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Assessing Consumer Preferences and Attitudes Toward Meat and Meat Products

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SUMMARY

Consumer sensory evaluation is a powerful tool in assessing consumer preferences. Qualitative consumer techniques are a way of assessing general trends and insight into consumer issues. Focus groups and in-depth interviews or probe panels are the main tools used to assess meat and meat products. Quantitative consumer evaluation provides data that can be statistically analyzed and hypotheses can be tested. Four methods of quantitative consumer evaluation are Consumer Location Tests, In-Home Use Tests, Experimental Auctions and Purchase Simulations. Each of these methods provides consumer input into acceptability, but each method has strengths and weaknesses and the application or inference of the results are limited to the type of method used. Meat scientists have used multivariate statistical models like Principle Components to help understand what variables drive consumer acceptance. Probit models can also be used to assess the combined effect of multiple variables including price on consumer acceptance.

INTRODUCTION

The consumer is king! This is not a new adage, but it is a very complex, difficult adage to determine and it is an adage that changes constantly. The bottom line is that the ultimate goal of the meat industry is to produce products that meet consumers' needs, wants and preferences. While that sounds easy, it is a difficult task. Consumers know what they want and they are always right! The problem arises in determining, without biases, what it is that they want. The effective communication and determination of consumer preferences is a science unto itself. Yet, meeting consumers' demands or needs is the ultimate goal of the meat industry and it is what our industry lives or dies by. It is imperative that as an industry within each country we utilize consumer evaluation tools to understand preferences and attitudes toward meat and meat products to maintain and gain competitiveness.

Some of the difficulty in evaluating consumer preferences is that consumer preferences may differ across products. For example, consumers may accept or want visual intramuscular fat or marbling on a high priced steak that they are purchasing for a special occasion meal, but they do not want visual fat in the sliced ham that they are purchasing for use as a sandwich or for use in a salad. Additionally, there can be conflicts in consumer preferences. A consumer may prefer meat with a low amount of visual fat as they are concerned about diet/health issues. However, when eating meat, they prefer meat that is higher in fat content. The challenge then becomes to engineer a

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meat product that meets the palatability expectations but has minimal visual fat content.

Another challenge with consumer research and data is that this type of information is extremely variable. While it would be easier and simpler to have normally distributed data that shows a strong general trend, this is most likely not the case. The rule is: **consumers are extremely variable!** They are not easily classified into groups or discrete classifications, they are continuous and therefore, their data are continuous. Most of the traditional statistical tools that meat scientists use assume that data are normally distributed. For consumer assessment, the data must be first tested for normality, adjusted if the data are not normally distributed, and then analyzed. Additionally, consumer preference data is usually multivariate as multiple factors contribute to consumers' acceptance of a product, while meat scientists traditionally examine an individual variable's impact on consumer preference or acceptance. Many times, assessment of the data using multivariate and univariate data analyses techniques can provide information on consumer preferences.

The overall objective of this paper is to discuss tools used to assess consumer visual and eating quality preferences. Specifically, consumer assessment tools will be examined, the advantages and disadvantages of using each tool will be discussed, and examples of information obtained when the consumer preference tool was used will be presented. The ultimate goal is that meat scientists will gain a stronger understanding of consumer assessment tools that could be used in consumer issues related to their research, industry or country.

Factors that Affect Consumer Preference

Visual appearance. How a product looks and the color of the lean has been shown to be highly related to consumer acceptance. Meat and meat product visual appearance attributes have been defined as lean color, the amount of discoloration or off-colors, the amount of visual fat (intramuscular, seam or subcutaneous), the firmness of the lean, the amount of package purge and visually assessable water on the surface of meat.

Eating quality. Eating quality or as meat scientist define it, meat palatability, relates to how meat tastes and has been defined as juiciness, tenderness and flavor. These three attributes have been related to consumers' perception of overall acceptability and preference and are generally recognized as the three major components of palatability. Juiciness is the amount of perceived juices in the meat during chewing or mastication. Tenderness is how easily meat breaks down during chewing. Toughness would be the opposite of tenderness or it is the resistance of meat to breakdown during chewing. In processed meat products, tenderness may not be an appropriate texture attribute, but the texture or the structural integrity of the

meat may be related to palatability such as the hardness, springiness, cohesiveness, cohesiveness of mass, or juiciness of the product (Meilgaard et al., 1991). Flavor or taste is a combination of smell from the olfactory senses defined as odor; aromatics perceived during consumption of the meat from the olfactory senses defined as flavor aromatic; the basic tastes of salt, sour, sweet and bitter from the tongue; and feeling factors in the mouth during consumption of the meat. Also, flavor consists of aftertastes perceived after consuming the product. A full lexicon of odor and flavor aromatics related to food was reported by Lyons and Civille (1996).

Consumer attributes. The aforementioned visual and eating quality attributes are attributes that can be defined and measured using a trained sensory panel or with instruments. As meat scientists, some of these attributes have been used to determine if treatments affected the visual or eating quality of meat or meat products. However, consumers are different. They many times do not understand the technical terms of visual assessment or meat palatability. In fact, many consumers do not know what specifically drives their acceptability or preference, they just know when they like a product and when they don't like a product. You don't hear consumers referring to the slight amount of connective tissue and moderate muscle fiber tenderness in combination with the high beefy/brothy taste of a steak and just a slight amount of cooked beef fat and serum/bloody flavor attributes during a dining experience. However, consumers do know whether they like a steak and perceive it as tender or tough. Therefore, consumer evaluation many times does not include the same technical terms or attributes of visual assessment and meat palatability as trained sensory evaluation or instrumental measurements.

