Willingness to Pay for Alternate Merchandising Strategy of Beef Top Round

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Abstract

Whole top round steaks can lack color uniformity between the deep and superficial cuts, leading to changes in consumers' willingness to pay (WTP), potentially leading to wasted meat products or loss in revenue. A choice experiment was used to elicit consumers' preferences and WTP for alternate merchandising strategies of whole beef top round steaks. Using a two-stage model, results show heterogeneity in the purchase decision across steak and respondent characteristics with differences in purchase likelihood and WTP. Results indicate that consumers may be open to alternative merchandising strategies in markets that struggle with excessive margin losses, increased labor demands, or meat waste.

Keywords: meat merchandising, willingness to pay, beef, top round

Introduction

Food quality attributes are primary factors in consumer willingness to pay for beef products. Tastes and preferences are often led by appearance and perceived palatability by the consumer, and if a product is perceived to be less desirable or has a limited shelf-life, monetary losses for retailers, and potential meat waste can occur. Consumers consider leanness, tender appearance, and freshness of beef steak as primary factors in purchasing beef and beef products (Gao and Schroeder, 2009; Khan, Jo, and Tariq, 2015; Morales, Ehmke, and Sheridan, 2022). Bright red coloring in beef, determined by the amount of myoglobin (the protein that gives meat its red coloring), is considered an indicator of freshness and wholesomeness (Hunt et al., 2004; Holman et al., 2017) , and consumers rely on the color as an important criterion for quality judgement (Seideman et al., 1984; Felderhoff et al., 2020; Morales, Ehmke, and Seridan, 2022). Discolored beef or beef with more grey hues is considered less fresh and is generally marketed in reduced-value form or would need to have value added, such as aging, to be marketed with a premium (Faustman and Cassens, 1990; Felderhoff et al., 2020). For example, top round has mixed colors compared to top sirloin and would command a lower price in comparison. Discolored meat may be ultimately marked down or discarded in markets. Discarded products have been found to have caused $1 billion of losses to the U.S. beef industry (Suman et al., 2014). Whole top round steaks can lack color uniformity due to both a deep and superficial portion of the meat, which varies the myoglobin, leading to discounts or loss as consumers' willingness to pay is reduced. To mitigate profit losses and meat waste due to discoloration of top round steaks, an alternate merchandising strategy can be used to drive sales and provide retailers a strategy in the face of market losses and meat waste. The alternative marketing strategy for top round is to separate the whole beef top round steak into a deep portion and superficial portion. By cutting top round into smaller portions, a more red, superficial cut could be marketed as a steak, and the darker deep cut could be marked alternatively in ground meat or aging to add value to the product. These alternative strategies may make these cuts more sellable and appealing to buyers who are concerned about the steak appearances and preferences on freshness. We compared the deep portion, superficial portion, and whole beef top round steaks using a choice experiment to determine consumer willingness to pay and preferences for the cuts to determine whether consumers would purchase the individual cuts and at what price.

Findings from this study provide a more comprehensive view of consumers preference and choice in the American beef market and help beef retailers better market their product and reduce meat waste from discolored whole top round.

Background

Various studies have analyzed the factors affecting willingness to pay for beef steak. Quality attributes of steak, marbling and Warner-Bratlzer shear force, the country-based origin of steak, information on the beef husbandry system, and type of feed (corn feed versus grass feed), are some of the factors that affect consumers' willingness to pay for steak (Umberger et al., 2002; Platter et al., 2005; Gao and Schroeder, 2009; Lim et al., 2013; Risius and Hamm, 2017; Morales, Ehmke, and Sheridan, 2022). In general consumers prefer a tender cut of meat, such as top loin, which rates highly in consumer acceptability (Martinez et al., 2017). Demographics can play a role in preferences, where sex, age, and socioeconomics affect purchase behavior (Reicks et al., 2011). Contrarily, top round has the highest Warner-Bratlzer sheer force (least tender) of steaks tested and is consistently ranked lower on preferences (Martinez et al., 2017; Gonzalez and Phelps, 2018).

