

Consumer Evaluation of Beef of Known Categories of Tenderness¹

S. J. Boleman², S. L. Boleman², R. K. Miller², J. F. Taylor³, H. R. Cross⁴,
T. L. Wheeler⁵, M. Koochmarai⁵, S. D. Shackelford⁵, M. F. Miller⁶,
R. L. West⁷, D. D. Johnson⁷, and J. W. Savell^{2,8}

Texas Agricultural Experiment Station, Texas A&M University, College Station 77843-2471

ABSTRACT: A study was conducted to determine consumer perceptions of beef top loin steaks of known shear force and to evaluate how buying trends were modified by the tenderness and price variations of these steaks. Strip loins were cut into 2.54-cm-thick steaks, and the center steak from each strip loin was used to determine Warner-Bratzler shear force. The remaining steaks were placed into one of the following shear force categories based on that shear force and color-coded accordingly: 1) 2.27 to 3.58 kg (Red); 2) 4.08 to 5.40 kg (White); and 3) 5.90 to 7.21 kg (Blue). Randomly recruited consumers were allowed to evaluate steaks and then purchase steaks based on

their findings. A \$1.10/kg price difference was placed between each category. Results of the analysis indicated that consumers were able to differentiate between the three categories of tenderness ($P < .05$). In addition, consumers gave higher ($P < .05$) juiciness and flavor ratings to Red steaks than to Blue steaks. Overall satisfaction was higher ($P < .05$) for Red steaks than for the other two categories of steaks. The following percentages of steaks were purchased: 1) Red, 94.6%; 2) White, 3.6%; and 3) Blue, 1.8%. These results suggest that consumers could discern between categories of tenderness and were willing to pay a premium for improved tenderness.

Key Words: Beef, Tenderness, Consumers, Prices

J. Anim. Sci. 1997. 75:1521-1524

Introduction

Findings from the National Beef Tenderness Survey (Morgan et al., 1991) revealed that beef was too variable in tenderness. Consumer studies such as the National Consumer Retail Beef Study (Savell et al., 1987, 1989) have used grades or marbling scores to create different kinds or categories of beef for consumers to evaluate. These kinds or categories of beef have been thought to have different potential palatability characteristics, and the findings of these studies have shown that consumers found various degrees of tenderness within each category. Results of studies such as those reported by Savell et al. (1987, 1989)

can be used to recategorize or possibly redraw grade lines, but they do not address whether consumers will be more satisfied, or more importantly, be willing to pay more in the marketplace for beef that is *guaranteed* tender. Until some measure of what real, not perceived, differences in tenderness are worth to the consumer, there is limited research information to convince those in the beef industry that tenderness is something to search for, manage, and market. Without information regarding economic incentives, most entities within the beef industry will continue to ignore tenderness, and beef will remain variable in eating quality to the consumer. Therefore, this study was designed to determine consumer perceptions of beef top loin steaks of known shear force and to evaluate how buying trends were modified by tenderness and variations of these steaks.

Materials and Methods

Sample Preparation. Strip loins, IMPS 180A (USDA, 1988), were cut into 2.54-cm-thick steaks with no more than .32 cm of external fat trim and 1.27-cm tails. Steaks with an exposed gluteus medius were eliminated from the study. The steaks were individually vacuum-packaged, frozen, and stored at

¹Technical Article from the Texas Agric. Exp. Sta.

²Meat Sci. Section, Dept. of Anim. Sci.

³Anim. Genet. Section, Dept. of Anim. Sci.

⁴Inst. Food Sci. and Eng., Texas A&M University, College Station, 77843-2471.

⁵USDA-ARS, Roman L. Hruska Meat Animal Research Center, Clay Center, NE 68933.

⁶Dept. of Anim. Sci., Texas Tech Univ., Lubbock, 79409.

⁷Dept. of Anim. Sci., Univ. of Florida, Gainesville, 32611.

⁸Author to whom correspondence should be addressed.

Received June 10, 1996.

Accepted January 16, 1997.

Table 1. Retail prices for beef top loin steaks bought by consumers during initial purchase (Phase II) and repurchase (Phase III)

Product	Red (Tender)	White (Intermediate)	Blue (Tough)
Phase II			
Without discount, \$/kg ^a	12.10	12.10	12.10
With 30% discount, \$/kg	8.46	8.46	8.46
Phase III			
Without discount, \$/kg	13.20	12.10	11.00
With 30% discount, \$/kg	9.56	8.46	7.36

^aBased on local retail prices.

-23.3°C. No attempt was made to categorize steaks based on origin, length of aging, or quality grade. It was not important how or why the meat became tender or tough, but rather what the consumer response would be.

