

Beef customer satisfaction: Factors affecting consumer evaluations of calcium chloride-injected top sirloin steaks when given instructions for preparation¹

J. M. Behrends, K. J. Goodson,² M. Koohmaraie,³ S. D. Shackelford,³ T. L. Wheeler,³ W. W. Morgan,⁴ J. O. Reagan,⁵ B. L. Gwartney,⁵ J. W. Wise,⁶ and J. W. Savell⁷

Department of Animal Science, Texas Agricultural Experiment Station,
Texas A&M University, College Station 77843-2471

ABSTRACT: The objectives of this study were to evaluate whether instructions can help consumers properly prepare top sirloin steaks and to evaluate the use of calcium chloride injection to decrease the sensitivity of top sirloin steaks to degree of doneness, thereby improving customer satisfaction ratings. An in-home study evaluated top sirloin steaks (gluteus medius) as influenced by calcium chloride injection (injected vs. noninjected), 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 instructions (given vs. not given). Consumers evaluated overall like, tenderness, juiciness, flavor like, and flavor

amount using 10-point scales. Beef loyalists consistently rated steaks higher for overall like, juiciness, and flavor when instructions were provided ($P < 0.05$) and rated top sirloin steaks higher for overall like and tenderness when given instructions for grilling ($P < 0.05$). Budget rotators and variety rotators rated steaks differently among cooking methods ($P < 0.05$). Correlation and stepwise regression analyses indicated that flavor like was the most highly correlated with overall like, followed by tenderness, flavor amount, and juiciness. Calcium chloride injection had no effect on consumers' likes or dislikes or on tenderness ($P < 0.05$). For top sirloin steaks, it was likely that preparation played a major role in consumer satisfaction, and beef loyalists benefited the most from providing cooking instructions.

Key Words: Beef, Consumer Preference, Market Research

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Introduction

Improving consumer satisfaction with the palatability and consistency of beef products continues to be a

major focus for the beef industry. There have been a number of studies evaluating consumer preferences with regard to beef (Morgan et al., 1991b; Savell et al., 1991; Goodson et al., 2002). Savell et al. (1987, 1989) was one of the first to accumulate information on consumer practices on a large-scale basis. Palatability traits have been evaluated through numerous studies and have shown that there might be regional or a combination of various factors that influence consumer satisfaction (Neely et al., 1998, 1999; Lorenzen et al., 1999). Branson et al. (1986) reported that development of a consumer target based on sound consumer preference information is critical to developing beef marketing and production strategies.

Top sirloin steaks remain a troublesome cut for the beef industry because of the sensitivity of this steak to degree of doneness (Savell et al., 1999). Research has shown that calcium chloride injection can improve tenderness of tougher meat cuts (Koohmaraie et al., 1988; Morgan et al., 1991a; Wheeler et al., 1991). Thus, the hypothesis of this study was that calcium chloride injection of top sirloin steaks would affect consumer satisfac-

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²Present address: 646 South Main, Navy 5, San Antonio, TX 78204.

³USDA, ARS, Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, NE 68933-0166.

⁴Present address: 1525 Old Covington Road Northeast, Conyers, GA 30013.

⁵National Cattlemen's Beef Association, 9110 E. Nichols Ave., Centennial, CO 80112.

⁶USDA, AMS, Standardization Branch, 5890 Lake Drive, Mounds, OK 74047.

⁷Correspondence: 2471 TAMU (phone: 979-845-3935; fax: 979-845-9454; e-mail: j-savell@tamu.edu).

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tion and that consumer satisfaction would be affected by the supplementation of cooking instructions. As an extension of the Beef Customer Satisfaction Study (Neely et al., 1998; Goodson et al., 2002), the objective of this study was to examine the role that instructions, calcium chloride injection, degree of doneness, cooking method, and consumer segment had on customer satisfaction of top sirloin steaks.

