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J ANIM SCI 1996, 74:91-97.

Effect of Beef Tenderness on Consumer Satisfaction with Steaks Consumed in the Home and Restaurant

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ABSTRACT: Loin steaks were eaten by 67 consumers over a 15-wk period (n = 739 consumer observations) to determine the consumer acceptability of beef tenderness in the home and a "white table cloth" restaurant. Steaks were rated for tenderness, juiciness, flavor, and overall palatability on an 8-point scale. The acceptability levels for tenderness were established based on Warner-Bratzler shear (WBS) force values, tenderness ratings, and a chi-square analysis of the judgment of tenderness and overall acceptability by the same consumers in both the home and restaurant. Results based only on observations from consumers in Lubbock, TX indicated that the beef industry should target production of beef steaks that have a Warner-Bratzler shear force value of 4.1 kg or less to ensure high levels (98%) of consumer acceptability. Results suggest that an acceptable level of beef tenderness for consumers can be determined and WBS values can be used as criteria for determining which steaks will be considered acceptably tender to consumers before distribution to retail outlets. The beef industry needs to conduct a nationwide research study to determine whether the results from this study will apply to all U.S. beef consumers.

Key Words: Acceptability, Beef, Consumers, Restaurants, Steaks, Tenderness

J. Anim. Sci. 1996. 74:91–97

Introduction

Lifestyle changes have made major impacts on the consumption of beef over the last decade (Menkaus et al., 1993); it declined 23% from 1979 to 1990 (USDA, 1990). Much of this decline is due to a change in the intensity of consumer preference for attributes such as speed of preparation, convenience, and health that have an important influence on beef products and services that compete to fulfill consumer needs (Anderson and Shugan, 1991).

Despite the decline in the overall consumption of beef, little evidence of this trend exists in the food service industry, especially restaurants. Beef usage by food service operators has increased over the past decade (Anderson, 1991). Stringent health and nutrition rules that consumers might follow at home are put aside when eating out. Industry analysts indicate that Americans have shifted their passion for consuming steaks in the home to consuming steaks in restaurants (Farkas, 1993). Important in capitalizing on the desirability of beef is the restaurant owners' need to be able to identify exactly how tender their particular customers like their steaks.

Tenderness has been identified as the most important palatability attribute of meat and, thus, the primary determinant of meat quality (Dikeman, 1987; Miller et al., 1995). Retailers and restauranteurs rated tenderness as one of their top 10 concerns (Smith, 1992). Establishing a tenderness acceptability level for consumer markets (restaurant vs home) could lead to new marketing schemes, for which a tenderness value is actually placed on a package for sale to restaurants or in the retail case. Knowing what a consumer perceives as acceptable tenderness in a restaurant, as opposed to the home, has important implications.

Objectives of this study were to determine consumers' perceptions of tenderness, flavor, and juiciness of beef steaks served in the home and restaurant setting; to determine the acceptability level for beef steak tenderness as evaluated by consumers; and to establish the relationship between WBS force values and beef tenderness ratings by consumers.

[1]Mention of a trade name, propriety product, or specific equipment does not constitute an approval to the exclusion of other products that also may be suitable.

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Received December 19, 1994.

Accepted October 19, 1995.

Materials and Methods

Meat

Loin strips (IMPS #180, n = 320) were purchased from the Excel Corporation in Plainview, TX. The meat was aged for 7 d at the Texas Tech University Meat Laboratory in a 2°C cooler. Individual steaks 2.54 cm thick were cut from the longissimus muscle. The strip portion of this muscle was selected because it is the most typical cut served in restaurants and is also available from retail outlets. Each steak was vacuum-packaged in Cryovac B550 bags (Cryovac Division of W.R. Grace & Co., Duncan, SC). The steaks for the home and restaurant study were stored at –20°C for 45 d until data collection.

Warner-Bratzler Shear Evaluation

Steaks for WBS evaluation were thawed at 2°C for 48 h before WBS evaluations; two steaks from each loin strip were evaluated for WBS. The steaks were broiled on an Open Hearth electric broiler (Farberware, Bronx, NY) to an internal temperature of 70°C. Temperature was monitored with a digital meat thermometer (Model 9865, Taylor, KOCH Supplies, Kansas City, MO). Steaks were cooked to 40°C and turned once. Steaks were chilled for 24 h at 4°C for shear force testing; six cores 1.3 cm in diameter were taken from each of the chilled steaks, parallel to the muscle fiber orientation. After reaching room temperature, each core was sheared once with the WBS device, and an average was obtained for each steak. The WBS force values from the steaks evaluated in the laboratory were matched to the steaks from the same loin strip that were consumed and evaluated by the consumers in the home and restaurant.

