
RECENT TRENDS: BEEF QUALITY, VALUE AND PRICE

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“The bitterness of poor quality remains long after the sweetness of low price is forgotten.” Benjamin Franklin

MEETING EXPECTATIONS OF TODAY’S BEEF CONSUMERS

Consistently providing consumers with a pleasurable eating experience at a compelling price is the core of beef’s value proposition. Consumer tracking data (Pelegrin Research Group, 2014; Lusk and Murray, 2015) suggest that “taste” continues to be the number-1 attribute valued by a majority of consumers when purchasing food and the primary reason many consumers express a preference for beef compared with other types of meat. Moreover, quality remains a key demand driver within the beef category (Steiner, 2014).

In the past few years, as beef has become more expensive, beef consumers have become increasingly discriminating with respect to quality and value and have demonstrated a willingness to “trade up”, paying premium prices to obtain the kinds of beef products and eating experiences they desire. For example, from 2009 through 2014, growth in consumer demand for premium-quality, Certified Angus Beef® (CAB) increased by 112 percentage points, whereas demand for commodity Choice beef declined by 2 percentage points (Zimmerman and Schroeder, 2013; Suther, 2015). Within the same time period, branded Choice boxed-beef sales, expressed as a percentage of total boxed beef sales, increased dramatically (Speer, 2013).

Recent beef industry survey data provide further insight into consumers’ perceptions of beef’s quality, value, and price in today’s marketplace. According to the March 2015 Consumer Beef Index survey, 73% of consumers believe that steaks offered at retail “are priced just about right” or “are expensive but worth it” (The Beef Checkoff, 2015). Today’s quality driven consumers seem willing to pay more for beef as long as the eating experience justifies the price.

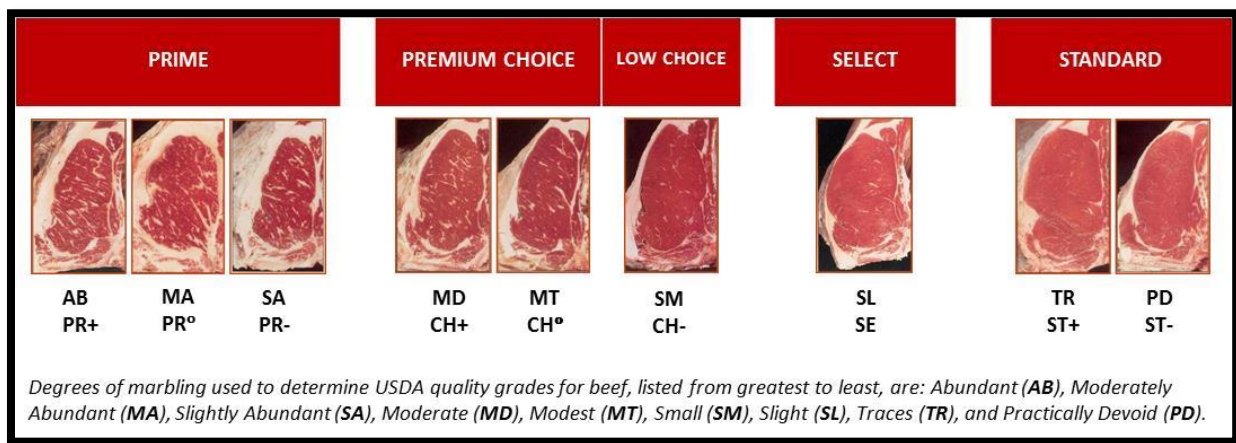
COMMUNICATING BEEF QUALITY AND VALUE

Coordination of the beef supply chain to consistently meet consumers’ expectations for eating quality requires that differences in those product attributes most valued by beef consumers be accurately identified and clearly communicated across the entire beef chain. This presents a challenge for the beef industry, in part because the primary attribute of interest, taste, is an “experience attribute” (Ford et al., 1988) – in-other-words, consumers cannot assess a beef product’s performance and value until they have tasted it. Because a beef product’s flavor, juiciness, and

tenderness cannot actually be determined and verified beforehand, the beef industry has been forced to rely on other, indirect approaches for assessing beef sensory attributes and transmitting market signals that reflect differences in product performance and value from sector-to-sector between consumers and cattle producers.