Materials and Methods

Beef Selection

Carcasses were selected from the Excel Corporation (Schuyler, NE) beef processing facility as described by Goodson et al. (2002). Carcasses were graded by a USDA Standardization Branch representative, and 57 carcasses were selected to represent high Select (upper half of Slight marbling; USDA, 1997).

Top sirloins [Institutional Meat Purchase Specifications (IMPS) #184; USDA, 1996; gluteus medius and gluteobiceps] were obtained from both sides of carcasses ($n = 114$). Top sirloins from one side of each carcass were designated for calcium chloride injection. Top sirloins designated for calcium chloride injection were weighed and then passed through a multi-needle injector (Koch model 12354, 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 (Food Chemicals Codex dry food-grade, anhydrous; Tetra Chemicals, Houston, TX) made using cold tap water. After injection, cuts were allowed to drip for 5 min and then reweighed. All top sirloins were 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.

Steak Processing and Packaging

Following an aging period of 14 to 21 d, five paired steaks were removed from the right and left top sirloin of each carcass. Following the removal of the gluteobiceps, top sirloins (IMPS #1184; USDA, 1996; gluteus medius) were fabricated into 2.54-cm thick steaks. Beginning at the anterior end of the top sirloin, the first steak was assigned for shear force determination, whereas the remaining steaks were paired with their mirror steaks from the top sirloin of the opposing side of the same carcass for in-home consumer evaluations. All steaks were trimmed free of subcutaneous fat and vacuum-packaged individually on an American Can Bivac machine using roll stock oxygen barrier film (American National Can, Chicago, IL) before blast freezing at -40°C. Steaks remained frozen through delivery to the consumer.

Consumer Recruitment and Steak Distribution

Consumers in Chicago were recruited as reported by Goodson et al. (2002). Wirthlin Worldwide (Chicago,

IL) analyzed this information and, using an in-house cluster analysis algorithm, 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 levels and split their consumption among beef, poultry, and other foods.

Paired top sirloin steaks were presented to each consumer, which allowed for the evaluation of one steak with calcium chloride injection and one steak without from a single carcass. Additionally, one-half of the households ($n = 150$) were assigned randomly to a group that received a package describing several preparation methods, and the other one-half did not. In summary, households ($n = 300$) received two top sirloin steaks, one steak with calcium chloride injection and one steak without, for each consumer in the household; one-half of all households received cooking instructions, and the other one-half did not receive instructions. The study began with 600 consumers, and 436 completed the study.

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 cuts 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 flavor extremely, and an extreme amount of flavor to 1 = dislike extremely, not at all tender, not at all juicy, dislike flavor extremely, and no flavor at all). Each evaluation form also asked participants to determine degree of doneness of the beef at the time of consumption according to the National Live Stock and Meat Board beef steak color chart. Participants responded to this question by choosing 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" (National Live Stock and Meat Board, 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 (WBSF) determination followed the procedure described by Goodson et al. (2002). Steaks were cooked 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 WBSF 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 the GLM procedure of SAS (SAS Inst., Inc., Cary, NC), and the model for customer satisfaction ratings of top sirloin steaks included the main effects of calcium chloride injection, instructions, segment, degree of doneness, and cooking method, as well as 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). Pairwise correlation coefficients (PROC CORR) were generated between consumer ratings to determine the relationship of palatability attributes (tenderness, juiciness, and flavor) to overall like ratings. Stepwise regression analysis (PROC REG) was performed to develop equations involving those sensory traits that most contributed to overall like ratings.

Results

Some cooking methods and degrees of doneness were used infrequently and were combined for analysis. 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, three categories were created: medium and less (medium, medium rare, rare, and very rare), medium well, and well done and more (well done and very well done).

Overall Like Rating. Beef loyalists who received instructions rated top sirloin steaks higher ($P < 0.05$) in overall like than those who did not receive instructions (Table 1). Beef loyalists who did not receive instructions rated top sirloin steaks lower ($P < 0.05$) than budget rotators and variety rotators.