The center steak of each strip loin was designated for Warner-Bratzler shear force determination. Shear force steaks were thawed (4°C), broiled to an internal temperature of 35°C, turned, and broiled to an internal temperature of 70°C. Steaks were cooled to an ambient temperature (25°C) before removal of six cores (1.27 cm diameter) parallel to the longitudinal orientation of the muscle fibers. Each core was sheared once with a Warner-Bratzler shearing device. The remaining steaks from each strip loin were placed into one of the following categories based on their respective shear force values: 1) 2.27 to 3.58 kg (tender); 2) 4.08 to 5.40 kg (intermediate); and 3) 5.90 to 7.21 kg (tough). Shackelford et al. (1991) stated that the threshold for Warner-Bratzler shear force values for retail beef was 4.6 kg. Therefore, this value was used as the midpoint for the intermediate category, and the remaining categories were established around the intermediate category. Category 1 steaks were color-coded with Red labels, category 2 steaks with White labels, and category 3 steaks with Blue labels. Product that met the shear force specifications for the Blue category was difficult to obtain. Therefore, it was necessary to use a limited number of steaks with zero fat trim and no tail.

Phase I. Forty-two families were recruited from the Bryan-College Station, TX, area to serve as consumers for the study. Specific demographics of the consumers were not obtained. The intent was not to project consumer targets, but to obtain information so that an in-depth consumer study could be designed if findings proved positive. Two steaks from each category were delivered to each household by Texas A&M University (TAMU) personnel. To account for sampling variation, the household was instructed as to the order in which the categories of steaks should be evaluated. There were six possible combinations in which the three color categories could be ordered. These six possible combinations were assigned randomly among the 42 households, resulting in seven households per

combination. The steaks were identified to the consumers only by their color-coded labels. Therefore, consumers associated their likes and dislikes with a particular color category. Two participating adults from each family were given 2 wk to prepare and evaluate the steaks as they wished. An evaluation form for each steak was completed by each participant using a 23-point scale (National Live Stock and Meat Board, 1995). Evaluations were made concerning the consumers' satisfaction with the product, as well as the thawing methods, preparation methods, and degree of doneness. At the time of delivery, TAMU personnel presented the consumers with detailed instructions for completing the evaluation form, both orally and in written form. The TAMU personnel answered all questions and made certain that all consumers completely understood the requirements of their participation.

Phase II. Two weeks following Phase I, a retail display of the color-coded steaks was made available at the Texas A&M University Rosenthal Meat Science and Technology Center for the consumers participating in Phase I. Vacuum-packaged steaks were displayed in a commercial retail display case (Tyler model DM8). All three categories of steaks were priced the same, regardless of their known shear force values (Table 1). Consumers were not informed of the known shear force values. Consumers were given the opportunity to purchase steaks based on their observations from Phase I. Because the purchase of steaks was essential to data collection, the consumers were given a 30% price reduction, relative to then-current Bryan-College Station prices, as an incentive to purchase steaks. Phase II was accessible to consumers on three consecutive days. Data were collected on the number of steaks purchased from each category.

Phase III. Three weeks following Phase II, consumers were contacted via telephone and given another opportunity to purchase steaks based on their observations from Phases I and II. Their purchasing decisions were made strictly via telephone. The steaks were priced according to their shear force category with a \$1.10/kg difference between each of the three groups (Table 1). Additionally, consumers were informed of the known shear force values. As in Phase II, a 30% price reduction was given as an incentive to

Table 2. Mean scores for palatability evaluations of beef top loin steaks segmented according to Warner-Bratzler shear force^a

Variable	Red (Tender)	White (Intermediate)	Blue (Tough)	SEM
Overall satisfaction	16.91 ^b	14.06 ^c	12.90 ^c	.44
Tenderness	16.61 ^b	13.66 ^c	11.61 ^d	.46
Tenderness satisfaction	16.51 ^b	13.53 ^c	11.53 ^d	.48
Juiciness	16.40 ^b	13.24 ^c	12.51 ^c	.45
Juiciness satisfaction	16.43 ^b	13.29 ^c	12.53 ^c	.46
Flavor	15.81 ^b	14.43 ^{bc}	12.98 ^c	.46
Flavor satisfaction	16.07 ^b	14.47 ^c	13.34 ^c	.48

^aBased on a 23-point scale: 23 = very satisfied, very tender, very juicy, or very flavorful, and 1 = very dissatisfied, not at all tender, not at all juicy, or no flavor at all.

^{b,c,d}Means within rows with different superscripts differ ($P < .05$).

purchase steaks. Data were collected on the number of steaks purchased from each category.