Currently in the U.S. beef trade, consumers' preferences for "taste" attributes (tenderness, flavor, and juiciness) are communicated from sector-to-sector along the beef chain primarily via price signals associated with USDA quality grades (USDA, 1997). The current grade-based beef pricing structure stratifies carcasses and beef cuts produced by youthful, steers and heifers (i.e., animals less than approximately 30 months old and classified as "A maturity") into 5 marketing categories (Figure 1) based on degree of marbling (amount and distribution of intramuscular fat in the rib eye at the 12th rib) and associated differences in expected eating quality (Prime > Premium Choice > Low Choice > Select > Standard).

Figure 1. Beef marketing categories based on USDA quality grade



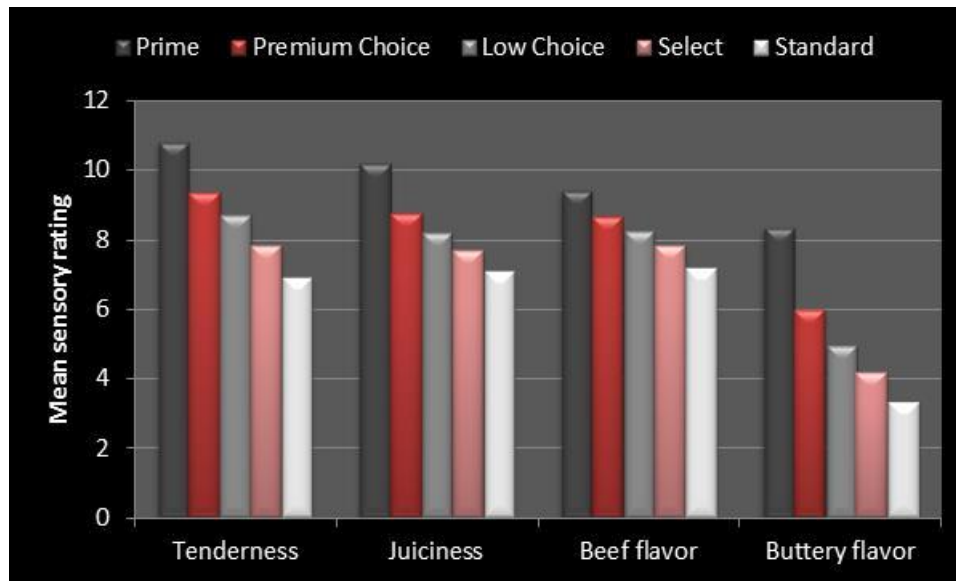
Quality Grades and Beef Sensory Attributes

Numerous studies have examined the effectiveness of the USDA quality grade system for identifying differences in eating quality of beef with varied results (Smith et al., 2008). The most comprehensive (and most widely referenced) evaluation of the USDA beef grading system to date was completed 35 years ago (Smith et al., 1980) and reported in the scientific literature by Smith et al. (1982, 1984, 1987). Results of that investigation showed that USDA quality grades of Standard through Prime effectively categorized loin steaks according to differences in overall palatability (Prime > Choice > Select > Standard) and predicted loin steak flavor, tenderness and overall palatability with 30 to 38% accuracy (Smith et al., 1987). Over time, however, modifications of USDA grade standards, shifts in consumer preferences, and (or) changes in cattle production and beef marketing systems necessitate periodic re-examination of the effectiveness of the quality grading system.

A series of studies recently completed at Colorado State University re-examined relationships between USDA quality grades and sensory properties of beef strip loin steaks. Combined results of those studies (Emerson et al., 2013; Acheson et al., 2014; Semler, 2015), showing the effects of USDA quality grade on tenderness, juiciness, and flavor attributes of strip loin steaks produced by cattle less than 30 months old, are summarized in Figure 2. Emerson et al. (2013) determined that, together, the 4 beef sensory attributes represented in Figure 2 (tenderness, juiciness, intensity of meaty-brothy flavor, and intensity of buttery-beef fat flavor) explained more than 90% of total variation in overall sensory experience.

