Will Consumers Pay for Guaranteed Tender Steak?

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Executive Summary

- Meat tenderness is one of the most important quality characteristics to beef consumers. Current beef quality grading standards are poorly correlated with meat tenderness. Even within the same quality grade, steak tenderness varies considerably. As a result of consumers frequently experiencing poor steak eating experiences, their confidence in, and demand for beef has been adversely affected.

- Consumers demonstrated a preference for tender steak. Blind taste tests revealed that 72 percent of consumers preferred tender steak relative to tough steak (as measured via Warner-Bratzler shear force tests) in terms of tenderness preferences. In these blind taste tests, 36 percent of consumers were also willing to pay an average of a $1.23/lb premium for a tender relative to a tough steak.

- When information regarding tenderness was revealed to consumers together with a taste sample, 90 percent preferred the tender steak. Overall, 51 percent of consumers were willing to pay an average premium of $1.84/lb for a tender relative to a tough steak when the level of steak tenderness was revealed to the consumers.

- Older, more highly educated consumers were more likely to prefer tender relative to tough steak and all consumers were 18 percent more likely to prefer tender steak when provided information regarding the product's tenderness. Of those individuals willing to pay a premium for tender steak, more highly educated, younger females, with higher household income levels, were willing to pay more.

- Consumers are willing to pay a premium for guaranteed tender steak. The beef industry needs to adopt objective measures of meat qualities important to consumers and bring those measures into the price discovery process. Beef tenderness is an important meat quality that appears economically feasible to commercially measure, sort, label, price, and market. The beef industry would gain by marketing products containing objective tenderness labels because it would have fewer dissatisfied consumers and could capture more consumer dollars to be divided across industry participants and producers.

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and Mohammad Koohmaraie*

Introduction

Tenderness has been identified as the most important palatability attribute of beef (Dikeman, 1987 and Miller *et al.*, 1995). A 1995 survey of packers, purveyors, restaurateurs, and retailers indicated tenderness was the second highest beef quality concern, behind low overall uniformity and consistency (Smith *et al.*, 1995). Problems with consistency, uniformity, and tenderness were also among the top 10 concerns listed in the 1991 National Beef Quality Audit, indicating that tenderness concerns, while growing in importance, are not new to the industry (Smith *et al.*, 1992).

The importance of meat tenderness to consumers can be viewed in monetary terms. The positive relationship at the retail level between the price of a cut of meat and its relative tenderness confirms the general willingness of consumers to pay a premium for more tender steaks (Savell and Shackelford, 1992). Boleman *et al.* (1997) concluded that consumers were able to distinguish between varying levels of steak tenderness and were willing to pay more for a guaranteed level of tenderness. Consumers demand tender meat products and they often reject tough meat. A supermarket chain that requested consumers return undesirable steaks had $364,000 worth of steaks returned over a three-year period. Over 78 percent of the steaks were returned because of tenderness problems (Morgan, 1992).

The importance of meat tenderness to consumers suggests that tenderness should be the primary determinant of meat quality. However, the current USDA quality grading system, which uses intramuscular fat or marbling as a measure of quality, provides an inadequate measure of tenderness. Savell *et al.* (1987, 1989) found that consumers perceived varying degrees of tenderness within different marbling categories. Wheeler *et al.* (1994) concluded that marbling explains, at most, five percent of the variation in palatability characteristics. Numerous studies have found inconsistency in meat tenderness to be a major problem facing the beef industry (Morgan *et al.*1991; Morgan 1992; Savell and Shackelford, 1992; and Smith 1992). Wheeler *et al.* (1994, p. 3150) concluded, "USDA quality grade does not sufficiently segregate carcasses for palatability differences, and thus a direct measure of meat tenderness is needed to supplement USDA quality grade."

The objective of this study is to determine consumer willingness to pay for tender steaks in an actual grocery store setting. In particular, the aims are to: 1) determine the price premium consumers will pay for steak tenderness, 2) quantify how economic and demographic factors influence consumer willingness to pay for steak tenderness, 3) compare consumer willingness to pay for tenderness to the costs of implementing a particular tenderness measurement system, 4) determine how information about tenderness affects willingness to pay for steak tenderness, and, 5) examine the implications of consumer willingness to pay for steak tenderness for beef quality grading systems. Results should prove helpful to USDA, beef producers, processors, and retailers evaluating the merits of alternative grading systems which provide improved measures of beef tenderness compared to the current quality grading system.

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Beef Quality Grading

The USDA initiated voluntary quality grading of beef in 1927 to identify the quality of beef throughout the marketing chain and to enable producers and consumers to make improved production and consumption decisions by transmitting better information through the marketing chain. Since then, there have been several modifications to the federal quality grade specifications and many debates over the effectiveness of the system. Quality grades apparently provide some valuable information or packers would choose not to participate in the voluntary grading system. The fact that, in 1995, about 85 percent of steers and heifers slaughtered were assigned quality grades provides evidence that both packers and their customers believe USDA's beef quality grades are useful (Smith *et al.*, 1995). Although the current USDA grading system contains valuable information regarding meat quality, there may be better methods of providing consumers information regarding the eating quality of individual beef cuts.

Ideally, quality grades should enable consumers to identify and choose products that provide a predictable eating experience. A primary criticism of the current system is that it fails to meet one of its main objectives – enabling consumers to identify products with predictable levels of meat tenderness. The current USDA quality grades do not provide consumers sufficient information to help them choose the level of beef tenderness they desire. Under the current USDA grading system, a visual subjective assessment of marbling (intramuscular fat content) is used as the primary indicator of beef quality. The problems with this method are: 1) grading is subjective which makes it prone to human biases and error, and 2) marbling is not an accurate or consistent predictor of meat tenderness. Koohmaraie *et al.* (1996, p. 4), indicated:

> Ideally, we would like to be able to measure (predict) meat tenderness with a rapid, automated, tamper-proof, non-invasive, accurate instrument. None of... [the current]... technologies have successfully predicted meat tenderness because these technologies are all based on indirect measurements that are not capable of sensing the subtle changes in raw meat that are responsible for variation in cooked meat tenderness.