Consumer Panel

Subjects were selected from consumers who sampled steaks at supermarkets in Lubbock, TX. Three stores within the same chain were targeted in different areas of the city to obtain consumers with variations in income, ethnicity, education level, gender, and age. Consumers tasted a sample of steak near the meat counter. Panelists rated the sample and filled out a prescreening form that included information on preferred cooking method, degree of doneness, and demographic characteristics. Researchers used the forms to obtain the sample of panelists for the study. Consumers were selected based on the following criteria: use of a grilling cooking method, a preference for steaks cooked to a medium degree of doneness, and specific demographic characteristics to ensure a wide distribution of family income, age, education level, ethnic origin, and gender.

For the home study, steaks were distributed to 90 families; 75 returned the research instrument, a return rate of 83%. Family size varied from one to eight members. A total of 159 consumers completed and returned the research instrument and 884 steaks were evaluated.

For the restaurant portion of the study, 75 panelists were selected from those who completed the home study. The selection criteria used for restaurant panelists were the same as in the home study. Sixty-seven panelists completed the restaurant study with a participation rate of 90%. A total of 345 steaks were evaluated in the restaurant. This study utilized paired data from consumers who participated in home and restaurant. Only evaluations from consumers who participated in both environments were used (home n = 394, restaurant n = 345).

Consumer Evaluation Process

Home Use Tests. Eight loin strip steaks were randomly assigned to each family for evaluation. The steaks were bagged with identification tags and instructions for cookery, sensory evaluation forms, and a beef steak color guide for doneness of muscle (The Meat Board Beef Steak Color Guide, 1979). The instructions explained cooking method (i.e., grilling), evaluation procedures, tenderness ratings, and phone numbers to contact the researcher with any questions. Consumers were asked to grill the steaks to a medium degree of doneness as illustrated in the beef steak color guide.

Each family member older than 8 yr was asked to score each steak on an 8-point scale (8 = extremely tender, 7 = very tender, 6 = moderately tender, 5 = slightly tender, 4 = slightly tough, 3 = moderately tough, 2 = very tough, and 1 = extremely tough; Cross, 1978). Panelists also were asked to rate juiciness, flavor, and overall palatability on a similar 8-point scale. Tenderness and overall acceptability was judged “acceptable” or “unacceptable” on the same evaluation form. Consumers also were asked which trait was most important to beef palatability (tenderness, juiciness, or flavor). The data collection period lasted 2 mo.

Restaurant. Each consumer was randomly assigned six loin strip steaks for evaluation. Steaks were thawed in a 2°C refrigerator for approximately 36 h, transported to the restaurant, and stored at 2°C on the day of service. The vacuum packages were removed and a restaurant-type steak pick was labeled with the corresponding five-digit assigned number and placed in the steak. Steaks were held in refrigerated (2°C) conditions until they were pulled for grilling.

Data were collected at Skyviews of Texas Tech, a laboratory restaurant used by the Restaurant, Hotel, and Institutional Management (RHIM) program in the College of Human Sciences, Texas Tech University. Skyviews provides an upscale dining environment with linen tablecloths, fine china, silver, stemware, and cloth napkins. Consumer panelists were asked to attend six 1.5-h test meals over a

7-wk period. The consumer panel was composed of families, consisting of one to five members who dined at 1730, 1800, or 1830. Each panelist was assigned the same seat for the six evaluation sessions.

Upon arrival at Skyviews, panelists were seated and drink orders were taken. Wine was offered to the panelists when the entree course was presented. Panelists were instructed not to consume the wine until they had rated all of the sensory attributes of the steak, to ensure that the alcohol would not affect results.

Restaurant-type tickets with panelist numbers were turned over to an expediter in the kitchen. Steaks then were pulled from the cooler according to the panelist numbers on the ticket. The appetizer and salad course was presented and the grilling process was initiated.