Results summarized in Figure 2 indicate that, across the spectrum of grades ranging from Standard to Prime, strip steak tenderness and juiciness increased ($P < 0.05$) incrementally and desired beef flavor characteristics became more ($P < 0.05$) pronounced as quality grade progressed from Standard to Select, Select to Low Choice, Low Choice to Premium Choice, and Premium Choice to Prime.

Figure 2. Effect of USDA quality grade on sensory attributes of strip loin steaks



Compared with results of previous studies, a unique feature of the comparisons shown in Figure 2 is that official USDA quality grades of the 1,768 carcasses from which the steaks originated were determined using instrument-based marbling scores (USDA, 2006). Research conducted during the past several decades to quantify marbling's contribution to differences in eating quality of beef generally has demonstrated low to moderate, positive relationships between graders' visual assessments of marbling and beef tenderness, juiciness, and flavor (Briskey and Bray, 1964; Carpenter, 1974; Smith et al., 2008). For example, in a study involving youthful (A-maturity)

carcasses with marbling scores ranging from Practically Devoid (PD) to Abundant (AB), Campion et al. (1975) reported that marbling accounted for no more than 10% of the variation in sensory properties of beef rib steaks and suggested that degree of marbling may be relatively unimportant in steaks produced by young cattle. On the other hand, somewhat stronger, positive relationships between marbling and beef palatability characteristics were reported by Smith et al. (1984), who found that, among loin steaks from A-maturity carcasses, differences in marbling (ranging from PD to MA) explained 24%, 27%, 30% and 34% of the variation in sensory panel ratings for juiciness, tenderness, flavor and overall palatability, respectively. Emerson et al. (2013) determined that, among A-maturity carcasses, instrument assessments of marbling (ranging from TR to MA) explained 45%, 40%, 32%, and 71% of the variation in juiciness, tenderness, beef flavor intensity, and buttery/beef fat flavor intensity, respectively, and 61% of the variation in overall sensory experience. Increased precision of instrument-based versus visual assessments of marbling likely contributed to the stronger relationships between marbling and beef sensory attributes observed by Emerson et al. (2013) compared with those reported previously.

Quality Based Price Signals

Market signals that communicate supply-demand relationships for different grades of beef through the supply chain originate in the boxed-beef market. Value differences established between quality grade categories in the boxed-beef trade are reported by USDA-AMS as “boxed-beef” cutout values (Table 1), which are calculated using negotiated prices and estimated average yields of individual sub-primal cuts and credit items (USDA, 2015a). In USDA’s boxed-beef cutout calculations, the rib and loin represent about one-third of the carcass, yet items derived from these 2 primal cuts account for most of the among-grade variation in carcass cutout value. Correspondingly, quality signals in the beef chain are driven primarily by “middle meat” value differences (Table 1).

Table 1. Average boxed-beef cutout values and wholesale prices for various rib and loin cuts

Item	Prime	Branded Choice	Commodity Choice	Select	Ungraded
Comprehensive boxed-beef cutout value	243.41	212.96	207.02	197.91	190.47
Lip-on ribeye (112A)	997.94	716.49	662.71	576.36	483.72
Strip loin (180)	966.76	588.25	560.40	473.08	366.44
Tenderloin (189A)	1376.81	1068.67	1011.81	925.19	873.69
Top butt (184)	378.94	343.18	328.67	294.29	280.71

Source: Annual LPGMN Statistics Summary (2012-2014)

As shown in Table 1, separate boxed-beef cutout values currently are reported for “branded” and “unbranded” beef within the Choice grade. In today’s beef industry, meeting consumers’ expectations often requires differentiation of a broader array of product attributes with much greater specificity than can be achieved via grading. Growing consumer demand for high-quality,

differentiated products possessing a greater variety of attributes (including both experience and credence attributes) has resulted in the development of a number of beef brands, most of which utilize third-party certification or process verification to support various product claims. In many cases, branded beef product claims include USDA quality grade specifications. Results of recently completed research (O’Quinn, 2015) demonstrated that simple knowledge of brand identity enhanced consumers’ perceptions of beef quality by 10 to 12%.