When instructions were provided, top sirloin steaks that were fried received higher ($P < 0.05$) overall like ratings than other cooking methods, whereas steaks that were broiled received lower ($P < 0.05$) overall like ratings than steaks that were grilled or fried when instructions were not provided (Table 2). Budget rotators and variety rotators gave higher ($P < 0.05$) overall like ratings to top sirloin steaks cooked medium and less compared with steaks cooked well done and more (Table 3). Variety rotators who broiled top sirloin steaks rated them among the lowest for overall like (Table 4). Budget rotators and variety rotators who fried top sirloin steaks rated them among the highest ($P < 0.05$) of all other combinations and greater ($P < 0.05$) than those grilled and broiled within each of their segments.

Table 1. Instructions \times segment interactive effects on in-home sensory evaluations of top sirloin steaks

Sensory trait	Segment ^a			P-value
	Beef loyalists	Budget rotators	Variety rotators	
Overall like ^b				0.021
Instructions provided	7.13 ^{ef}	7.27 ^{ef}	6.85 ^{fg}	
Instructions not provided	6.45 ^g	7.58 ^e	6.98 ^{ef}	
Juiciness ^c				0.006
Instructions provided	6.57 ^e	6.15 ^{ef}	6.32 ^e	
Instructions not provided	5.55 ^f	6.55 ^e	6.04 ^{ef}	
Flavor like ^d				0.014
Instructions provided	7.10 ^e	6.85 ^{ef}	6.55 ^f	
Instructions not provided	6.52 ^f	7.31 ^e	6.89 ^{ef}	

^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.

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

^d10 = like flavor extremely to 1 = dislike flavor extremely.

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

Tenderness Ratings

There were no effects of calcium chloride injection on tenderness ($P = 0.585$). When instructions were provided, top sirloin steaks that were fried received higher ($P < 0.05$) tenderness ratings than the other cooking methods, whereas steaks that were broiled had among the lowest tenderness ratings of the cooking methods when instructions were not provided (Table 5). Tenderness ratings for top sirloin steaks that were grilled were lower ($P < 0.05$) when instructions were provided than when instructions were not provided.

Top sirloin steaks that were broiled by budget rotators and variety rotators received among the lowest tenderness ratings compared with the other combinations of cooking method \times segment (Table 4). Beef loyalists gave top sirloin steaks that were fried lower ($P <$

Table 2. Instructions \times cooking method interactive effects on in-home sensory evaluations of top sirloin steaks

Sensory trait	Cooking method			P-value
	Grilled ^a	Broiled ^b	Fried ^c	
Overall like ^d				0.031
Instructions provided	6.68 ^h	6.35 ^h	8.21 ^f	
Instructions not provided	7.16 ^g	6.30 ^h	7.55 ^{fg}	
Juiciness ^e				0.009
Instructions provided	5.71 ^g	5.70 ^{gh}	7.62 ^f	
Instructions not provided	6.12 ^g	5.19 ^c	6.83 ^f	

^aGrilled included outdoor grilled and indoor grilled.

^bBroiled included broiled, oven roasted, and pan broiled.

^cFried included deep fried, pan fried/sautéed, and stir fried.

^d10 = like extremely to 1 = dislike extremely.

^e10 = very juicy to 1 = not at all juicy.

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

Table 3. Degree of doneness × segment interactive effects on in-home sensory evaluations of top sirloin steaks

Sensory trait	Segment ^a			P-value
	Beef loyalists	Budget rotators	Variety rotators	
Overall like ^b				0.039
Medium and less ^c	6.82 ^{ij}	8.06 ^h	7.10 ⁱ	
Medium well ^d	6.64 ^{ij}	7.28 ^{hi}	7.27 ^{hi}	
Well done and more ^e	6.92 ^{ij}	6.94 ^{ij}	6.36 ^j	
Tenderness ^f				0.001
Medium and less ^c	6.68 ^{ijk}	7.77 ^h	7.05 ^{hij}	
Medium well ^d	6.12 ^{kl}	6.92 ^{hijk}	7.40 ^{hi}	
Well done and more ^e	6.81 ^{ijk}	6.54 ^{ijkl}	5.92 ^l	
Juiciness ^g				0.012
Medium and less ^c	6.72 ⁱ	7.46 ^h	7.00 ^{hi}	
Medium well ^d	5.53 ^{kl}	6.11 ^{ijk}	6.46 ^{ij}	
Well done and more ^e	5.92 ^{jk}	5.48 ^{kl}	5.08 ^l	

^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.