Recent technological developments have made possible a more objective, accurate, and consistent test for tenderness. These new technologies, while not currently employed in USDA quality grading, may provide a competitive advantage to beef processors who adopt a tenderness measurement system. However, neither the beef industry nor the USDA is likely to adopt tenderness classification technology without better information regarding consumers' willlingness to pay for tenderness.

An Alternative Tenderness Grading System

One direct method for measuring tenderness is the Warner-Bratzler (W-B) shear force test. The W-B test measures the amount of force required to penetrate a cut of meat and assigns a numerical value to a cut of steak indicating its tenderness level. The W-B method explains more of the variation in meat tenderness than any other currently available tenderness testing system (Shackelford *et al.* 1996). Recently, Shackelford *et al.* (1996, 1999) have developed a beef processing system that incorporates the W-B test and can be used in a commercial processing plant.

An outline for the on-line tenderness grading system, taken directly from Shackelford *et al.* (1996, p. 4), is:

1. Tenderness-based classification is accomplished during the traditional quality and yield grade process.

2. At the time at which carcasses are normally ribbed for grading, a 1" ribeye steak is automatically removed from between the 12th and 13th ribs of the right carcass half by a modified ribbing saw. By the time the ribeye has "bloomed" and the carcass is ready to be graded, the process is completed.

3. The steak is placed onto a conveyor belt and advances to a water jet trimming system, which automatically separates the ribeye from the fat and bone.

4. The ribeye steak is transferred to a continuous-feed cooker. The actual cooking process requires about 4 minutes and an additional 2 minutes is required for post cooking temperature rise.

5. The cooked steak advances to a water jet trimming system which automatically removes a 1 cm (0.4 inches)-thick slice from the center of the steak. This slice is removed at a 45-degree angle so that it is parallel to the orientation of the muscle fibers. The water jet trimming system automatically sizes the slice to a consistent length (5cm = 2 in.).

6. A universal-testing machine measures the shearing strength of the cooked muscle sample.

7. The tenderness classification of each carcass is automatically entered into the packing plant's computer database and tenderness classification tags are printed at the grading stand.

8. The tenderness grading system described above segregates carcasses into different tenderness classifications – guaranteed tender, probably tender, and probably tough - with 90 percent accuracy, which is higher than with other systems. Using experimental data, Shackelford *et al.* (1996) estimated that 29 percent of carcasses would fall into the guaranteed tender category, 66.5 percent would be probably tender, and 4.5 percent would be classified in the probably tough category. The current USDA grading system segregates carcasses as follows: 1 percent Prime, 11 percent top Choice, 36 percent low Choice, 57 percent Select, and 5 percent Standard (Shackelford *et al.* 1996). In addition to providing a consistent prediction of eating quality, this tenderness classification system would result in more carcasses achieving the highest quality grade than under the current USDA quality grade system. This occurs because some carcasses in the Choice and Select grades would meet the standard for the guaranteed tender classification.

Costs and Benefits of an Alternative Tenderness Grading System

Adoption of a tenderness assessment system is costly. Shackelford *et al.* (1996) estimated the cost of using their tenderness classification system in a commercial beef packing plant to be $4.36/carcass or $0.62/cwt. Their estimates include the costs of: 1) a 1-inch ribeye steak removed from each carcass for shear-force testing, 2) labor (it is estimated that four additional employees will be required for tenderness based classification), and 3) machinery for the tenderness classification system. The cost estimates are based on the following assumptions: 1) a plant will process 3,000 carcasses per day, 5 days a week, 52 weeks per year, 2) a ribeye removed from the carcass will cost $4.00, and 3) employees are paid $10 per hour. The estimates did not include the cost of capital financing, i.e. the interest rate charged for the capital investment, and additional carcass sorting costs for packers. Therefore, the actual costs per carcass are likely to be somewhat greater than those estimated by Shackelford *et al.* (1996).

Boleman *et al.* (1997) investigated consumer preferences for three tenderness levels of steaks (segregated via the W-B test) and determined that consumers would pay more for steaks with higher tenderness levels. In that study, consumers were allowed to sample three steaks – tender, intermediate, and tough. The experiment consisted of two components. In part 1, participants were not told which steaks were more tender and all three steaks were priced the same – at $8.46/kg. In part 2, participants were informed of the W-B test and steak tenderness levels were revealed. In this test, steaks were priced

as follows: 1) tender - $9.56/kg, 2) intermediate - $8.46/kg, and 3) tough - $7.36/kg. When all steaks were priced the same and tenderness levels were not revealed, approximately 55 percent of consumers purchased the most tender steak, 12 percent bought the intermediate tender steak, and 32 percent bought the tough steak. However, in part 2, when the level of steak tenderness was revealed to consumers and prices of the three tenderness levels differed by $1.10/kg, almost 95 percent of consumers purchased the most tender steak and approximately four percent purchased the intermediate tender steak.

Although Boleman *et al.* confirmed that consumers prefer tender steaks and concluded that consumers were willing to pay more for tender steaks, the study did not extract full willingness to pay for more tender steaks and its findings are based on a limited number of observations (47 families). A larger and more representative study is needed to draw more reliable inferences about consumers' willingness to pay for beef tenderness and the impact of different demographic characteristics on willingness to pay.

Methods

In this study, we use an experimental market procedure to elicit consumer willingness to pay for steaks with different tenderness levels. Non-hypothetical experimental methods have the potential to provide more reliable measures of willingness to pay than a hypothetical survey method. Fox *et al.* (1995) point out four advantages of experimental valuations: 1) bidding is designed to truthfully reveal preferences, 2) using real food, real money, and repeated market participation ensures reliability, 3) use of a requirement-to-eat factor reinforces the non-hypothetical aspect of the study, and 4) absence of non-response bias.