Steaks were placed on the grill, and the numbered pick was placed in a rectangular styrofoam block in the position to correspond with the steak on the grill. Steaks were grilled to a medium degree of doneness, using a Star-Max Broiler (Star Manufacturing International, Smithville, TN). The internal temperature of the steaks was monitored using an Omega DP80 series potentiometer (Omega Engineering, Stamford, CT). When the steaks reached 70°C the corresponding numbered pick was inserted into the steak, salt and pepper seasoning was added, and the steak was placed on a dinner plate.

At the completion of the salad course, the entree course of the steak sample, vegetable medley, roasted new potatoes, and freshly baked bread was presented. Evaluation notebooks then were distributed to the panelists by the service manager who gave a brief discussion of the evaluation forms, instructed the panelist to follow the instructions on the evaluation forms, and answered questions. The panelists were given ample time to complete the evaluation form, with the same scales as in the home, for the steak sample during the entree course. A dessert course completed the meal.

Statistical Analysis

In this study, the demographic groupings, tenderness, and overall acceptability were considered to be the descriptive data and the ratings of tenderness, juiciness, flavor, and overall palatability were considered to be the qualitative data.

Descriptive data were analyzed with PROC FREQ (SAS, 1990). Frequencies and percentages of tenderness and overall acceptances in home and restaurant environments were analyzed separately. Chi-square analysis for acceptable/unacceptable questions across the 8-point tenderness ratings were generated for the whole model. If the chi-square value for the whole model obtained from SAS showed significance (df = 7, $P < .05$), further partition of chi-square to df = 1, $P < .05$ (Steel and Torrie, 1980) for each tenderness rating was calculated to identify the differences between tenderness ratings for the home and restaurant.

The tenderness, juiciness, flavor, and overall palatability data were analyzed as a complete randomized design (CRD) using demographic grouping as treatments. These treatments were considered to be the random effects. Least squares means were separated by Fisher's Protected Least Significance Differences (LSD) procedure as described in the Steel and Torrie (1980) GLM procedure.

Warner-Bratzler shear values were analyzed by the GLM procedure using tenderness ratings as random treatments. Least squares means were separated by the Fisher-LSD procedure (Steel and Torrie, 1980).

The amount of variation accounted for in overall palatability by tenderness, juiciness, and flavor in the home and restaurant was analyzed by maximum R stepwise regression analysis (Steel and Torrie, 1980).

Results and Discussion

Consumer Panel

Table 1 shows the demographic characteristics of the 67 consumers. Education level ranged from less than a high school education to Ph.D. degrees. Family income ranged from <$20,000 to >$60,000, with a

Table 1. Profile of consumer panelists

Variable	Number of consumers	Percentage
Education level		
Less than high school	9	14
High school	13	20
Junior college	12	18
Bachelor's degree	16	24
Master's degree	10	14
Ph.D. degree	7	10
Income, $		
<20,000	16	24
20,000 – 40,000	20	30
40,000 – 60,000	24	36
>60,000	7	10
Age, yr		
<21	9	14
22 – 29	11	16
30 – 39	28	42
40 – 49	11	17
>50 – 59	8	11
Gender		
Male	35	52
Female	32	48
Ethnicity		
White	55	82
African-American	6	9
Hispanic	5	8
Indian	1	1

median income range of $40,000 to $60,000. The age range of the panel was from 8 to 75 yr, with a mean of 36 yr. A majority of the panelists were white; other ethnic groups represented on the panel included Hispanic, Indian, and African American. Fifty-three percent of the panelists were male and 47% were female.

Consumer Acceptability Scores

Figure 1 shows the mean WBS value for each point on the tenderness scale. As WBS value decreased, the tenderness score generally increased (indicated more tenderness). This result shows that the consumers in the present study were able to detect tenderness levels similar to the tenderness instrument. Figure 2 illustrates the percentages of steaks by tenderness ratings that were considered acceptable in tenderness by consumer panelists. Results shown in Figures 1 and 2 indicated that the acceptability levels for WBS values for the consumers in this study in both the home and restaurant occurred between 4.8 and 5.6 kg in the restaurant setting and 4.4 and 5.2 kg in consumers' homes. The data presented in this study indicates that Lubbock consumers could recognize varying degrees of tenderness and relate them to WBS force values. The beef industry needs to conduct research on a nationwide basis to determine the relationship of WBS to the tenderness acceptability rating of beef that gives a 98% acceptability level for each geographical region of the United States. The present study indicates that it would be possible for the beef industry to establish a WBS force value control point for a beef tenderness threshold. The results in the present study indicate that a WBS value of 4.1 kg would result in a 98% acceptability level for consumers in both the home and restaurant.