^cMedium and less includes the degrees of doneness of medium, medium rare, rare, and very rare.

^dMedium well includes the degree of doneness of medium well.

^eWell done and more includes the degrees of doneness of well done and very well done.

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

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

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

0.05) tenderness ratings than the other segments who cooked with this method. Among the cooking methods, budget rotators and variety rotators gave higher ($P < 0.05$) tenderness ratings to steaks that were fried and gave the lowest ($P < 0.05$) tenderness ratings to steaks that were broiled.

Juiciness Ratings

For the instructions × segment interaction (Table 1), beef loyalists rated top sirloin steaks higher ($P < 0.05$) in juiciness when provided with instructions. Top sirloin steaks that were fried received higher ($P < 0.05$) juiciness ratings than steaks prepared using other cooking methods, regardless of whether instructions were provided (Table 2).

Beef loyalists and budget rotators rated top sirloin steaks cooked to a medium and less degree of doneness juicier ($P < 0.05$) compared with other degrees of doneness (Table 3). Among all segments, top sirloin steaks cooked medium and less generally received higher juiciness ratings than those cooked to higher degrees of doneness.

Top sirloin steaks that were fried generally received among the highest juiciness ratings from all three segments (Table 4). Top sirloin steaks that were broiled received among the lowest juiciness ratings from the budget rotators and variety rotators.

Table 4. Cooking method × segment interactive effects on in-home sensory evaluations of top sirloin steaks

Sensory trait	Segment ^a			P-value
	Beef loyalists	Budget rotators	Variety rotators	
Overall like ^b				0.022
Grilled ^c	6.67 ^{kl}	7.17 ^{jk}	6.92 ^{kl}	
Broiled ^d	6.65 ^{klm}	6.38 ^{lm}	5.95 ^m	
Fried ^e	7.05 ^{ijkl}	8.72 ⁱ	7.87 ^{ij}	
Tenderness ^f				0.029
Grilled ^c	6.65 ^{jk}	6.81 ^j	6.83 ^j	
Broiled ^d	6.24 ^{ijkl}	5.99 ^{kl}	5.76 ^l	
Fried ^e	6.71 ^{jk}	8.43 ⁱ	7.78 ⁱ	
Juiciness ^g				0.009
Grilled ^c	5.83 ^{kl}	5.96 ^{kl}	5.97 ^{kl}	
Broiled ^d	5.95 ^{kl}	5.04 ^m	5.35 ^{lm}	
Fried ^e	6.40 ^{jk}	8.05 ⁱ	7.23 ^{ij}	
Flavor amount ^h				0.005
Grilled ^c	6.54 ^j	6.88 ^j	6.63 ^j	
Broiled ^d	6.67 ^j	5.76 ^k	5.59 ^k	
Fried ^e	6.65 ^j	7.97 ⁱ	7.12 ^{ij}	

^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.

^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.

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

Flavor Like Ratings

Cooking method ($P < 0.001$) and instruction × segment interaction ($P < 0.014$) affected consumer flavor like ratings. Top sirloin steaks that were fried received the highest ($P < 0.05$) flavor like ratings followed by grilled and then broiled (7.67, 6.77, and 6.18, respectively). For the instructions × segment interaction (Table 1), beef loyalists gave higher ($P < 0.05$) flavor like ratings to top sirloin steaks when instructions were provided than when instructions were not provided.

