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Tenderness, Juiciness, and Flavor Contribute to the Overall Consumer Beef Eating Experience

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Abstract
Overall beef palatability can be attributed to three primary traits, tenderness, juiciness, and flavor, as well as the interaction among these traits (Smith and Carpenter, 1974). Multiple authors have worked to identify which of these palatability traits contributes the most to overall eating satisfaction and have historically identified tenderness as the most important palatability trait (Savell et al., 1987; Miller et al., 1995a; Savell et al., 1999; Egan et al., 2001). Overall eating quality of beef steaks may excel at one or even two of these traits, yet fail to meet consumer eating expectations due to the unsatisfactory level of another trait. Conversely, a steak may be deemed acceptable by consumers primarily due to the outstanding level of a single trait despite the lower and even unacceptable levels of one or both of the other traits. To date, no comprehensive study has evaluated this interaction among palatability traits and assessed the relative risk of an unacceptable overall eating experience associated with the failure of a single or combination of palatability traits. It was the objective of this report to combine consumer palatability data collected during the past five years as a result of a series of trials that have evaluated the palatability traits of a diverse set of treatments in order to evaluate the relative contribution of tenderness, juiciness, and flavor to overall consumer eating satisfaction.

Keywords
consumer, palatability, marbling

Cover Page Footnote
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CATTLEMEN'S DAY 2017

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L.N. Drey and T.G. O'Quinn

Introduction

Overall beef palatability can be attributed to three primary traits, tenderness, juiciness, and flavor, as well as the interaction among these traits (Smith and Carpenter, 1974). Multiple authors have worked to identify which of these palatability traits contributes the most to overall eating satisfaction and have historically identified tenderness as the most important palatability trait (Savell et al., 1987; Miller et al., 1995a; Savell et al., 1999; Egan et al., 2001). Overall eating quality of beef steaks may excel at one or even two of these traits, yet fail to meet consumer eating expectations due to the unsatisfactory level of another trait. Conversely, a steak may be deemed acceptable by consumers primarily due to the outstanding level of a single trait despite the lower and even unacceptable levels of one or both of the other traits. To date, no comprehensive study has evaluated this interaction among palatability traits and assessed the relative risk of an unacceptable overall eating experience associated with the failure of a single or combination of palatability traits. It was the objective of this report to combine consumer palatability data collected during the past five years as a result of a series of trials that have evaluated the palatability traits of a diverse set of treatments in order to evaluate the relative contribution of tenderness, juiciness, and flavor to overall consumer eating satisfaction.

Key words: consumer, palatability, marbling

Experimental Procedures

Data from 11 consumer studies conducted within the past five years were selected for this report. Within each study, the same 100 mm line scales were used for consumer evaluation of steak tenderness, juiciness, flavor, and overall liking. Scales were anchored as extremely tough/dry/dislike extremely at the 0 end point and extremely tender/juicy/like extremely at the 100 end point. Additionally, consumers rated each trait as either acceptable or unacceptable (yes/no), providing definitive consumer perceptions of steak acceptability for each trait. All samples used in these studies were cooked using similar dry-heat grilling procedures. Collectively, these studies used more than 1,800 beef consumers from multiple regions of the United States and included 1,505 unique samples resulting in more than 12,000 individual consumer observations. The raw data from all studies were compiled as a single dataset. The average sensory score for each

palatability trait was determined for each sample by averaging across the individual consumer ratings for the sample. A multivariate regression model was constructed using the sample means to determine the relative contribution of tenderness, juiciness, and flavor to consumer overall liking scores. Sample overall liking scores were used as the dependent variable and consumer tenderness, juiciness, and flavor liking scores as well as their interactions were used as explanatory variables. A step-wise selection procedure was used for inclusion of variables in the regression model. All variables that entered the model were significant ($P<0.05$) and had to remain significant ($P<0.05$) to be included in the final regression model. Additionally, the intercept was highly non-significant ($P>0.70$) and was therefore excluded from the model. The odds and relative risk of an unacceptable overall eating experience were determined based on the acceptability of the three individual sensory traits.

Results and Discussion

The final beef palatability model determined was:

Consumer overall liking = (0.42 × tenderness) + (0.07 × juiciness) + (0.48 × flavor)

This model accounted for greater than 99% of the variation ($R^2>0.99$) in consumer overall liking scores. This provides clear evidence that the linear combination of tenderness, juiciness, and flavor accounts for practically all of the variation in overall consumer eating satisfaction. The interaction terms among the three traits never entered the model, as they were non-significant ($P>0.05$). This indicates that the effects of tenderness, juiciness, and flavor on overall eating satisfaction are not dependent upon the level of the other traits.