The tenderness ratings and acceptability levels shown in Figures 1 and 2 show that the WBS value that corresponds to a moderately high tenderness rating (98 and 99% acceptable) occurs at 4.1 kg. The largest change in tenderness acceptability occurs between tenderness ratings 3 and 4 (Figure 2).

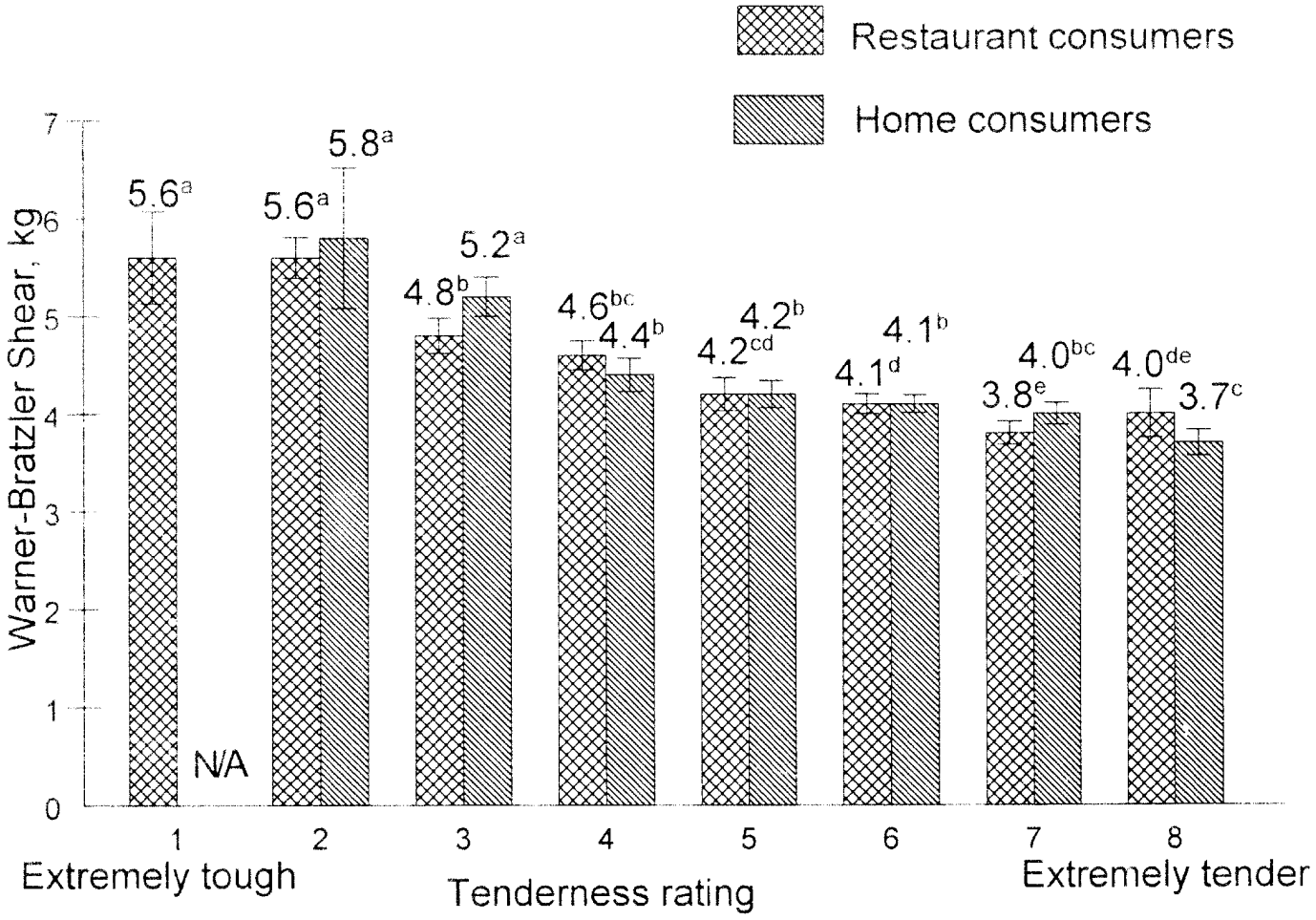

Figure 1. Warner-Bratzler shear force values by sensory tenderness ratings of steaks by consumers at home and at a restaurant. No consumers at home gave a 1 rating. [a,b,c,d]Means in a dining environment with different superscripts are different ($P < .05$).