Because visual presentation of beef is paramount in consumers' purchase decisions (Morales, Ehmke, and Sheridan, 2022), beef cuts that are less favorable are often discounted or disposed of if they cannot sell. Aging of top round is one solution to market the product to reduce markdowns related to discoloration and tenderness, but the impact of aging differs by size of carcass (Lancaster et al., 2020; Lancaster et al., 2022). Ramanathan et al. (2022) found that, on average, 2.55% of kg of beef (across cuts) sold are discarded due to discoloration. Consumers prefer bright red coloration and as the meat ages on the shelf, it loses this preferred color, leading to either discounts or meat waste (Killinger et al., 2004; Holman et al., 2017; Ramanathan et al., 2022). Top rounds are tougher than other cuts and tend to rank lower in consumer preferences (Gonzalez and Phelps, 2018). This toughness is coupled with discoloration, or more accurately, mixed coloration, in whole top round cuts because of the muscle structures of top round and the respective pH levels of the different muscle tissues (Lancaster et al., 2022). McKenna et al. (2005) demonstrated that beef muscles can be classified based on color stability. They categorized the semimembranosus (Top Round) as being a "moderate" color stability muscle when aged for 3 days and subjected to 5 days of retail display. Colle et al. (2016) noted that top round color decreases rapidly after 21 days of aging. They also found that top round steaks were less uniform in color (more two-toning) than bottom round steaks. When shopping, consumers compare top round steaks to a top sirloin steak with consistent coloring and a more tender Warner-Bratlzer sheer force, leaving the top round wanting. Estimated sales losses related to discoloration account for 194.7 million kg of beef or $3.73 billion annually for all beef cuts (Ramanathan et al., 2022). Alternative marketing strategies may be used to reduce meat waste and retail losses and capture more of the true market value of beef cuts.

Methodology

A choice experiment was used to elicit consumers preferences and WTP for alternate merchandising strategies of whole beef top round steaks. Two analyses were estimated, including

the propensity to purchase the alternative steak cut and how the WTP was affected by buyer characteristics (demographics and purchasing behavior). This approach allows for an understanding of whether these cuts are acceptable to consumers as an alternative to the current market choices and if it is equal to WTP.

Choice Experiment

A choice experiment is a survey implement that allows for consumers to consider hypothetical market scenarios and make tradeoff decisions between product attributes. For this experiment, USDA Choice top round steaks were purchased from a commercial meat distributor and aged between 21 and 24 days from their pack before breaking them down into the semimembranosus (SM) muscle and then dividing them into five steaks per top round. These whole beef top steaks were cut proximally to distally and assigned a day-of-retail display from 0 to 4 days (D0, 1, 2, 3, or 4). Each steak was displayed in a glass-fronted retail display case at 3°C until the day assigned. The steak was then unpackaged, placed on a white background, and a photograph (Sony Cyber-shot DSC-H300, New York, NY) was taken at 15 inches above the steak. The whole steak was then separated into a superficial and deep portion (approximately 5 cm from the steak's superficial edge), and photographs were taken of both the deep and superficial portions. These images were used to create a choice experiment developed and distributed online through Qualtrics. The University of Idaho Institutional Review Board certified this project as exempt. A link to the survey was sent to the Cattlemen's Association and various University of Idaho newsletters, administered on December 2020, and was open for 16 weeks. A limitation of this survey design is the variance in color between monitors and consumers; however, all steaks were photographed in the same lighting so any differences would be consistent across the full set of steak choices. Future work could replicate this study and include in-person responses to limit differences in viewing settings and monitors.