Fox (1995) describes an experiment to evaluate consumer acceptability of milk from cows treated with bovine somatotrophin (bST). Consumers were given a $15 dollar endowment and a glass of milk from a cow treated with bST. Consumers then bid under a sealed Vickery auction system, where the highest bidder received the product but paid the amount of the second highest bid, for a glass of milk from a non-bST treated cow. The Vickery 2nd price auction was used because it is incentive compatible – i.e., respondents have an incentive to bid an amount equal to their true maximum willingness to pay.

Experimental valuation using the Vickery auction is well established in the economics literature. It has been used to examine differences in willingness to pay and willingness-to-accept values (Shogren *et al.*, 1994), the value of safer food (Hayes *et al.,* 1995), and the value of pork chop characteristics (Melton *et al.,* 1996). This study expands on previous work in experimental valuation by moving from a controlled laboratory setting to a grocery store where consumers' actual purchasing decisions are made.

Procedures

Data were collected from shoppers at retail grocery stores owned by a Midwestern chain in several locations within Kansas. Two experimental treatments were used and the procedure was as follows.

Treatment 1

1. Shoppers at the meat counter were asked to participate in an experiment conducted by the Agricultural Economics Department at Kansas State University.

2. Once a consumer agreed to participate in the experiment, a short written survey was completed which required disclosure of basic demographic information including age, gender, household

size, household income, education level, and preference for steak doneness and USDA quality grade[1].

3. When the survey was completed, consumers were asked to sample two different types of steaks labelled Red and Blue: Red was "guaranteed tender" (according to a slice shear force test) and Blue was "probably tough"[2]. In experimental treatment 1, consumers were not told that the samples differed in tenderness - they had to make this assessment independently. Consumers then responded to questions about which steak they preferred in terms of taste, tenderness, texture, juiciness, and overall palatability.

4. Consumers were given, free of charge, a Blue (tough) steak for participating in the experiment. If they indicated a preference for the Red (tender) steak, consumers were asked to indicate their willingness to pay to exchange their Blue (tough) steak for the Red (tender) steak. Bids were elicited in a procedure designed to reveal their true valuation for the upgrade. In particular, consumers were informed that if their bid exceeded a predetermined price level (unknown to them), they would make the exchange at the predetermined price. If their bid was less than the predetermined price, then they kept their Blue (tough) steak. In this setting, as in the Vickery auction, the exchange price is unknown (exogenous) to the consumer and thus their incentive is to reveal their true willingness to pay. The instructions included an explanation of why it was best to bid true willingness to pay in this setting.

Treatment 2

The second treatment of the experiment was identical to the first except that the words Red and Blue were replaced with "Guaranteed Tender" and "Probably Tough", respectively. The following statement was provided to consumers in Treatment 2:

> "The USDA has developed a technology to categorize steaks according to tenderness. The classification system uses shear force to give an actual value of steak tenderness. Steaks are separated into different categories according to shear force values. The three categories are: Guaranteed Tender, Intermediate Tender, and Probably Tough."

A flow diagram of both treatments of the experiment is shown in Figure 1.

The steaks used in this study were deemed tender or tough according to a slice shear test using the procedures outlined in Shackelford *et al.* (1996) and carried out by the Meat Animal Research Center at Clay Center, Nebraska. Tender and tough steaks were categorized under the supervision of Shackelford, Wheeler, and Koohmaraie.

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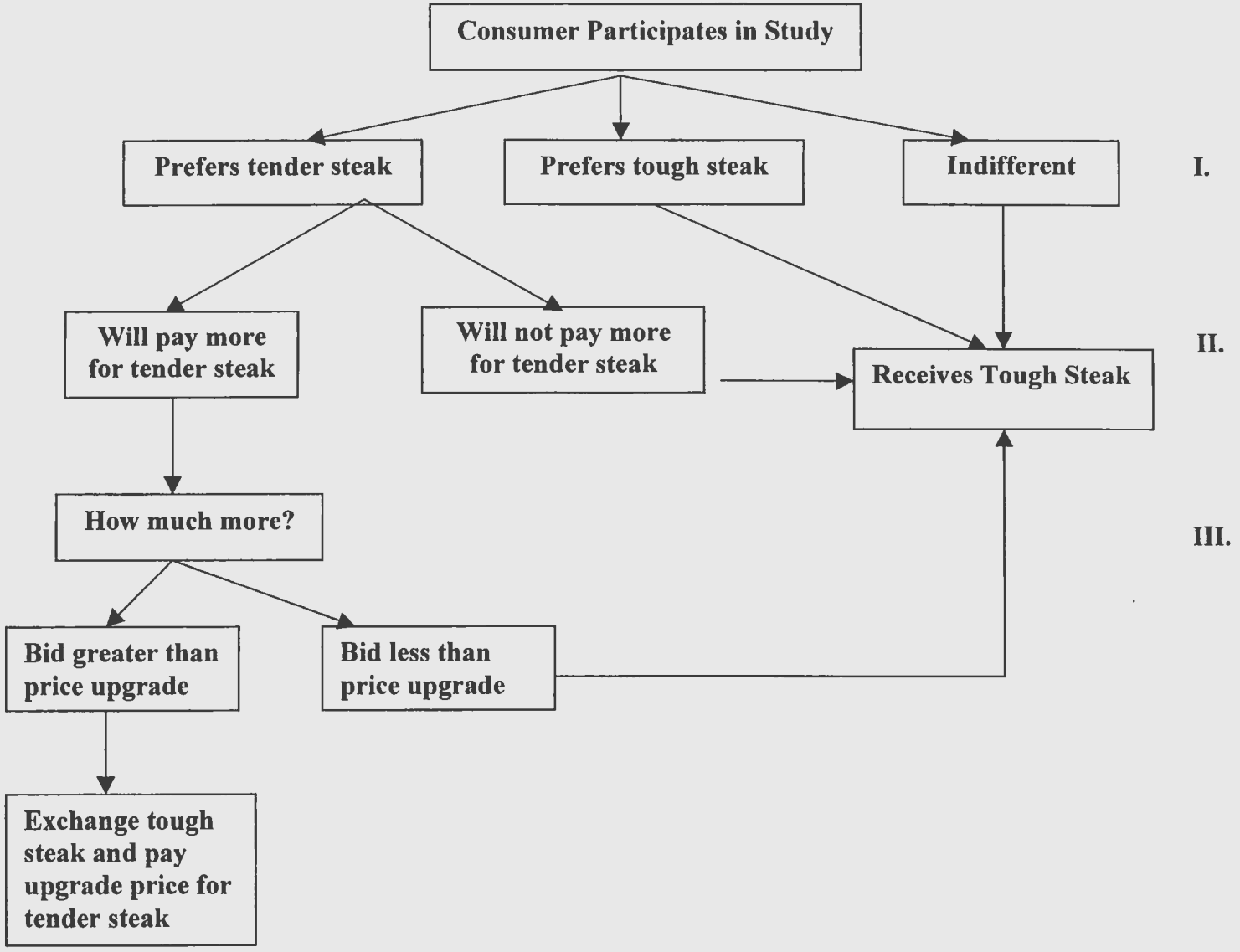
[1] A copy of the written survey instrument is included in Appendix A.