Within the past 15 years, rapid proliferation of USDA certified beef brands (Speer, 2013), has greatly influenced how U.S. Choice beef is marketed in today’s beef trade (McCully, 2010). Currently, there are 25 different USDA certified branded beef programs that feature Premium Choice beef and another 59 USDA certified programs with quality grade specifications that include all or part of the U.S. Choice grade (USDA, 2015b). Consequently, a significant proportion of U.S. Choice beef (including nearly all Premium Choice and an increasing amount of Low Choice beef) is branded and sold at premium prices. Based on USDA beef market statistics, about one-third of U.S. Choice boxed beef was marketed under a brand designation in 2014.

Quality signals generated in the boxed-beef trade, as discussed above, are transmitted from packers to the cattle feeding sector via carcass quality grade premiums and discounts (Figure 3). Cattle feeders who sell cattle on value-based pricing systems receive premium prices for carcasses grading Prime and Premium Choice (e.g., CAB) and discounted prices for carcasses grading Select and Standard (Figure 3).

Figure 3. 2012-2014 average beef carcass grid premiums and discounts



Alignment between Quality-Based Price Signals and Sensory Performance

Effective industrywide communication of beef quality and value also requires close alignment between grade-based price signals and product performance. Sensory data from Emerson et al. (2013), Acheson et al. (2014), and Semler (2015) were used to examine relationships between price signals (Table 1 and Figure 3) and mean overall sensory performance of strip loin steaks.

The relationship between the 2012 to 2014 annual average wholesale, boxed-beef strip loin prices (Table 1) and mean ratings for overall sensory experience of Standard, Select, Commodity Choice, and Prime strip loin steaks is shown in Figure 4. Branded Choice was not included in the analysis summarized in Figure 4 because the exact quality grade mix within that category is unknown. Very close association ($r^2 = 0.98$) between the 2 variables in Figure 4 suggest that, at least for the strip loin, grade-based price differentials established in the boxed-beef trade are reflective of differences in product sensory performance. Similarly, Figure 5 shows the relationship between the 2012 to 2014 average carcass grid premiums/discounts and mean overall sensory experience ratings for Standard, Select, Commodity Choice, Premium Choice, and Prime strip loin steaks. Once again, the 2 variables in this analysis (Figure 5) were very closely associated ($r^2 = 0.95$). Based on results shown in Figures 4 and 5, quality signals originating in the boxed-beef trade and transmitted to the cattle production sector via carcass quality premiums and discounts appear to be reasonably well aligned with quality grade effects on sensory performance of strip loin steaks.

Figure 4. Relationship between 2012 to 2014 annual average wholesale, boxed-beef strip loin prices and mean sensory performance of beef strip loin steaks differing in quality grade