Table 5. Instructions × cooking method interactive effect on top sirloin steak tenderness ratings (10 = very tender to 1 = not at all tender)

	Cooking method			P-value
	Grilled ^a	Broiled ^b	Fried ^c	
Instructions provided	6.49 ^f	6.14 ^{fg}	7.95 ^d	0.012
Instructions not provided	7.04 ^e	5.85 ^g	7.34 ^{de}	

^aGrilled included outdoor grilled and indoor grilled.

^bBroiled included broiled, oven roasted, and pan broiled.

^cFried included deep fried, pan fried/sautéed, and stir fried.

^{d,e,f,g}Least squares means that do not have common superscript letters differ, $P < 0.05$.

Table 6. Simple correlations of consumer ratings for top sirloin steaks

	Overall like	Tenderness	Juiciness	Flavor like
Tenderness	0.812*			
Juiciness	0.735*	0.763*		
Flavor like	0.870*	0.762*	0.735*	
Flavor amount	0.747*	0.676*	0.654*	0.833*

* $P < 0.001$.

Flavor Amount Ratings

The cooking method \times segment interaction revealed that beef loyalists gave higher ($P < 0.05$) flavor amount ratings to top sirloin steaks that were broiled than budget rotators and variety rotators (Table 4). Budget rotators gave top sirloin steaks that were fried higher ($P < 0.05$) flavor amount ratings than the other specified cooking methods. Top sirloin steaks that were broiled received the lowest ($P < 0.05$) flavor amount ratings from budget rotators and variety rotators.

Correlation and Regression of Consumer Attributes of Top Sirloin Steaks

All traits were highly correlated to each other (Table 6). Flavor like was the sensory trait that was most highly correlated to overall like, followed by tenderness, flavor amount, and juiciness. It was clear that flavor desirability was of great importance to consumer satisfaction of top sirloin steaks. For all three segments, flavor like was the palatability trait most highly correlated with overall like (Table 7). Budget rotators had fairly similar correlations for tenderness, juiciness, and flavor amount with overall like. Finally, the primary difference between the variety rotators and beef loyalists was that beef loyalists had higher correlations between flavor amount and juiciness with overall like than did variety rotators.

For the stepwise regression analysis (Table 8), flavor like was the first variable entered into the equation for predicting overall like. The second variable entered was tenderness, and the third variable was juiciness. Flavor

Table 7. Simple correlations of overall like ratings with the other consumer ratings for top sirloin steaks stratified by segment

Segment ^a	Tenderness	Juiciness	Flavor like	Flavor amount
Beef loyalists	0.843*	0.782*	0.894*	0.794*
Budget rotators	0.773*	0.761*	0.858*	0.770*
Variety rotators	0.800*	0.677*	0.854*	0.692*

^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.

* $P < 0.001$.

amount did not meet the significance level ($P < 0.05$) requirement for entry into the model. Although tenderness increased the R^2 of the equation, it was obvious that juiciness did not materially add to the predictive nature of the model. Hence, flavor like was driving customer satisfaction of the top sirloin steaks.

Warner-Bratzler Shear Force Determination

For top sirloin steaks, no differences in WBSF values were found between calcium chloride-injected and non-injected treatments (2.72 vs. 2.90 kg; $P = 0.173$). Mean values generally were very tender, and shear force values reported were above average for this cut. Shear force values reported in this study either reached (top sirloin steaks) or exceeded expectations for tenderness.