[2] "guaranteed tender" steaks have a slice shear force value of $\leq$ 15Kg and "probably tough" steaks have a slice shear force value of $>$ 35 Kg.

Figure 1 – Consumer Decision Tree in Steak Tenderness Experiment



Several steps were taken to maintain consistency among steak samples during the experimental trials, thus promoting more accurate consumer willingness-to-pay bids. All steaks were individually vacuum packaged and aged at 0 to 3 degrees Celsius until 14 days post-mortem and then frozen to –20 degrees Celsius. Twenty-four hours prior to the experiment, the steaks were thawed to approximately 5 degrees Celsius. Steaks were held at this temperature until cooking. During cooking, steak samples were turned over when an internal temperature of 40 degrees Celsius was obtained. The steak was removed from the grill when the internal temperature reached 75 degrees Celsius (which is equivalent to a medium doneness). After the samples were cooked, all fat and muscles were removed from the sample, except the *logissimus thoracis et lumborum* (ribeye or strip loin). The remaining muscle was cut into 1cm square samples. Two 1cm cubes were placed on a toothpick. The samples were then made available to be consumed by participants in the experiment.

Results

1. Demographics and Consumption Habits

A total of 313 consumers participated in the study, 227 in the first treatment and 86 in the second. Table 1 provides summary statistics for the combined groups of consumers. Almost 66 percent of the consumers in the study were female reflecting the population in the grocery store during the experiments. The average age of the participants was approximately 48 years. Participants, on average, had at least some college education and between $40,000 and $50,000 of annual household income. Only six percent of the respondents were full time students.

Concerning consumption habits, consumers ate ground beef about 2.3 times a week at home and 1.3 times a week away from home. Participants indicated that steak was consumed 1.1 times per week at home and 0.57 times a week away from home. Thirty-eight percent of consumers indicated they typically purchased USDA Choice beef whereas 22 percent indicated they did not know the grade of beef they typically purchased. Both USDA Select and store brand beef were typically purchased by about 19 percent of the respondents. Respondents, on average, preferred their steak cooked to a medium doneness.

The fact that almost one in four respondents did not know what grade of beef they purchased is important. USDA quality grades are intended to inform consumers about beef quality. The fact that such a large proportion of participants failed to recognize USDA grades as an indicator of quality may be attributed to several factors including difficulty in understanding the current grading system.

2. Consumer Preferences for Sampled Steak

Consumers who participated in the study and sampled the two types of steaks were asked which steak they preferred for taste, tenderness, texture, juiciness, and overall palatability. Table 2 shows the results from the experiment's first treatment where it was not revealed to consumers which steak was more tender. The Red (Guaranteed Tender) steak was preferred overall by 69 percent of participants. Of the four quality attributes, more people indicated they preferred the Red steak for tenderness (72 percent) than for any of the other attributes. Sixty-five percent of participants preferred the Red steak for taste and texture, and 60 percent preferred the Red steak for juiciness. Importantly, consumers were able to determine independently that the distinguishing characteristic between the two steaks was tenderness.

Table 1 - Variable Definitions and Summary Statistics

Variable	Definition	Mean	Std. Dev.
Gender	1 if female, 0 if male	0.66	0.48
Age	age in years	47.51	15.25
Education	education level of respondent. 1 = less than 12th grade, 2 = high school graduate 3 = some technical, trade, business school, 4 = some college, 5 = B.S. B.A., complete, 6 = some graduate work, 7 = M.S., M.A. complete, 8 = Ph.D., D.D.S., M.D., J.D., etc.	4.44	1.80
Income	household income level 1 = less than $20,000, 2 = $20,000 to $29,000, 3 = $30,000 to $39,999, 4 = $40,000 to $49,999, 5 = $50,000 to $59,999, 6 = $60,000 to $69,999, 7 = $70,000 to $79,999, 8 = $80,000 to $89,999, 9 = $90,000 to $99,999, 10 = $100,000 to $109,999, 11 = $110,000 to $119,999, 12 = more than $120,000	4.79	2.80
Adults	number of adults in household	1.97	0.65
Children	number of children in household	0.72	1.12
Student	1 if full time student, 0 otherwise	0.06	0.24
Beef home	number of times per week respondent consumes ground beef (hamburger) at home	2.26	1.54
Beef away	number of times per week respondent consumes ground beef (hamburger) away from home	1.28	1.49
Steak home	times per week respondent consumes steak at home	1.10	0.84
Steak away	times per week respondent consumes steak away from home	0.57	0.82
Doneness	preference of steak doneness; 1 = rare, 2 = medium rare, 3 = medium, 4 = medium well, 5 = well done	3.17	1.04