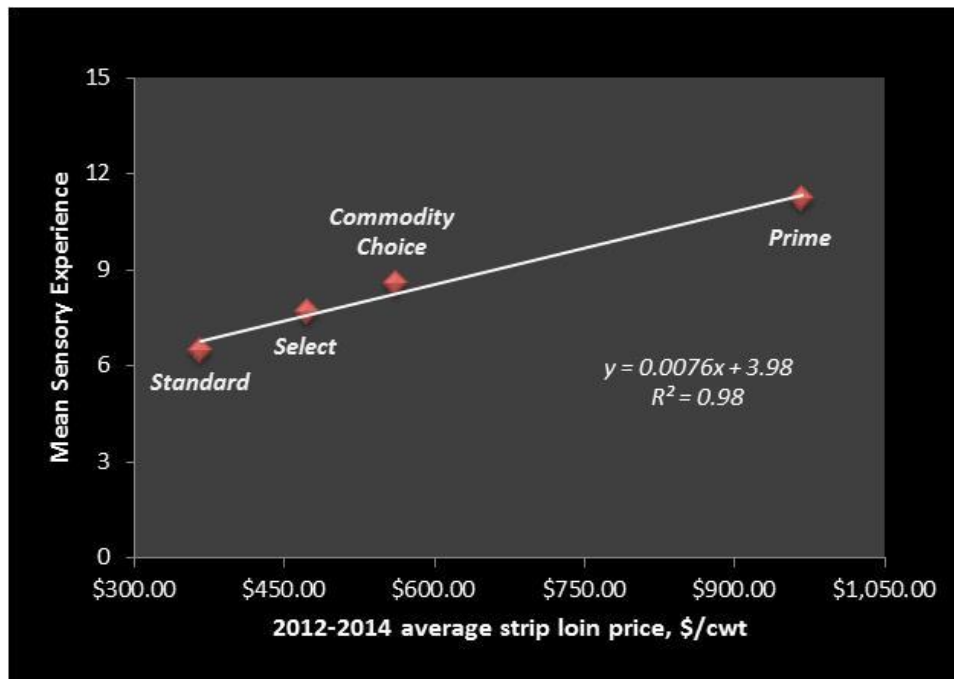
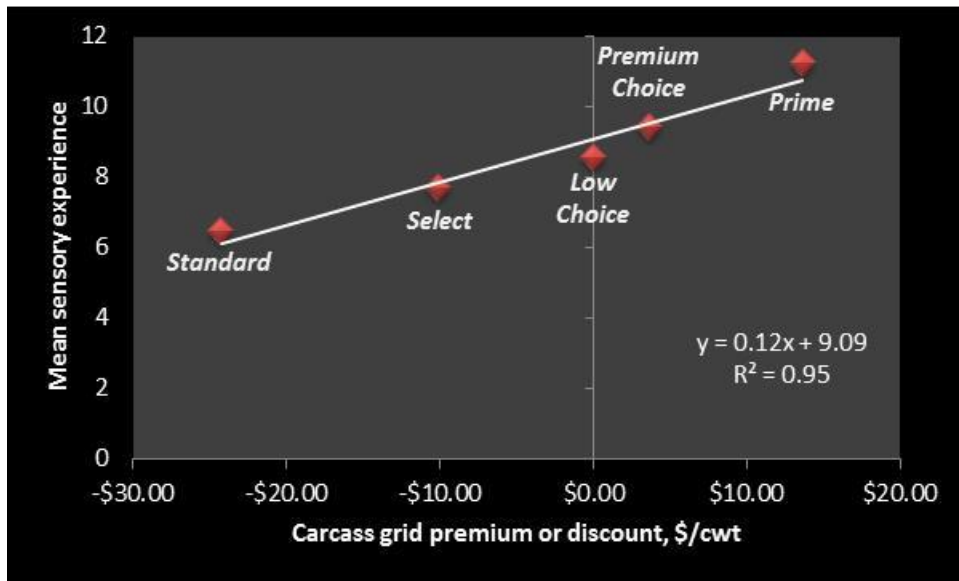
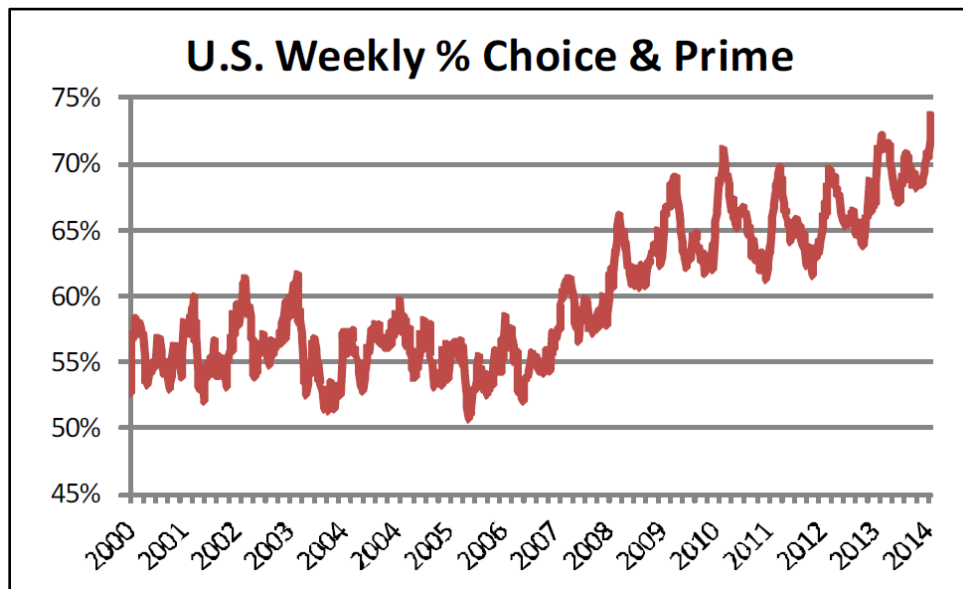