Discussion

It is inevitable that consumers will prepare beef using different cooking methods and degrees of doneness. The work by Savell et al. (1987, 1989) demonstrated that consumers from different cities responded differently to the same kinds of beef. Savell et al. (1999) found that some cooking methods were affected by degree of doneness. As degree of doneness increased, palatability ratings decreased, whereas other cooking methods displayed increased palatability ratings when steaks were cooked to a well-done or higher degree of doneness (Savell et al., 1999). In the current study, consumers rated steaks cooked to a medium and less degree of doneness juicier than other degrees of doneness for sirloin steaks. Similarly, Neely et al. (1999) found that top round steaks cooked to lower degrees of doneness received higher juiciness ratings, and when steaks were cooked using various cooking methods, such as stir fry, pan broil, or simmered and stewed, there were no differences resulting from degree of doneness. Lorenzen et al. (1999) found consumer sensory overall like scores were highest for steaks cooked to medium rare or lower degrees of doneness; however, consumers preferred medium and well done or more degrees of doneness over medium well. The importance of these findings is that cooking method determines much of the consumer palatability ratings. When consumers were given instructions on how to cook the top sirloin steaks, some cooking methods performed better than others on consumer palatability ratings.

Results of the current study indicated that flavor was the most important palatability characteristic in determining overall like; however, all palatability characteristics were highly correlated with overall like. These findings differ from Savell et al. (1987, 1989), who reported that the single most important factor affecting consumer perceptions of beef was tenderness. However, Neely et al. (1998) found that flavor may be just as, or more important than, tenderness in determining overall like. Nonetheless, all palatability traits must be evaluated to understand consumer acceptability fully.

Table 8. Stepwise regression for predicting overall like ratings of top sirloin steaks with the other consumer ratings^a

Equation	R ²	C _p	Intercept	Flavor like	Tenderness	Juiciness
1	0.759	221.45	1.2806	0.827		
2	0.810	6.17	0.7648	0.573	0.332	
3	0.811	3.43	0.7603	0.553	0.307	0.050

^aOnly variables that met the significance level ($P < 0.05$) were included in the model.

The current study indicates that when meat is acceptable in tenderness, flavor will play a major role in consumer satisfaction. Miller et al. (1995a) reported that tenderness scores increased as shear force value decreased, indicating that consumers could detect changes in shear force values. In addition, they found that consumers tolerated tougher meat in the restaurant than in their homes, and when rating overall acceptability of steaks, consumers were less critical than when rating tenderness acceptability (Miller et al., 1995a).

There have been many attempts to improve the consistency of beef through injection of calcium chloride. Several studies have evaluated the effect of prerigor injection of calcium chloride on tenderness (Koochmaraie et al., 1989; Morgan et al., 1991a), which helps to activate the calcium-dependent proteolytic systems and increases tenderness (Koochmaraie et al., 1988, 1990; Koochmaraie and Shackelford, 1991). In the current study, the injection of calcium chloride was postrigor, which might have limited the effectiveness of the calcium-dependent proteolytic systems on tenderness; however, postrigor calcium chloride injection has been shown to improve tenderness (Wheeler et al., 1997). Lansdell et al. (1995) and Miller et al. (1995b) reported that consumers rated postrigor steaks treated with calcium chloride higher for tenderness, juiciness, flavor, and palatability than control steaks.

Shackelford et al. (1991) reported that WBSF threshold could be used as a tenderness benchmark in beef palatability. They identified two critical shear force threshold levels of 3.86 kg for rib and loin cuts and 4.59 kg for round and chuck cuts. In addition, Huffman et al. (1996) found that WBSF values of ≤ 4.1 kg would ensure a high level (98%) of consumer acceptability. In the current study, shear forces were below the threshold, and, as expected, consumers deemed top sirloin steaks acceptable in tenderness. Aging of the top sirloins could help explain the lack of differences between treatments for WBSF. Aging might have eliminated any initial effect that injection of 5% calcium chloride might have had on top sirloin steaks. Wheeler et al. (1992), however, found that even postrigor injection of calcium chloride can increase tenderness. There were no WBSF differences for degree of doneness, despite findings by Wulf et al. (1996), who reported lower shear force values at medium rare and medium degree of doneness for sirloin steaks.

In conclusion, factors that make beef desirable are interrelated and complicated. To understand fully the potential of a muscle, or a cut such as the top sirloin steak, consumer assessment must be done to ensure proper marketing for optimal customer satisfaction.

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