Based on survey length, and to ensure a representative across the different cuts, age days, and steaks, respondents were presented 18 individual randomized images and were asked if they would purchase each steak. Respondents selected from one of four possible responses, "definitely would not," "probably would not," "probably would," or "definitely would." Utilizing a payment card, a follow-up question asked respondents to select their willingness to pay for the steak shown. Prices presented on the payment card included $2.58/pound, $3.58/pound, $4.58/pound, $5.58/pound, and $6.58/pound. These prices were selected to provide a range of prices around the current average market price for top round steak from a local retail grocery store in Idaho at the time of the study ($4.58/pound). If the decision to purchase was "no," they were asked the reason for this decision, which included the following options: amount of trim, toughness, color, and amounts of marbling. Meat purchasing behavior and demographic information were also collected to account for respondent heterogeneity. A total of 265 consumers completed the survey, and 3,375 hypothetical purchase decisions were made, with 56.8% responding they would purchase the presented steak.

A summary of the responses is presented in Table 1. The respondents were predominantly female (69.9%) from the Northwest United States (Idaho, Montana, Oregon, and Washington) (81.4%)

with even proportion of household income levels across the sample. This sample has a slightly higher female population compared to the United States as a whole (50.8%) (Blakeslee et al., 2023). Consumers reported purchasing steaks across multiple outlets with the most frequent being grocery stores (80.5%) and least frequent being community-based retailers (44%), such as a local retailer. Steaks were purchased frequently as defined by at least every other shopping trip 32.1% of the time, as opposed to infrequently and never purchasing steaks (22.0% and 6.8%, respectively, not reported).

Table 1: Select Summary of Responses for Alternative Top Round Choice Experiment

Variable	Description	N	Mean	Std. dev.	Min	Max
Lower Bound	Lower Bound of Price Selected	2,331	4.595	0.930	2.58	6.58
Upper Bound	Upper Bound of Price Selected	2,637	4.133	0.981	2.58	5.58
Age	Age of Respondent	3,284	38.818	17.476	18	84
Day	Display Day of Steak	3,375	1.991	1.399	0	4

Binary Variables[1]	Description		N	Percent of Observations
Buy	Purchase decision		3,375	56.8%
Deep steak	Steak cut is deep portion		3,375	33.8%
Superficial steak	Steak cut is superficial portion		3,375	33.9%
Whole steak	Steak cut is whole top round steak		3,375	32.3%
Grocery store	Purchase beef products at grocery store		3,366	80.5%
Specialty meat store	Purchase beef products at specialty meat store		3,366	23.5%
Directly from producer	Purchase beef products directly from producer		3,366	44.1%
Community-based retailer	Purchase beef products from community-based retailer		3,366	9.5%
Frequently	Purchase steak at least every other shopping trip		3,266	32.1%
Female	Respondent identified as female		3,375	69.9%
Northwest[2]	Respondent from northeast USA 2		3,432	81.4%
HHI: $29,999 or Less	Household income $29,999 or less		3,342	27.1%
HHI: $30,000 to $69,999	Household income $30,000 to $69,999		3,342	22.1%
HHI: $60,000 to $99,999	Household income $60,000 to $99,999		3,342	26.0%
HHI: $100,000 or More	Household income $100,000 or more		3,342	24.8%

Notes:[1] All Binary Variables defined as 1 as described, 0 otherwise.
[2] Northwest as defined as Idaho, Montana, Oregon, and Washington.

Econometric Modeling

The WTP questions were asked only to those responding positively to the willing-to-purchase question. As such, the data are truncated. The economic analysis of the choice experiment used a two-stage, selection correction estimation, with the first stage estimating the purchase decision (probit model) and the second the WTP estimation (interval regression), accounting for the truncation in the data for WTP. To estimate the consumer purchase decision, probit was used, capturing the consumer's propensity to purchase the alternate steaks across the different choices presented. The empirical probit model is detailed in Equation 1 as:

$$Purchase_i = \beta_k S_i + \gamma_l C_i + \varepsilon_i \tag{1}$$

where the binary purchase decision is a function of steak-specific factors (S) and consumer-specific factors (C) for the *i*-th steak selection, with β_k and γ_l representing the estimated coefficients. Standard errors (ε_i) were clustered to account for respondent correlation between steak selections.