Figure 5. Relationship between 2012 to 2014 carcass grid premiums/discounts and mean sensory performance of beef strip loin steaks differing in quality grade



In the past decade, a gradual shift away from traditional trading of live cattle, toward greater use of carcass-based transactions that involve carcass quality premiums and discounts, has intensified quality based market signals, encouraging production of higher grading cattle. As a result, beef carcass quality grade performance has improved steadily since the mid-2000s (Figure 6).

Figure 6. USDA Quality Grade trend 2000-2014 (Source: Dykstra, 2015)



In the 2005 National Beef Quality Audit (NBQA), insufficient marbling (and its impact on product quality and consistency) was identified as the number-1 greatest quality challenge by purveyors, retailers, and restaurateurs (Smith et al., 2006). Furthermore, a primary goal established for improving beef quality was to clarify signals that encourage production of cattle, carcasses, and cuts that conform to industry targets (Smith et al., 2006). The quality grade targets identified in the 2005 NBQA were 31% Select, 33% Low Choice, 29% Premium Choice, and 7% Prime (Smith et al., 2006). Results of the cooler audit phase of the 2005 NBQA documented that, at that time, the percentages of fed beef carcasses with quality grades of Select, Low Choice, Premium Choice, and Prime were approximately 40.1%, 33.7%, 18.2%, and 2.6%, respectively (Garcia et al., 2008). Recent USDA statistics show that, for the first 3 quarters of 2015, percentages of carcasses with quality grades of Select, Low Choice, Premium Choice, and Prime have averaged 20.6%, 42.3%, 27.0%, and 4.9%, respectively. This marked shift in the quality grade distribution, away from Select toward Premium Choice and Prime, reflects significant progress in improving beef carcass quality during the past 10 years. Steiner (2014) estimated that, between 2005 and 2013, added-value to the beef industry stemming from quality premiums totaled nearly \$4.5 billion.

THE SENSORY EXPERIENCE – IMPROVING THE ODDS

For beef enthusiasts, very few dining experiences rival that of enjoying a great tasting steak. Research has shown that consumers' overall perceptions of the taste of beef are influenced by three primary sensory attributes – tenderness, flavor, and juiciness (Neeley et al., 1998). Consumer studies conducted in the 1980s and 1990s identified tenderness as the most important beef sensory attribute contributing to consumer satisfaction (Savell et al., 1987; Miller et al., 1995; Huffman et al., 1996). However, results of more recent consumer studies suggest that beef flavor may have become more important than tenderness to today's consumers (Corbin et al., 2015; O'Quinn 2015).

In the 2011 National Beef Quality Audit, food service operators and retailers were asked to define beef eating satisfaction (Igo et al., 2013). The most frequent response in both groups was “flavor” (62.5% of food service participants and 70% of retailers), followed by “tenderness” (52.1% of food service participants and 66.7% of retailers). Corbin et al. (2015) asked consumers which sensory attribute (tenderness, flavor, or juiciness) was most important when consuming beef steaks. Flavor was considered most important (by 50.8% of consumers), followed by tenderness (30.8% of consumers), and juiciness (18.4% of consumers). Similarly, O'Quinn (2015) reported that 49.6% of consumers considered flavor the most important beef sensory attribute, whereas 40.5% and 9.9% of consumers placed the most emphasis on tenderness and juiciness, respectively.