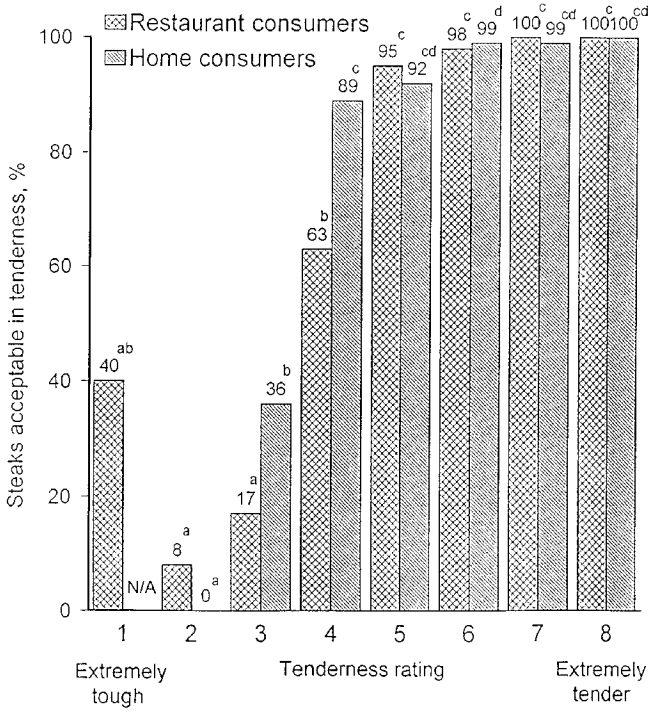

Figure 2. Percentage of steaks by sensory tenderness scores considered acceptable in tenderness by consumer panelists. [a,b,c]Means in a dining environment with different superscripts are different ($P < .05$). Restaurant n ( ) by tenderness rating: 1(5), 2(26), 3(35), 4(47), 5(40), 6(106), 7(80), and 8(18). Home n ( ) by tenderness rating: 1(0), 2(2), 3(25), 4(36), 5(51), 6(138), 7(86), and 8(58).

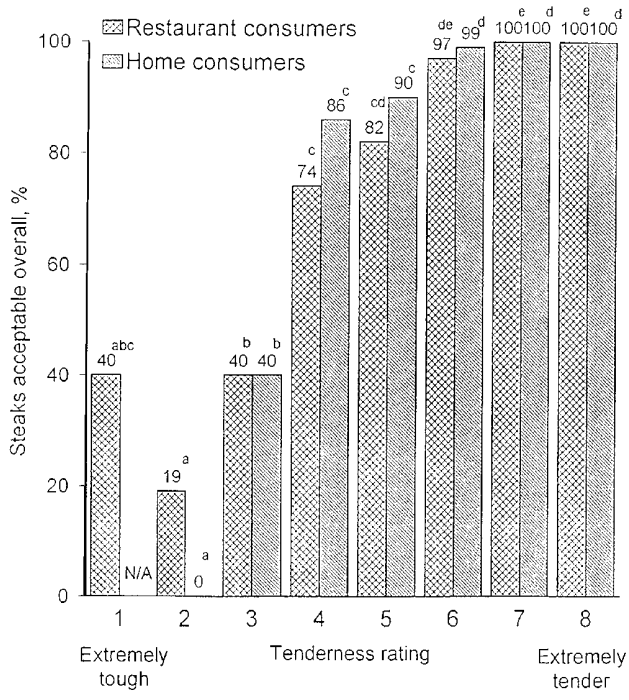

Figure 3. Percentage of steaks by tenderness rating considered overall acceptable by consumer panelists. [a,b,c,d]Means in a dining environment with different superscripts are different ($P < .05$). Restaurant n ( ) by tenderness rating: 1(5), 2(26), 3(35), 4(47), 5(40), 6(106), 7(80), and 8(18). Home n ( ) by tenderness rating: 1(0), 2(2), 3(25), 4(36), 5(51), 6(138), 7(86), and 8(58).

