of top round steaks is clearly one of the most important factors in determining consumer acceptability.

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