Statistical Analyses. Analysis of variance was performed using the GLM procedure of SAS (1985). The main effect of shear force category was analyzed for differences in consumer overall satisfaction, tenderness, tenderness satisfaction, juiciness, juiciness satisfaction, flavor, and flavor satisfaction. When analysis of variance indicated significance ($P < .05$), mean separations were performed using Tukey's test, with a predetermined significance level of $P < .05$. Class frequencies were compared using the Neyman-Pearson likelihood ratio test in which a general multinomial model was fit under the alternate hypothesis and pairs of class frequencies were sequentially constrained to equality in each null hypothesis.

Results and Discussion

Phase I. Table 2 presents mean scores for evaluations of beef top loin steaks based on a 23-point scale. Overall satisfaction was highest ($P < .05$) for Red steaks, and no difference ($P > .05$) was detected in overall satisfaction between White and Blue steaks. Consumers were able to detect differences between each of the three categories of tenderness ($P < .05$), with Red steaks receiving the highest tenderness scores and Blue steaks receiving the lowest tenderness scores. Similar results were observed for tenderness satisfaction; consumers were most satisfied with the tenderness of the Red steaks and least satisfied with the tenderness of the Blue steaks ($P < .05$). Juiciness and juiciness satisfaction were the highest ($P < .05$) for the Red steaks compared with either the White or Blue steaks. No difference ($P > .05$) was observed between the White and Blue steaks for these two traits. Consumers gave more desirable ($P < .05$) flavor scores to Red steaks than to Blue steaks, and they were most satisfied ($P < .05$) with the flavor of the Red steaks compared with either the White or Blue steaks.

The evaluation forms completed by each consumer provided information concerning thawing methods,

preparation methods, and degrees of doneness. However, no attempt was made to determine how these preparation methods may have influenced customer satisfaction. When consumers were asked, "How did you thaw the beef?," the majority ($P < .01$) of consumers reported that they thawed the product in the refrigerator the day before they wished to prepare it. The second most ($P < .01$) common method was reported by 15.9% of the consumers who placed the product in the refrigerator the same day they wished to prepare it. Microwaving the product and allowing the product to thaw at room temperature each accounted for 6.1% of the responses, and 1.7% of the consumers reportedly cooked the product from its frozen state.

When consumers were asked, "What was added to the beef as it was prepared or cooked?," 60% reported pepper, 47.6% reported herbs or spices, and 45.5% reported salt. Tenderizer, marinade, flour, sauce, and other ingredients were added by 9.8, 8.1, .8, 12.5, and 5.8% of the consumers, respectively. Fourteen percent of the consumers reported that they added nothing to the product as it was prepared or cooked. A higher ($P < .01$) percentage of consumers added pepper than any other ingredient, and salt or herbs/spices was added more ($P < .05$) frequently than tenderizer, marinade, flour, sauce, other ingredients, or nothing.

Outdoor grilling was the predominant ($P < .01$) cooking method used by consumers, representing 66.6% of all steaks cooked, followed by broiling (16.7%), pan frying/sautéing (8.4%), indoor grilling (4.2%), braising (2.1%), deep frying (.8%), other (.8%), and pan broiling (.4%). None of the consumers reported cooking the steaks by oven roasting, stir frying, or stewing. Neely et al. (1995) reported similar findings; the most common method of cookery for beef consumers of top loin steaks was outdoor grilling (50%). The slightly higher percentage observed in the present study is most likely due to the mild climate of the location of the study, which is more conducive to outdoor grilling, compared with the climates of the locations used by Neely et al. (1995).

Degree of doneness frequencies revealed that consumers cooked 45.5% of steaks to a medium-well

degree of doneness or higher. The following are frequencies by degree of doneness: very well done, 2.9%; well done, 19.1%; medium well, 23.5%; medium, 28.7%; medium rare, 25.4%; rare, .4%; and very rare, 0%. Steaks were less ($P < .01$) frequently cooked to a very well, rare, or very rare degree of doneness than to the other degrees of doneness. Additionally, a higher ($P < .01$) percentage of consumers preferred a medium degree of doneness than a well degree of doneness. These values are comparable to those reported by Neely et al. (1995), with 58% of consumers cooking their steaks to a medium well degree of doneness or higher.