Table 1 provides the estimates for the likelihood of overall palatability failure based on the failure/acceptance of the other traits. Odds ratios represent the relative increase in the odds of an event occurring (overall palatability failing) due to another event (unacceptable rating for tenderness, juiciness, or flavor). For example, in Table 1, the odds of overall palatability failing when tenderness is acceptable is 1 in 10 (10% chance), whereas the odds of overall palatability failing when tenderness is unacceptable is 2.2 to 1 (69% chance). Therefore, the odds ratio is 20.8 (odds when tenderness is unacceptable / odds when tenderness is acceptable). So the odds of overall palatability failing when tenderness is unacceptable is 20.8 times higher than when tenderness is acceptable. The relative risk is the increased risk of an event occurring (overall unacceptable) due to another event (unacceptable tenderness). Thus, the likelihood of unacceptable overall palatability is 7.2 times higher when tenderness is unacceptable. With respect to flavor, only 1 in 15 (6.7% chance) steaks fail for overall palatability when flavor is also acceptable; however, this increases to 3.3 to 1 (76% chance) when flavor is unacceptable. The odds of overall palatability failing when flavor is unacceptable are 49 times higher than when flavor is acceptable, and overall palatability failure is 12.3 times more likely due to unacceptable flavor. For juiciness, 1 in every 9 steaks (11% chance) are unacceptable overall when juiciness is acceptable compared to close to 2 out of every 3 (66% chance) when juiciness is unacceptable. This indicates overall palatability is 6.5 times more likely to fail when juiciness is unacceptable, with the odds of failure 17.1 times greater due to juiciness failure. When more than one palatability trait fails, the odds of overall palatability failure increase dramatically. Most notably, when tenderness and flavor are both unacceptable, the odds of overall palatability failing are 516.5 times greater than when

both traits are acceptable, with overall palatability more than 46 times more likely to fail when both traits are unacceptable. When juiciness fails in combination with tenderness or flavor, the odds of overall palatability failure are increased 92 and 294 times, respectively. Lastly, when all three traits are acceptable, only 1 in every 93 steaks (~1% chance) are unacceptable overall. However, when all three traits fail, the odds of failure increase almost 2,000 times to more than a 95% chance and the likelihood of overall failure is 89.5 times more likely.

Table 2 provides the percentage of A maturity, grain-finished strip loin steaks of various U.S. Department of Agriculture quality grades cooked to a medium degree of doneness rated as acceptable by consumers. More than 91% of USDA Prime samples were rated acceptable for all traits other than flavor, representing a greater percentage than all lower grading beef. Conversely, almost 25% of Select beef failed to meet consumer expectations for all palatability traits, and had a similar percentage of samples rated unacceptable for all traits, other than flavor, as Standard. These results differ from previous authors who have evaluated the probability of an unsatisfactory eating experience based on quality grade. A study by Smith et al. (2008) compiled results from 14 previous works and determined the probability of an unsatisfactory eating experience for Prime to be 1 in 33 (3%), Premium Choice to be 1 in 10 (10%), Low Choice to be 1 in 6 (16%), Select to be 1 in 4 (25%), and Standard to be 1 in 2 (50%). The observed differences between the current work and that of Smith et al. (2008) is likely the result of the differences in study types used for the analyses. Smith et al. (2008) included studies in their analyses that were comprised of trained sensory panelists. Trained panels are designed in order to evaluate sensory traits as objectively as possible. Because of this, the data from trained sensory panelists should not be interpreted the same as results from consumer panelists who assess samples based on their own individual biases and interpretations. It is also interesting to note that Premium Choice (upper 2/3 of Choice grade) had a greater portion of samples rated acceptable overall than Low Choice, however a similar percentage of samples rated acceptable for each palatability trait. This advantage in overall palatability and demand by consumers is reflected in the premiums garnered by the wholesale cut prices of this category over commodity Choice products (USDA, 2016a).

Implications

These results indicate the importance and impact of tenderness, juiciness, and flavor on overall eating experience as well as the significant impact of even single palatability trait failure on eating experience.

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Table 1. Odds of an unacceptable eating experience based on tenderness, juiciness, and flavor acceptability

Palatability trait	Odds when trait is acceptable[1]	Odds when trait is unacceptable[2]	Odds ratio[3]	Relative risk[4]
Tenderness	1 in 10	2.2 to 1	20.8	7.2
Juiciness	1 in 9	1.9 to 1	17.1	6.5
Flavor	1 in 15	3.3 to 1	49.0	12.3
Tenderness and juiciness	1 in 15	6.3 to 1	92.0	13.5
Tenderness and flavor	1 in 50	10.3 to 1	516.5	46.8
Juiciness and flavor	1 in 35	8.3 to 1	293.7	32.4
Tenderness, juiciness, and flavor	1 in 93	21.5 to 1	1989.1	89.5

[1]Odds of overall eating experience failing when individual palatability trait is rated acceptable.
[2]Odds of overall eating experience failing when individual palatability trait is rated unacceptable.
[3]Relative increase in odds of unacceptable eating experience when trait is rated unacceptable (i.e. odds of failure are X times greater than when trait is acceptable).
[4]Increased risk of unacceptable eating experience when trait is unacceptable (i.e. overall unacceptable rating is X times more likely than when trait is acceptable).

Table 2. Percentage of grain-finished strip loin steaks of various USDA quality grades cooked to a medium degree of doneness rated as acceptable by consumers

USDA Quality Grade	Tenderness	Juiciness	Flavor	Overall liking
Prime	95.14[a]	92.42[a]	88.11[a]	91.37[a]
Premium Choice	86.61[b]	84.97[b]	85.44[ab]	86.83[b]
Low Choice	86.31[b]	83.33[b]	83.83[b]	83.08[c]
Select	77.30[c]	75.96[c]	75.38[c]	74.75[d]
Standard	74.53[c]	67.99[d]	72.29[c]	72.04[d]
SEM[1]	1.81	1.94	1.86	1.86
P-value	< 0.01	< 0.01	< 0.01	< 0.01

[abcd]Means in the same column lacking a common superscript differ (P<0.05).
[1] SEM = standard error of the mean.