Chi-square analysis showed that the largest increase in tenderness acceptability for the steaks occurred between a 3 and 4 tenderness rating ($P < .05$). This increase establishes the tenderness acceptability level for beef steaks and relates to a WBS value of 4.5 kg. The distribution of steaks by tenderness rating for tenderness acceptability showed that consumers rated steaks a 6, 7, or 8 most frequently. Results indicate that 98% of the steaks were rated acceptable for tenderness by the consumers in the present study when given at least a 6 rating. The WBS force value (Figure 1) associated with the 6 rating (Figure 2) is 4.1 kg. Therefore, the beef industry should target production of beef steaks that have WBS values of 4.1 kg to ensure high levels (98%) of consumer tenderness acceptability. The present study used consumers in Lubbock, TX; these consumers may or may not be representative of the average beef consumer.

Figure 3 illustrates the percentage of steaks by tenderness ratings that were considered to be overall acceptable by consumer panelists. The acceptability level again occurred between a 3 and 4 tenderness rating ($P < .05$), which is consistent with tenderness acceptability levels. In homes and at the restaurant, if steaks were given a minimum of a 4 tenderness rating, at least 74% were rated overall acceptable. If the score was 3 or lower for tenderness, the consumers in the restaurant found a larger percentage of the steaks overall acceptable than in the homes. The overall acceptability distribution by tenderness rating for the home and restaurant environments showed that the 6 tenderness rating corresponding to a WBS value of 4.1 was highly acceptable to consumers from both the home (99%) and the restaurant (98%).

Consumers were asked which sensory attribute, tenderness, flavor, or juiciness, was the most important in determining their eating satisfaction. The results show that 51% of consumers considered tenderness the attribute they want most in a steak in the home and restaurant environments. Tenderness is important; however, overall acceptability encompasses more than just tenderness. Flavor was rated most important by 39% of the consumers, and juiciness was rated most important by 10% of the consumers. These data are in agreement with those reported by Miller et al. (1995).

Regression analyses using tenderness, juiciness, and flavor scores were used to determine the amount of variation accounted for in overall palatability in the home and restaurant. In consumers homes, flavor alone accounted for the most variation in overall

palatability with an R^2 = .67. When the model was expanded to two variables, flavor and tenderness explained 78% of the variation (tenderness accounted for an additional 11%). With a three-variable model, juiciness was added and explained an additional 1% of the variation in overall palatability.

In the one-variable model for restaurant data, tenderness accounted for the most variation in overall palatability with an R^2 = .56. With a two-variable model 64% of the variation in overall palatability was explained (flavor accounted for an additional 8% of the variation); juiciness was added to the three-variable model and contributed an additional 2%.

A large proportion of the variation was unaccounted for in the home (21%) and restaurant (34%). Dining environment could be one explanation for the unaccounted variation. In the home, someone has to prepare the food and wash the dishes. In the restaurant the food is professionally prepared and served. Further research should be conducted on a nationwide consumer panel to determine what influences overall palatability in addition to tenderness, flavor, and juiciness in both the home and restaurant. The present study suggests that consumers will accept slightly tough meat if the flavor and juiciness are acceptable. Therefore, beef steak palatability and consumer satisfaction may be dependent on other factors that influence flavor and juiciness, such as marbling and days of aging postmortem prior to consumption.

Demographics

Income. The consumers were divided into four income groups (Tables 2 and 3) based on annual family income. Family income had much less effect on sensory scores for the steaks in the restaurant than in the homes. None of the scores for the four sensory traits differed ($P < .05$) across income levels when steaks were eaten in the restaurant; however, differences in sensory traits were found in the home environment. As family income increased, ratings for tenderness, juiciness, flavor, and overall palatability in the home tended to decrease. This result implies that consumers with higher income levels have greater expectations of beef steaks and are more critical than lower income consumers when rating tenderness, juiciness, flavor, and overall palatability.

Age. Tables 2 and 3 show that no apparent trend was found for the effects of age of consumers on their sensory ratings of the steaks, although several significant differences were found among age groups in the home and restaurant for flavor, juiciness, and overall palatability. No significant differences in age for tenderness were found in the restaurant; however, differences ($P < .05$) were found in tenderness across age groups in consumers' homes.