Table 2 – Summary Statistics for Treatment 1. (Tenderness Levels not Revealed)

Variable	Average	Std. Dev.	Min.	Max.	Observations
Gender	0.69	0.47	0	1	227
Age	47.76	16.06	19	85	220
Education	4.50	1.88	1	8	227
Beef home	2.28	1.57	0	10	213
Beef away	1.32	1.58	0	10	212
Steak home	1.12	0.85	0	6	189
Steak away	0.54	0.87	0	6	189
Income	4.39	2.71	0	12	214
Adults	1.96	0.64	1	5	227
Children	0.71	1.13	0	6	227
Student	0.09	0.28	0	1	226
Doneness	3.22	1.07	1	5	225
% preferring Red steak for taste[a]	65.04	0.48	0	1	226
% preferring Blue steak for taste	23.45	0.42	0	1	226
% indifferent for taste	11.51				226
% preferring Red steak for tenderness	72.12	0.45	0	1	226
% preferring Blue steak for tenderness	18.58	0.39	0	1	226
% indifferent for tenderness	9.30				226
% preferring Red steak for texture	65.48	0.48	0	1	226
% preferring Blue steak for texture	22.12	0.42	0	1	226
% indifferent for texture	12.40				226
% preferring Red steak for juiciness	59.73	0.49	0	1	226
% preferring Blue steak for juiciness	27.88	0.45	0	1	226
% indifferent for juiciness	12.39				226
% preferring Red steak overall	69.16	0.46	0	1	227
% preferring Blue steak overall	22.02	0.42	0	1	227
% indifferent overall	8.82				227
% willing to pay more for Red steak	36.12	0.48	0	1	227
Willing to pay ($/lb)	1.23	0.67	0.3	3.3	82

[a] "Red" steak was the "Guaranteed Tender" steak and "Blue" was "Probably Tough" using Warner-Bratzler shear force test.

Summary statistics for the second treatment are contained in table 3. In this treatment, consumers were told that one steak was guaranteed tender and the other was probably tough. Interestingly, results from the first and second treatments suggest that consumers were more likely (84 percent compared to 69 percent) to prefer the Red or Guaranteed Tender steak when the difference in the steak samples was revealed. This suggests that merely labelling the steaks can affect consumers' preferences.

Table 3 – Summary Statistics for Treatment 2. (Tenderness Level Revealed)

Variable	Average	Std.Dev.	Min.	Max.	Observations
Gender	0.58	0.49	0	1	86
Age	46.87	12.91	19	77	83
Education	4.29	1.60	2	8	85
Beef home	2.21	1.46	0	7	78
Beef away	1.17	1.21	0	5	78
Steak home	1.05	0.82	0	4	76
Steak away	0.63	0.71	0	4	76
Income	5.78	2.77	1	12	85
Adults	2.02	0.70	0	4	86
Children	0.74	1.09	0	5	86
Student	0.00	0.00	0	0	86
Doneness	3.05	0.97	1	5	85
% preferring Tender steak for taste	77.91	0.42	0	1	86
% preferring Tough steak for taste	10.47	0.31	0	1	86
% indifferent for taste	11.62				86
% preferring Tender steak for tenderness	89.53	0.31	0	1	86
% preferring Tough steak for tenderness	4.65	0.21	0	1	86
% indifferent for tenderness	5.82				86
% preferring Tender steak for texture	69.77	0.46	0	1	86
% preferring Tough steak for texture	13.95	0.35	0	1	86
% indifferent for texture	16.28				86
% preferring Tender steak for juiciness	75.58	0.43	0	1	86
% preferring Tough steak for juiciness	10.47	0.31	0	1	86
% indifferent for juiciness	13.95				86
% preferring Tender steak overall	83.72	0.37	0	1	86
% preferring Tough steak overall	9.30	0.29	0	1	86
% indifferent overall	6.98				86
% willing to pay more for Tender steak	51.16	0.50	0	1	86
Willing to pay ($/lb)	1.84	0.95	0.3	4	44

When asked to evaluate samples based upon tenderness, almost 90 percent of consumers in treatment 2 indicated they preferred the guaranteed tender steak. However, 9 percent of treatment 2 consumers still preferred the probably tough steak for overall palatability after sampling the steaks. This can be attributed to a number of factors. While degree of doneness was held constant among samples (cooked to an internal temperature of 75 degrees celcius, or a medium doneness) consumers may have had perceptions about the color of one steak versus another that also influenced their opinion. Another possibility is that juiciness, taste, and texture could have varied across samples since the only quality attribute controlled in the experiment was tenderness.

This study was designed to determine whether consumers are willing to pay more for a tender vs. a tough steak and, secondly, if consumers are willing to pay more for tender steaks, how much are they willing to pay? While most consumers preferred the tender steak, some were not willing to pay more to exchange their tough steak for a tender one. In treatment 1, 69 percent of respondents preferred, but only 36 percent were willing to pay extra to obtain, a Red (tender) steak. In treatment 2, 84 percent preferred, but only 51 percent were willing to pay more for the Guaranteed Tender steak. Table 4 provides a summary of the demographics for a classification of respondents into three categories: 1) consumers preferring and willing to pay more for the tender steak, 2) consumers preferring but not willing to pay more for the tender steak, and 3) consumers preferring the tough steak. It is interesting to note that, in treatment 1, the average income level of consumers who preferred the tender steak but were not willing to pay for it was higher than the average income of those who decided to pay. However, such simple correlation can be misleading about the true relationship between willingness to pay and demographic characteristics since other variables that may affect willingness to pay are not being held constant. To more accurately examine these relationships multiple regression techniques will be used.