Although a number of chemical compounds contribute to the flavor of cooked beef (Wood et al., 2003; Calkins and Hodgen, 2007), intramuscular lipids and the volatile compounds they produce during cooking are major contributors to desired flavors and aromas that are unique to grain-fed beef (O'Quinn et al., 2016). Therefore, a sufficient amount of intramuscular fat is fundamentally important to development of the beef flavor profile preferred by today's discriminating consumers (O'Quinn et al., 2016).

O’Quinn (2012), in a study conducted to determine flavor preferences of discriminating beef consumers, reported a correlation of 0.77 between intramuscular lipid percentage and consumers’ ratings for flavor desirability of strip loin samples and found that increased intramuscular fat content was associated with greater ($P < 0.01$) intensities of desirable flavors described as buttery/beef fat ($r = 0.85$), browned/grilled ($r = 0.81$), nutty ($r = 0.77$), sweet ($r = 0.77$), and beefy/brothy ($r = 0.65$), as well as lesser ($P < 0.01$) intensities of undesirable flavors characterized as bloody/metallic ($r = -0.72$), livery ($r = -0.66$), gamey ($r = -0.47$), and fishy ($r = -0.47$). Moreover, consumers involved in that study demonstrated a clear preference for the flavor profiles of premium grades of beef. The flavor profile of Prime samples was rated most ($P < 0.05$) desirable, followed by that of Premium Choice and flavor profiles for samples in both of these categories were rated as more desirable ($P < 0.05$) than flavor profiles of Low Choice or Select samples (O’Quinn, 2012). Similar results, showing consumer preference for the flavor of steaks from carcasses grading Prime or Premium Choice were reported by O’Quinn et al. (2012).

For an “experience good” such as steak, the likelihood that the product will provide a positive eating experience not only is an important criterion affecting consumer preference and purchase behavior (Lusk and Schroeder, 2006), but also is one of the most useful and practically meaningful measures of overall beef product performance. Research has shown that USDA quality grade is indicative of the odds of a positive or negative beef eating experience. For example, Smith (2005), using research results reported by Smith et al. (1980, 1983, 1984, 1987), Branson et al (1984, 1986), Savell et al. (1987), Jones and Tatum (1991a, 1991b, 1994), Huffhines et al. (1992, 1993), and George et al. (1999), estimated that the odds of a rib or loin steak delivering an unacceptable (negative) eating experience were 1 in 33 (3% failure rate) for Prime, 1 in 10 (10% failure rate) for Premium Choice, 1 in 6 (16% failure rate) for Low Choice, 1 in 4 (27% failure rate) for Select, and 1 in 2 (50% failure rate) for Standard (Smith et al., 2008). For the purposes this review, results of 5 more recent studies (Platter et al., 2003; O’Quinn et al., 2012; Emerson et al., 2013; Corbin et al., 2015; O’Quinn, 2015) were analyzed to obtain updated likelihood estimates for strip loin steaks representing 5 different quality grade categories (Table 2).

Table 2. Likelihood of a positive or negative eating experience for strip loin steaks

Quality Grade	Probability (\pm SEM) of a Positive Eating Experience	Odds of a Negative Eating Experience	Failure Rate ¹ , %		
			Flavor	Tenderness	Juiciness
Prime	0.97 \pm 0.011 ^a	1 in 33.6	2.9 ^e	2.4 ^d	3.3 ^e
Premium Choice	0.93 \pm 0.023 ^b	1 in 13.8	6.2 ^d	9.2 ^c	9.2 ^d
Low Choice	0.82 \pm 0.050 ^c	1 in 5.4	18.3 ^c	13.7 ^b	14.6 ^c
Select	0.66 \pm 0.073 ^d	1 in 2.9	28.0 ^b	25.6 ^a	30.5 ^b
Standard	0.55 \pm 0.083 ^e	1 in 2.2	45.7 ^a	30.0 ^a	41.2 ^a

¹ Percentage of steaks failing to meet expectations for flavor, tenderness, and juiciness.