To account for the sample selection in the WTP estimates, where only the observations of respondents positively responding to the purchase decision, were asked how much they were willing to pay, an inverse Mills ratio (IMR) was calculated. The IMR accounts for a truncated sample of those responding positively to the purchase question. It is included in the second step to adjust the sample and account for sample selection bias as proposed by Heckman (1979). The IMR is calculated using the ratio of the probability distribution function of the standard normal distribution (ϕ) to the cumulative distribution function (Φ) as shown in Equation 2 (Heckman, 1979).

$$IMR = \frac{\phi(x)}{\Phi(x)} \tag{2}$$

The IMR is calculated for each observation and is used in the second stage of the analysis. The selection correction works well with linear models such as the interval regression estimated.

The WTP for the different steak cuts were estimated using interval regression, which is a generalized tobit model for observable intervals. Respondents were presented a list of prices for choosing the one that closest represented their WTP. This method implies the ranges in which the true WTP lies. For example, if a respondent chose \$3.58, it can be inferred that the true WTP is at least \$3.58 and less than \$4.58. Using the ranges as presented in Table 2, an interval regression is calculated using the log likelihood in Equation 3 (Cameron and Trivedi, 2010; StataCorp, 2021),

$$\ln L = -\frac{1}{2}\sum_{i \in Uncensored}\left\{\left(\frac{y_i - x_i\beta}{\sigma}\right)^2 + log2\pi\sigma^2\right\} + \sum_{i \in LeftCensored} log\Phi\left(\frac{y_{LB,i} - x_i\beta}{\sigma}\right) +$$
$$\sum_{i \in RightCensored} log\left\{1 - \Phi\left(\frac{y_{UB,i} - x_i\beta}{\sigma}\right)\right\} + \sum_{i \in IntervalCensored} log\left\{\Phi\left(\frac{y_{UB,i} - x_i\beta}{\sigma}\right) - \Phi\left(\frac{y_{LB,i} - x_i\beta}{\sigma}\right)\right\}$$

$$\tag{3}$$

Where the true value lies within the given censored intervals using the upper bound (UB) as the limit for left-censored data, lower bound (LB) for right-censored data, and both for interval-censored (i.e., $y_{LB,i} \leq Y_i \leq y_{UB,i}$) data. Effects of specific steak attributes (cut and day) and respondent attributes (age, sex, household income, region, and typical purchasing behavior) were accounted for in the modeling. Standard errors were clustered to account for respondent-correlated effects between steak selections.

Table 2: Intervals Used in Estimations Based on Choice Price Selections

Observed Selection	Lower Bound	Upper Bound	Percent of Purchasers
$2.58	$2.58	$3.57	15.50
$3.58	$3.58	$4.57	29.65
$4.58	$4.58	$5.57	30.12
$5.58	$5.58	$6.57	18.48
$6.58	$6.58	No upper limit	6.23

Results and Discussion

The results are separated into the purchase decision and the WTP results, both presented in Table 3.

Purchase Decision Results

For the choice experiment, 56.8% of respondents said they would purchase the steak presented. Results from the purchase decision analysis showed heterogeneity in the decision to purchase the steak across choice and respondent characteristics. All things held constant, respondents were 8.6% less likely to elect to purchase the deep steak portion than the whole steak portion. In contrast, respondents were 7.0% more likely to purchase the superficial steak portion, which indicates a preference by consumers for the superficial portion. While whole steak portions are sold in many markets capturing the value for the whole cut, indicating that consumers may be open to alternative merchandising strategies in markets that deal with excessive margin losses, increased labor demands, or meat disposal. The deep portion could be sold as is, ground and sold as ground beef, or even seasoned to add value.

Other factors that drove steak preferences to purchase a steak included where respondents typically shopped for steak. Respondents who typically purchased direct-from-producer were 10.8% less likely to purchase any of the steaks in general. In comparison, respondents who purchased from community-based retailers were 1.9% more likely to purchase the steak presented, all else being equal. This finding may indicate some heterogeneity based on retail market choice and collective preferences for steak appearance and perceptions of freshness and taste.