Table 4 – Selected Demographics versus Consumer Preference and Willingness to Pay for a Guaranteed Tender Steak

Variables	Willing to Pay for Tender Steak	Preferred Tender Steak, but not Willing to Pay	Preferred Tough Steak
Treatment 1. (No information)			
Percent Female	0.63	0.76	0.67
Average Age	48.36	47.32	45.47
Average Education	4.84	4.43	4.14
Average Income	4.04	4.98	4.23
Average Steak home	1.14	1.10	0.93
Average Steak away	0.59	0.48	0.50
Average Doneness	3.09	3.22	3.36
Treatment 2. (Information given)			
Percent Female	0.57	0.55	0.71
Average Age	46.12	51.57	39.38
Average Education	4.11	4.41	4.88
Average Income	5.69	5.42	6.75
Average Steak home	0.93	1.25	1.00
Average Steak away	0.60	0.52	1.06
Average Doneness	3.12	2.93	2.88

3. Comparison of Cost and Willingness to Pay

Overall, the average willingness to pay (only those consumers who were willing to pay for the tender steak) was $0.923 in treatment 1 and $1.38 in treatment 2. Since the steaks used in the experiment were 12 oz., the willingness-to-pay bids can be converted to a per-pound basis. Thus, the average willingness to pay per pound was $1.23 and $1.84 per pound for treatments 1 and 2 respectively.

The distribution of willingness-to-pay values is presented in Figure 2. Figure 2 includes all consumers that preferred the tender steak, regardless of whether they were willing to pay more for it. Some consumers, although preferring tender steak, were not willing to pay more for it relative to the tough steak. In both treatments, the modal value of willingness to pay is zero. The next largest category of willingness-to-pay values for both groups was $1.33 per pound. In treatment 1, the third largest category was $0.67, whereas in treatment 2, the third largest category was $2.67 per pound. The maximum willingness to pay was $3.33 and $4.00 per pound in treatments 1 and 2 respectively.

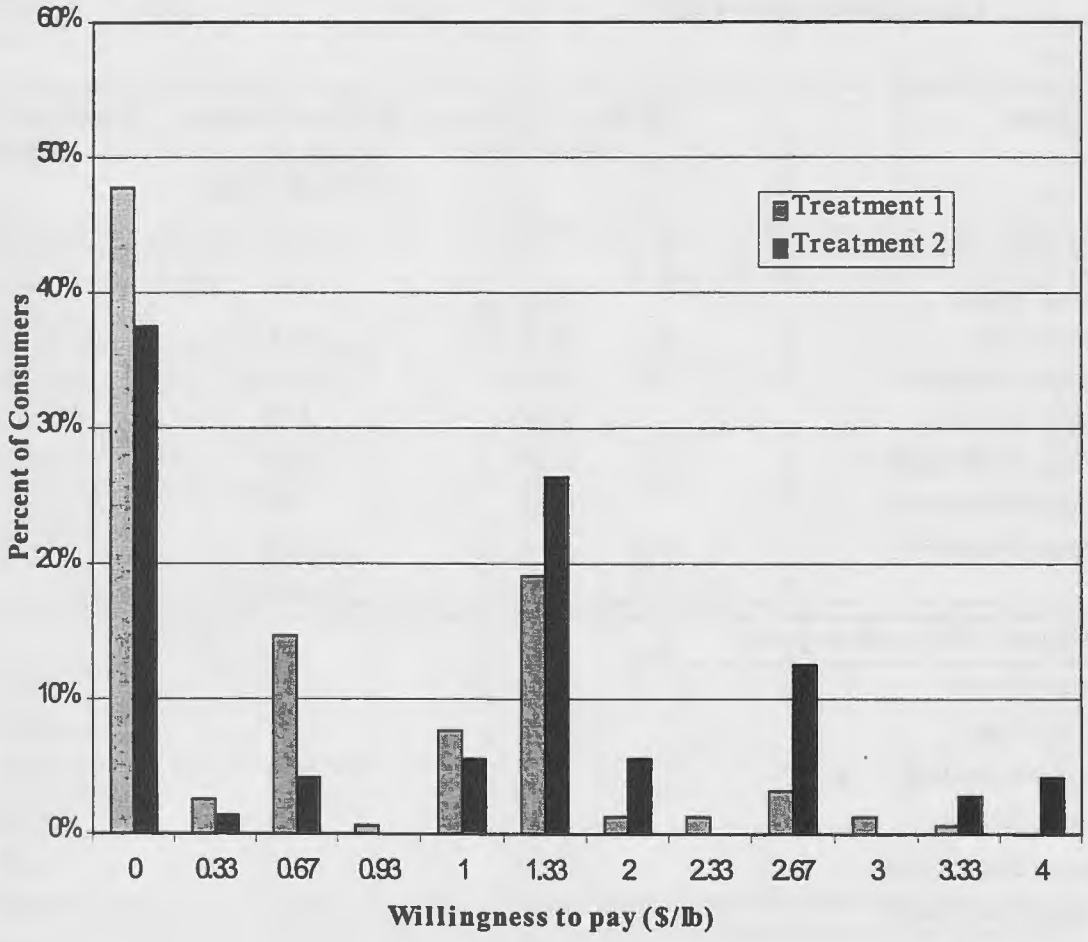


Figure 2 - Distribution of Willingness to Pay for Tender Steak

What do these willingness-to-pay values mean for beef processors? In order for beef processors to implement new tenderness testing technology, they must be assured they can recoup capital and operating costs by increases in selling price. As described earlier, Shackelford *et al.* (1996) estimated the cost of the tenderness classification system in a commercial beef packing plant to be $4.36/carcass.