^{a,b,c,d,e} Values in the same column that do not share a common superscript letter differ ($P < 0.05$).

Results of this 5-study analysis (Table 2) showed that each successive increase in quality grade was associated with a higher ($P < 0.01$) probability of a positive eating experience and reduced odds of a negative eating experience. Prime steaks were most ($P < 0.01$) likely to meet consumers' expectations for flavor, tenderness, and juiciness, with only 1 in 33.6 (3%) of strip loin steaks from Prime carcasses providing a negative eating experience (Table 2). Moreover, within the Choice grade, Premium Choice steaks offered a distinct advantage ($P < 0.01$) in sensory performance (93% of steaks provided a positive eating experience) compared with Low Choice steaks (82% of steaks provided a positive eating experience). In particular, Premium Choice steaks were more likely to meet consumers' expectations for flavor than were Low Choice steaks, as demonstrated by a 6.2% failure rate for Premium Choice, compared with a failure rate of 18.3% for Low Choice (Table 2). A noteworthy aspect of the results summarized in Table 2 was the poor sensory performance of Select strip loin steaks compared with steaks from carcasses grading Low Choice or higher. Approximately 1 in 3 Select steaks provided a negative eating experience (Table 2).

Additional results from the same 5-study analysis are presented in Table 3 to demonstrate how upgrading, from one quality grade to another, influences the odds of a satisfactory eating experience. Odds ratios presented in Table 3 simply quantify the increased odds of a favorable outcome (i.e., satisfactory steak performance with respect to flavor, tenderness, juiciness, and overall eating experience) associated with choosing a steak representing the higher of the 2 quality grades in each head-to-head grade comparison. For example, the Premium Choice vs. Low Choice comparison indicates that the odds of a satisfactory overall eating experience are 2.9 times greater if one chooses the Premium Choice steak (Table 3). In that same comparison, the odds of satisfactory flavor, tenderness, and juiciness were 3.4, 1.6, and 1.7 times greater for Premium Choice vs. Low Choice steaks (Table 3), implying that the flavor is the primary sensory attribute that differentiates Premium Choice steaks from Low Choice steaks. In all but one comparison shown in Table 3 (i.e., the Select vs. Standard tenderness odds ratio), opting for steaks of a higher quality grade significantly improved the odds of a satisfactory sensory experience.

Table 3. Effects of upgrading to improve the odds of a satisfactory sensory experience

Comparison	Odds Ratio ¹			
	Flavor	Tenderness	Juiciness	Eating Experience
Prime vs. Premium Choice	2.2	4.0	3.0	2.5
Prime vs. Low Choice	7.6	6.3	5.1	7.4
Prime vs. Select	13.2	13.7	13.0	17.1
Prime vs. Standard	25.6	17.1	20.8	26.2
Premium Choice vs. Low Choice	3.4	1.6	1.7	2.9
Premium Choice vs. Select	5.9	3.4	4.3	6.7
Premium Choice vs. Standard	12.9	4.3	6.9	10.3
Low Choice vs. Select	1.7	2.2	2.6	2.3
Low Choice vs. Standard	3.8	2.7	4.1	3.6
Select vs. Standard	2.2	1.2	1.6	1.5

¹ Increased odds of a favorable outcome (i.e., satisfactory flavor, juiciness, tenderness, or overall eating experience) associated with selecting steaks representing the higher of the 2 grades in each comparison.

Recent beef demand analyses, documenting stronger consumer demand for premium grades (Prime and Premium Choice) of beef and weaker demand for commodity grades (Low Choice and Select) of beef (Zimmerman and Schroeder, 2013; Steiner, 2014), are consistent with quality grade differences in sensory performance shown in Tables 2 and 3. From 2009 through the first 3 quarters of 2015 the average choice beef retail price increased 49%. Recent demand trends suggest that many quality conscious beef consumers are unwilling to pay today's prices for the level of performance provided by commodity beef and, instead, have opted to trade-up, purchasing premium beef products, thereby improving their odds of receiving a level of performance commensurate with the higher prices they are required to pay.

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