In terms of consumer heterogeneity, there were no significant sex differences. The age of the consumer affected willingness to purchase so that each additional year in the cross-sample increased purchases by 0.4%, possibly showing generational consumption differences. Regionally, respondents from the Northwest were 8.6% more likely to purchase the steak. Overall, 81.4% of respondents were from the Northwest, and future work could expand the sample to be more nationally representative and focus on regional preferences in steak purchases.

Willingness to Pay Results

For steaks that had a positive purchase decision, the interval regression results show the marginal effect on respondent WTP. There were no significant differences in WTP for the three cuts. This result implies that the WTP for the deep steak portion (the least desirable) is not lower than the whole or superficial cut, even though it is not the desired cut. For retailers with high discounts or product waste who wish to separate the whole steak into the two portions, they could grind the deep steaks and the rest could be alternatively marketed at the same rate per pound. There would be additional labor costs, but currently these retailers are paying additional labor to markdown, grind, or age the whole top round. The marginal changes in costs are not considered in the present study, but it should be noted that a change in strategy could affect the labor costs. Contrarily, this factor also means that there is not a premium for superficial steak. This alternative marketing strategy may not be effective or beneficial to retailers able to sell their steaks with only limited discounts but may be useful in driving volume sales where a whole steak may have previously been rejected and create opportunities for converting customers to the other two portions.

Respondents shopping at specialty meat stores had a $0.04 higher WTP for steak. This preference can be driven by a perception of quality at these stores. Baltzer (2004) and McCluskey and Loureiro (2003) reported a positive relationship between quality food and higher WTP. In this case, these customers may be used to paying a premium for their meats from this these types of stores, which helps in understanding the market perceptions and price perceptions at different formats.

While respondent heterogeneity impacted the purchase decision, it was less of a driver of WTP. Sex, age, and location had no significant impact on WTP. However, results show that consumers with an upper-middle-level annual income ($60-99 thousand) had a $0.45 per pound higher WTP than the lowest income level. This finding is plausible because consumers with higher annual income have more purchasing power and may place a premium on steak in their diet. This was not the case for the highest level of income.

Table 3: Results for Purchase Decision and Willingness to Pay for Alternative Top Round Steak Cuts

	Purchase Decision Results		WTP Results
	Probit Coefficients	**Average Marginal Effects**	**Interval Regression Coefficients**
Deep steak	-0.228*** (0.059)	-0.086*** (0.022)	-0.039 (0.070)
Superficial steak	0.188*** (0.063)	0.070*** (0.024)	0.043 (0.065)
Day	-0.020 (0.017)	0.007 (0.006)	0.009 (0.019)
Frequently buy steak	-0.006 (0.108)	0.002 (0.041)	0.0164 (0.150)
Grocery store	-0.035 (0.156)	-0.013 (0.059)	0.0171 (0.207)
Specialty meat store	-0.198 (0.130)	-0.074 (0.049)	0.042** (0.166)
Directly from producer	-0.289** (0.134)	-0.108** (0.050)	0.167 (0.167)
Community-based retailer	0.503** (0.204)	0.019** (0.076	0.098 (0.175)
Female	-0.028 (0.121)	-0.011 (0.045)	-0.217 (0.161)
Age	0.014 (0.023)	0.004*** (0.002)	-0.008 (0.024)
Age*age	0.000 (0.000)		0.000 (0.000)
Northwest	-0.230* (0.131)	0.086* (0.049)	0.208 (0.198)
HHI: $30,000 to $69,999	0.022 (0.164)	0.008 (0.061)	0.133 (0.237)
HHI: $60,000 to $99,999	-0.201 (0.159)	-0.076 (0.059)	0.447* (0.237)
HHI: $100,000 or More	0.10 (0.164)	0.004 (0.061)	0.306 (0.229)
Inverse mills ratio			-0.008 (0.012)
Constant	0.137 (0.425)		4.931*** (0.489)
Log Pseudolikelihood	-2030.298		-2450.241
lnSigma			-0.000
Wald	88.22***		36.77***
Observations	3,100	3,100	1,709
Average Predicted Value	0.568*** (0.020)		5.08*** (0.070)