Although the technology will increase the cost of the whole carcass by $4.36, tenderness can only be marketed on a portion of the carcass or selected cuts of beef. While consumers might pay more for a guaranteed tender ribeye, they are unlikely to pay a premium for ground beef produced using a guaranteed tender carcass. One approach to comparing costs and returns involves assigning the increase in carcass cost, on a per-pound basis, to those cuts that can be marketed as guaranteed tender.

In their cost estimates, Shackelford *et al.* (1996) assumed an average hot carcass weight of 700 lbs., implying that the cost increase of the tenderness system is $0.0062 ($4.36/700) per pound. Assume that only the sirloin, short loin, and flank contain cuts of meat that can be marketed as guaranteed tender. According to Potter (1986), the sirloin, short loin, and flank portions make up 20 percent of the carcass; thus, the amount of beef that can be marketed as guaranteed tender is 140 lbs. (700 x .2). Dividing the cost of tenderness testing per carcass ($4.36) by the amount of beef for which a premium might be obtained (140 lbs.) gives a break- even premium of $0.031 per pound. But since only 29 percent of animals slaughtered will fall in the "guaranteed tender" category (Shakelford *et al.*, 1995), the required break-even premium for guaranteed tender steaks is $0.11 per pound (0.031/0.29).[3]

The average willingness-to-pay values for treatment 1 and treatment 2 were $1.23 and $1.84 per pound, respectively. If guaranteed tender beef is to be introduced into the market, processors will no doubt advertise the advantages of their steak over that of others. Thus treatment 2, where tenderness levels of steaks are revealed, may provide a more accurate willingness-to-pay measure. When this willingness-to-pay value is compared with the cost increase of $0.11 per pound it appears, on the surface, that returns to tenderness are potentially higher than costs. However, the willingness-to-pay bids are based on an upgrade from a probably tough steak to a guaranteed tender steak, and not from a current grade in the marketplace, such as USDA Choice or Select, to guaranteed tender. In order for processors to recover capital and operating costs, the returns or willingness to pay must be greater than that for a typical steak on the market, which is not necessarily equivalent to the probably tough steak.

4. Willingness to Pay for Tender Steaks – Regression Models

Regression analysis can provide information about the determinants of consumer willingness to pay for guaranteed tender steaks and thus guide the development of a marketing strategy. If processors adopt tenderness technology, they will likely want to market their product by concentrating on demographic groups that have the most potential to buy guaranteed tender steak at profitable prices. In this study, consumers have three different decision nodes at which they reveal information about their preferences and willingness to pay. These include, as shown in Figure 1, I) tenderness preferences, II) willing or not willing to pay for tenderness, and III) amount willing to pay. These choices are all modelled in this study.

I. Choice of Tender or Tough Steak

The first regression model examines consumers' steak choice in the experiment. Each participant, after sampling the tender and tough steak, indicated which steak they preferred. A multinomial logit model is used to examine the probability that a consumer will choose the tough steak, the tender steak, or be indifferent between the two, given their demographic and steak preference characteristics. Table 5 presents the marginal effects for the model. The results indicate whether, given a one unit increase in the value of an explanatory variable such as age, the respondent is more or less likely to fall into one of three categories – preferring the tender steak, preferring the tough steak, or being

[3] This calculation assumes that the 1 percent of carcasses that grade as USDA Prime would continue to be marketed as such and that the associated premium for Prime is unaffected.

indifferent between them. For a given explanatory variable, the marginal probabilities across the three categories always sums to zero. The model contains 245 observations–lower than the total number of participants due to some respondent failure to answer one or more survey questions.

Among consumers that prefer tender steak, the marginal probabilities for age and education are positive and statistically significant. The estimates indicate that for every one year increase in age, a participant is 0.4 percent more likely to indicate a preference for the tender steak. Thus, a forty-five year old would be expected to be 8 percent more likely to prefer tender steak than would a twenty-five year old. For a one "unit" increase in the respondent's level of education (e.g. from "some college" to "B.S., B.A. complete"), the results indicate that a respondent is 4 percent more likely to prefer the tender steak. Perhaps the most important result here is the relatively large, positive, and statistically significant result for the treatment variable. It indicates that participants in the second treatment, where the tender and tough steaks were identified prior to tasting, were 18 percent more likely to prefer tender steak, than participants in treatment one where the tenderness levels of the steaks were not identified.

Table 5 – Multinomial Logit - Marginal Probabilities of Factors Affecting Consumers' Preference for Guaranteed Tender Steaks

	Category[c]		
Variable	**Prefers Tender**	**Prefers Tough**	**Indifferent**
Age	0.004[a]	-0.003[b]	-0.001
	(0.002)	(0.002)	(0.001)
Education	0.040[a]	-0.027[a]	-0.013
	(0.014)	(0.012)	(0.008)
Gender	0.071	-0.027	-0.044
	(0.060)	(0.053)	(0.033)
Income	-0.005	0.007	-0.002
	(0.011)	(0.010)	(0.007)
Treatment	0.181[a]	-0.142[a]	-0.039
	(0.069)	(0.061)	(0.041)
Doneness	-0.044[b]	0.035	0.009
	(0.025)	(0.022)	(0.014)
Steak Home	0.027	-0.047	0.020
	(0.034)	(0.032)	(0.016)
Steak Away	-0.003	0.006	-0.003
	(0.034)	(0.029)	(0.019)
Knowledge of Quality Grade	-0.004	0.032	-0.028
	(0.066)	(0.059)	(0.035)

[a] Statistically Significant at 5% level
[b] Statistically Significant at 10% level
[c] Numbers in parenthesis are standard errors
number of observations = 245

The only steak preference variable that influenced steak choice was cooking doneness--consumers who preferred their steaks cooked to a higher degree of doneness were less likely to prefer the tender steak.