Gender. No significant differences ($P > .05$) were found between male and female consumers for tenderness, flavor, juiciness, or palatability ratings of the steaks (Tables 2 and 3). When the tenderness rating

Table 2. Beef palatability sensory scores for beef steaks rated by consumers in their homes

Item	Tenderness	Juiciness	Flavor	Palatability
Income, $				
<20,000	6.1[b]	6.0[b]	5.9[c]	6.3[b]
SEM	.150	.145	.147	.139
20,000 – 40,000	6.6[c]	6.0[b]	5.9[c]	6.5[b]
SEM	.133	.128	.130	.122
40,000 – 60,000	5.7[a]	5.4[a]	5.5[b]	5.8[a]
SEM	.125	.120	.122	.115
>60,000	5.5[a]	5.1[a]	4.9[a]	5.6[a]
SEM	.200	.193	.196	.185
Age in years				
<21	5.6[ab]	5.5[abc]	5.3[ab]	5.8[a]
SEM	.185	.178	.181	.170
22 – 29	5.4[a]	5.2[a]	5.2[a]	5.7[a]
SEM	.190	.183	.186	.175
30 – 39	5.9[bc]	5.4[ab]	5.5[ab]	5.8[a]
SEM	.106	.102	.104	.098
40 – 49	6.2[cd]	5.9[c]	5.8[bc]	6.3[b]
SEM	.175	.169	.172	.162
>50	6.7[d]	6.0[c]	6.1[c]	6.7[b]
SEM	.209	.202	.205	.193
Gender				
Male	6.1[a]	5.7[a]	5.7[a]	6.1[a]
Female	5.9[a]	5.6[a]	5.5[a]	5.9[a]
CV	31.6	24.2	25.7	23.5

[a,b,c]Means in the same column within category with different superscripts differ ($P < .05$). n = 67 consumers.

Table 3. Beef palatability sensory scores for beef steaks rated by consumers in the restaurant

Item	Tenderness	Juiciness	Flavor	Palatability
Income, $				
<20,000	5.5[a]	6.0[a]	5.8[a]	6.0[a]
SEM	.204	.170	.170	.165
20,000 – 40,000	5.3[a]	5.8[a]	5.5[a]	6.0[a]
SEM	.170	.143	.142	.138
40,000 – 60,000	5.3[a]	6.0[a]	5.4[a]	5.8[a]
SEM	.167	.139	.139	.135
>60,000	5.6[a]	5.9[a]	5.6[a]	6.0[a]
SEM	.305	.255	.254	.247
Age in years				
<21	5.6[a]	6.3[b]	6.0[c]	5.9[b]
SEM	.256	.214	.213	.207
22 – 29	5.0[a]	5.6[a]	4.9[a]	5.5[a]
SEM	.249	.208	.208	.202
30 – 39	5.4[a]	5.7[a]	5.4[b]	5.7[a]
SEM	.150	.125	.125	.121
40 – 49	5.2[a]	5.5[a]	5.6[bc]	6.0[ab]
SEM	.241	.201	.201	.195
>50	6.0[a]	6.3[b]	5.9[bc]	6.5[b]
SEM	.268	.224	.224	.218
Gender				
Male	5.3[a]	5.7[a]	5.4[a]	5.8[a]
Female	5.3[a]	5.9[a]	5.5[a]	5.8[a]
CV	22.2	22.8	23.3	20.5

[a,b,c]Means in the same column within category with different superscripts differ ($P < .05$). n = 67 consumers.

was ≥ 5, at least 93% of the female consumers and 77% of the males rated the steaks “acceptable” for tenderness. However, when the tenderness rating was ≥ 5, 100% of the females and 92% of the males rated steaks “acceptable” for overall acceptability. This result again shows that consumers were more critical when rating tenderness acceptability than overall acceptability.

Implications

Consumer ratings were consistent with the Warner-Bratzler shear objective measure, which shows that consumers can accurately evaluate meat tenderness. The acceptability levels for tenderness were established based on Warner-Bratzler shear force values, tenderness ratings, and judgment of tenderness and overall acceptability by consumers. According to the results from this study a steak with a Warner-Bratzler shear value less than 4.1 kg will ensure a customer satisfaction level of 98% in both the home and restaurant. Results suggest that an acceptable level for consumer beef tenderness can be determined and Warner-Bratzler shear values can be used as criteria for determining which steaks will be considered acceptable in tenderness by consumers before distribution to retail or food service outlets.

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