Note: Robust standard errors, clustered by respondent presented in parenthesis. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Negative Purchase Decision

For those choosing "no" for each steak purchase decision, respondents were asked a follow-up question to provide a rationale for their choice. The breakdown of respondents' reasons is provided in Table 4, disaggregated by steak type. Based on purchase decision results above, we know that the deep steak was the least preferred, having a lower likelihood of being purchased and lower WTP. This is reflected in the percent (46%) of choice set that respondents chose not to purchase, which were deep steak options, followed by whole steak (30%), and superficial steak (22%). Deep steaks have a greyer hue than the superficial steak, which supports the preferences in the literature

indicating that a more red color is associated with freshness and quality (Seideman et al., 1984; Hunt et al., 2004). These colors were measured instrumentally (Puga 2019), but the discussion of color is based on consumer comments and their perceptions of quality and WTP.

Overall, the perceptions of toughness (56.9%), lack of appropriate marbling (59.3%), and coloring (43.8%) were the largest drivers of negative purchase response across all steaks. However, the factor importance varies by the steak portion. While perception of toughness was the largest reason for choosing whole steak, a significant difference was found in the top response for superficial and deep steaks. This result is interesting in that the two components individually are not perceived as tough as the full whole steak, or as a larger driver for a negative purchase response. This is the only response category where this holds. Across all other reasons, the whole steak and deep steak portions are not statistically different from one another.

The main differences in negative purchase responses were demonstrated through the comparison of whole and deep to superficial steaks. Insufficient marbling is the largest response for the superficial steak (72.7%), which is significantly different than whole or deep steaks. Superficial steaks are redder in color but also lack the fat profile of the deep portion, which is consistent with the perceptions of being off color as a large driver of respondents' preferences for whole (54.7%) and deep (46.9%) steaks, but not for superficial steak (23.6%). The smallest response across all three steaks was too much marbling, consistent with consumer surveys on beef tenderness and beef portions (Martinez et al., 2017; Gonzalez and Phelps, 2018).

Table 4: Reported Reasons for Negative Purchase Response

Reason[†]	Whole Steak			Superficial Steak			Deep Steak		
	N	Mean	St. Dev	N	Mean	St. Dev	N	Mean	St. Dev
Amount of trim	148	0.155[A]	0.364	110	0.382	0.488	226	0.186[A]	0.390
Looks tough	148	0.662	0.475	110	0.464[A]	0.501	226	0.553[A]	0.498
Off color	148	0.547[A]	0.499	110	0.236	0.426	226	0.469[A]	0.500
Not enough marbling	148	0.500[A]	0.502	110	0.727	0.447	226	0.584[A]	0.494
Too much marbling	148	0.027[A]	0.163	110	0.018[A]	0.134	226	0.018[A]	0.132

Notes: *Means in each column may sum to more than 100 as respondents could choose more than one reason for negative purchase response.
[†] Means sharing a letter across row are not significantly different at the 5% level.

Conclusion

Meat waste and lost marketing opportunities lead to losses in the beef industry annually. Alternative marketing strategies aim to provide a solution to less desirable products. The beef top round is a large muscle that varies in color and tenderness. This variation results in less appealing steaks that end up being discounted at the retail store. By separating a whole top round into two portions (i.e., a deep and superficial portion), a retailer with high loses or discounted product can drive more sales and better cater to customer preferences. Specifically, these findings would guide retailers to sell the superficial portion as a steak and either grind or season the deep portion. This would reduce the amount of or product reduced for quick sale. Further research should be

conducted to expand beyond the Pacific Northwest region and compare rural versus urban purchasing decisions.

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