II. Choice of Payment for Tender Steak

The second choice consumers made was whether they would pay to exchange their tough steak for a tender one, given that they previously expressed a preference for tender steak. Table 6 presents the marginal effects for a logit model that examines the effects of certain demographic and steak preference characteristics on the probability that a consumer will indicate a willingness to pay more for tender steak. It is important to note that this choice is conditional upon the first choice in that only those consumers who preferred the tender steak were given the opportunity to pay extra and substitute a tender steak for the free tough steak. Accordingly, the number of observations falls to 180.

Table 6 – Logit Model- Marginal Probabilities of Factors Affecting Consumers' Choice to Pay for Guaranteed Tender Steaks

Variable	Marginal Effect[c]
Age	-0.001 (0.002)
Education	0.024 (0.019)
Gender	-0.036 (0.082)
Income	-0.022 (0.015)
Treatment	0.083 (0.083)
Doneness	0.002 (0.035)
Steak Home	-0.020 (0.048)
Steak Away	0.046 (0.054)
Knowledge of Quality Grade	0.119 (0.089)

[a] Statistically Significant at 5% level
[b] Statistically Significant at 10% level
[c] Numbers in parenthesis are standard errors
number of observations = 180

The results in Table 6 indicate that none of the estimated marginal probabilities are statistically significant. Interestingly, however, the sign on the treatment variable is again positive suggesting that, even among participants who indicated a preference for tender steak, consumers who were informed about steak tenderness levels might be more willing to pay for tenderness than consumers who were not informed.

III. Consumer Choice of How Much to Pay for the Tender Steak

The model in table 7 investigates how much consumers would be willing to pay for the upgrade to tender steak given that: 1) they have indicated a preference for tender steak and 2) they have indicated they would be willing to pay more for tender steak. The model contains 98 observations.[4]

Table 7 – Regression Coefficients of Consumer Willingness to Pay for Guaranteed Tender Steak

Variable	Coefficient [c]
Constant	2.725
	(0.569)[a]
Age	-0.011
	(0.005)[a]
Education	-0.486
	(0.176)[a]
Education^2	0.054
	(0.018)[a]
Gender	0.305
	(0.165)[b]
Income	-0.279
	(0.096)[a]
Income^2	0.027
	(0.008)[a]
Treatment	0.624
	(0.142)[a]
Doneness	0.102
	(0.066)
Steak Home	-0.047
	(0.085)
Steak Away	-0.119
	(0.087)
Knowledge of Quality Grade	0.084
	(0.181)

[a] Statistically Significant at 5% level
[b] Statistically Significant at 10% level
[c] Numbers in parenthesis are standard errors
Adjusted R^2 = 0.26
number of observations = 98

[4] This model includes a correction for heteroscedasticity (non-constant variance in the error term)--a common problem with cross sectional data. The correction models the error term as a log-linear function of age, education, sex, and income.

All variables except those measuring consumption of steak, cooking preference, and knowledge of the USDA quality grading system were statistically significant at the 1 percent level. The coefficient on age was negative indicating that as an individual's age increases, the amount they would pay for a guaranteed tender steak decreases. However, for each additional 10 years in age, the amount they are willing to pay declines by only 11 cents/lb. Females had a higher willingness to pay than males. The model predicts that females are willing to pay $0.31 more per pound for a guaranteed tender steak than are males.

The coefficients on the quadratic terms for education and income suggest that consumers will pay more for a guaranteed tender steak at lower and higher education and income levels than they will pay at medium education and income levels. The estimates predict that minimum willingness to pay occurs at a household annual income level between $50,000 and $60,000 and at a level of education where one had completed a B.S. or B.A. This particular result is not consistent with prior expectations because the amount a person would be willing to pay for tender relative to tough beef would be expected to increase with income level. Possibly it is a unique aspect of the consumers in this particular sample. Further work needs to be done to confirm or reject this result.

Finally, the positive and statistically significant sign on the treatment variable indicates that participants in treatment 2, where the tenderness levels of the steaks were revealed, were willing to pay about $0.62 more per pound for a guaranteed tender steak than were participants in treatment 1 where tenderness levels were not revealed.

Summary and Conclusions

Consumers rank tenderness as the most important quality attribute in beef. Studies have shown that consumers perceive beef graded under the current USDA grading system to have too much variability in tenderness within grades. Recent advances in technology make more accurate measurement of beef tenderness possible. This study investigates the amount consumers are willing to pay for more tender steaks where steaks are classified according to one tenderness measurement system.

Results indicate that, in a blind taste test, 72 percent of consumers correctly identified and preferred tender relative to tough steak (as measured via Warner-Bratzler shear force tests). Moreover, when they relied only on steak taste samples to differentiate steaks, 36 percent of consumers were willing to pay an average of $1.23/lb more for a tender than a tough steak.

Consumers provided with information regarding steak tenderness levels were more likely to choose a tender steak and more willing to pay more for a tender versus a tough steak. *When steaks were identified as guaranteed tender or probably tough prior to a taste test, 90 percent of consumers preferred the tender to the tough steak.* Overall, consumers who received explicit information regarding steak tenderness levels were 18 percent more likely to choose a tender steak than they would have been without the tenderness information. *Fifty-one percent of consumers informed of steak tenderness levels were willing to pay an average premium of $1.84 per pound (versus $1.23/lb. without tenderness information) to exchange a probably tough for a guaranteed tender steak.*

Consumer demographics affected consumers' desire for tender vs. tough steak and the premium they were willing to pay for tender vs. tough steak. Older, more highly educated consumers were more likely to choose the tender over the tough steak. Among consumers willing to pay more for tender vs. tough steak, younger, more highly educated females with higher household income levels were willing to pay the largest premiums.

New technology makes it possible to grade steaks according to tenderness. *Consumers are willing to pay a significant premium for steaks that are guaranteed tender and the premium appears to exceed, by a wide margin, expected costs associated with implementing this tenderness classification system.* Perhaps it is time to consider implementing a tenderness-based quality grading system as an important step in revitalizing consumers' demand for beef.

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