Phases II and III. Table 3 contains the percentages of steaks purchased in Phases II and III. Twenty-eight of the 42 families attended Phase II of the study. Participants in this study were volunteers and were asked to purchase product in Phases II and III, which may have contributed to the loss of some of the participants. Of the 28 families attending Phase II, 19 purchased steaks. A total of 103 steaks was purchased; the following numbers of steaks were purchased from each category: 1) Red, 57; 2) White, 13; and 3) Blue, 33. These numbers correspond to 55.3, 12.6, and 32.0% of the steaks bought for the Red, White, and Blue categories, respectively. The higher ($P < .05$) percentage of steaks purchased from the Red category than from the White or Blue categories was indicative of the higher tenderness scores given to steaks in this same category. However, the fact that more ($P < .01$) steaks were purchased from the Blue category than from the White category does not follow the results of the tenderness evaluations. It is possible that the number of Blue steaks purchased was influenced by the amount of fat trim of some of the Blue steaks. Product that met the shear force specifications for this category was difficult to obtain, and it was necessary to use a limited number of steaks with zero fat trim and no tail. Consumer purchasing decisions may have been influenced by the lower fat trim level and marbling of these steaks.

In Phase III, 17 families purchased steaks; 111 steaks were purchased. The purchases were made via telephone communication, without visitation at the retail display. The following numbers were purchased from each category: 1) Red, 105; 2) White, 4; and 3) Blue, 2. These numbers correspond to 94.6, 3.6, and 1.8% of the steaks bought for the Red, White, and Blue categories, respectively. Although a \$1.10/kg price difference was placed between each category, purchases continued to reflect the results of the evaluation scores, with a higher ($P < .05$) percentage of consumers purchasing steaks from the Red category than from the White or Blue categories. The disclosure of the shear force values most likely reinforced consumer purchasing decisions, resulting in the purchase of 94.6% Red steaks. The greater leanness that resulted in the Blue steaks receiving an unexpectedly

Table 3. Percentages of beef top loin steaks purchased by consumers during initial purchase (Phase II) and repurchase (Phase III)

Category ^a	Phase II	Phase III
Red (Tender)	55.3 ^b	94.6 ^b
White (Intermediate)	12.6 ^c	3.6 ^c
Blue (Tough)	32.0 ^d	1.8 ^c

^aDetermined by Warner-Bratzler shear force.

^{b,c,d}Means within columns with different superscripts differ ($P < .05$).

high purchase rate in Phase II was not a factor in Phase III because consumers purchased by phone. The tenderness characteristics of the three categories were described to the consumers during the telephone conversation; thus, they did not see the leanness difference that they did in Phase II. The results from this study suggest that consumers can detect differences among three categories of tenderness in beef top loin steaks. Additionally, these same consumers were willing to pay a premium for guaranteed tenderness.

Implications

With the ability of consumers to discriminate among tenderness categories and their willingness to pay a premium for tender beef, it is possible that economic incentives may be used from retailers to packers to promote the production, identification, and marketing of tender beef. Future studies must identify the magnitude of price differential that would be paid for specific degree of tenderness and the mechanism for identification of tenderness categories in the live animal or carcass form.

Literature Cited

- Morgan, J. B., J. W. Savell, D. S. Hale, R. K. Miller, D. B. Griffin, H. R. Cross, and S. D. Shackelford. 1991. National Beef Tenderness Survey. *J. Anim. Sci.* 69:3274.
- National Live Stock and Meat Board. 1995. Beef customer satisfaction: Report to the industry. National Live Stock and Meat Board, Chicago, IL.
- Neely, T. R., J. W. Savell, R. K. Miller, J. D. Tatum, J. W. Wise, and J. O. Reagan. 1995. Customer satisfaction for beef: Behavioral frequency of cooking methods and endpoint temperatures used by beef consumers for in-home preparation of three retail cuts. *J. Anim. Sci.* 73(Suppl. 1):13(Abstr.).
- SAS. 1985. SAS User's Guide: Statistics (Version 5 Ed.). SAS Inst. Inc., Cary, NC.
- Savell, J. W., R. E. Branson, H. R. Cross, D. M. Stiffler, J. W. Wise, D. B. Griffin, and G. C. Smith. 1987. National Consumer Retail Beef Study: Palatability evaluations of beef loin steaks that differed in marbling. *J. Food Sci.* 52:517.
- Savell, J. W., H. R. Cross, J. J. Francis, J. W. Wise, D. S. Hale, D. L. Wilkes, and G. C. Smith. 1989. National Consumer Retail Beef Study: Interaction of trim level, price and grade on consumer acceptance of beef steaks and roasts. *J. Food Qual.* 12:251.
- Shackelford, S. D., J. B. Morgan, H. R. Cross, and J. W. Savell. 1991. Identification of threshold levels for Warner-Bratzler shear force in beef top loin steaks. *J. Muscle Foods* 2:289.
- USDA. 1988. Institutional meat purchase specifications for fresh beef. Agric. Marketing Serv., USDA, Washington, DC.