Consumer attributes are classified as either acceptance or preference data. To measure acceptance, hedonic scales are used that rate the like or dislike of a product. Preference data can be ascertained by asking consumers to select or rank products after the evaluation of two or more products. In addition, consumers can rate the intensity or level of an attribute; however, the attribute must be clearly defined or consumer terms must be used. For example, most consumers understand the term "tender and tough" and consumers could rate the tenderness to roughness of a beef steak. However, the flavor aromatic grainy/cow, while defined for trained sensory evaluation, most likely will not be interpreted similarly across consumers. You could ask a consumer to rate the grainy/cow flavor in a steak and they would provide an answer, but what flavor or attribute consumers rated would most likely vary across consumers. Therefore, question development must be carefully considered and the ballot should be tested on a select group of consumers to assure the researchers that they are measuring what they intend to measure.

While consumers know what they like and do not like, they are easily biased or influenced. It is important to

understand how to conduct consumer assessment so that the result provide a true evaluation of consumer preference and not what consumers think that you want to hear.

Other factors. Other factors also influence consumer acceptance in addition to the visual and eating quality attributes of a meat product. Price; packaging size, color and information; convenience and preparation issues; diet/health concerns; portion size; and food safety may impact a consumers' acceptance of meat and meat products. Many times, these attributes are considered and measured by marketing professionals and while of equal importance to meat science characteristics, only price will be considered in this presentation.

Qualitative Consumer Evaluation

Qualitative consumer evaluation is where information is derived from consumers, but the data are not statistically analyzed. A smaller number of consumers are utilized and consumers are asked questions to give direction and insight into consumer issues. These type of consumer evaluations can provide information on what are important consumer issues to measure in quantitative consumer sensory tests. Examples of qualitative consumer evaluation are focus groups and in-depth interviews or probe panels. These evaluation tools utilize a moderator that directs the evaluation and they are extremely dependent on the moderator to be unbiased, to conduct the consumer evaluation consistently across groups and to react to individual consumers to draw out or provide the reaction or thoughts of every consumer.

Focus groups are structured where consumers are selected based on a predetermined criteria. For example, consumers may be the primary shopper, between the ages of 21 and 59, must eat beef 1 or more times per week, and be willing to participate. The consumers are gathered in a central location and the focus group is conducted. The elements or sequential process of a focus group is that there is an introduction, the ground rules are defined, the participants introduce themselves, the moderator conducts rapport building, general topics are discussed, specific topics are discussed and then a visual or a tasting of the sample is conducted. During this time individual responses are recorded with previously obtained consent of the participants. The moderator then gives a false close or allows panelists to be by themselves while the moderator gets refreshments or the reward. This allows panelists to provide input without supervision. The moderator returns and conducts the actual close and summary of the study and then acknowledges any participants. During this process consumers attitudes toward an number of meat related issues can be discussed. The disadvantage of the focus group is that individuals responses may not be independent or they may be influenced by the group. There are biased based on the group interaction. But the group dynamics can provide in depth discussion and exchange of

ideas that may not be present in one-on-one evaluations. The results from Focus Groups are non-quantitative and is based on a small number of individuals. The Focus Group is very dependent of the effectiveness and non-biased interaction of the moderator, but Focus Groups are easy to conduct and do not take a lot of time.

In-depth interviews are another very common qualitative consumer sensory tool. In this method, consumers' responses are evaluated after they have tried a product in a central location or the actual situation. Then, they are asked a series of questions by a moderator. The moderator knows how to draw out the consumers' perception by asking neutral questions by identifying key words and then probing or getting more information about the consumer perception. With In-depth interviews or probe panels, individual responses are obtained that are not subjected to others opinions in a group and after conducted a large number of these responses, the data will approach quantification. Usually these studies use a large number of consumers and the moderator has slightly less influence as the series of questions are more standardized. However, these type of studies are more time consuming as more time is spent interacting with each consumer independently.

Quantitative Consumer Evaluation

There are four quantitative consumer evaluation tools commonly used to assess meat products. They are Central Location Tests, In-home Use Tests, Experimental Auctions and Purchase Simulations. These four consumer sensory methods will be discussed and examples of the type of information that can be obtained will be presented. The purpose of this discussion is to provide meat scientists with an understanding of what tool to use to answer a specific consumer sensory question. Prior to discussing the four methods, three common components that impact the validity and reliability of the data for quantitative consumer evaluation need to be discussed: 1) the ballot or the evaluation instrument; 2) consumer selection; and 3) product controls. Biases within each component can influence the final outcome. The overall goal of any consumer assessment is unbiased data that measures consumers acceptance or preferences for meat and meat products. While this is easily stated, it is much more difficult to obtain.

Develop a hypothesis. Before defining a project hypothesis, it is important to gain an understanding of what type of data can be obtained from a consumer sensory test. Consumer data is either preference data or acceptance data. Preference asks the consumer to select one product over one or more products, or to identify the product that they prefer. Acceptance data measures the degree of acceptance or liking and then asks specifics on what is liked or disliked about the sample. Acceptance data is usually measured using hedonic scales. For both types of data, subjects are asked to evaluate the product based on their subjective

and personal reaction to the product. The hypothesis will determine what types of questions will be developed on the ballot and what type of data will be collected. A clearly defined hypothesis states what is to be tested in the study. Examples of hypotheses are as follows: a) Pork lean color does not affect consumer acceptance of pork loin chops; and b) Marbling in beef strip loin, top sirloin and top round steaks does not affect consumer overall liking, flavor or tenderness perceptions.

Ballot. The ballot is the instrument used to test the hypothesis and should be unbiased and non-leading. The ballot defines the independent variables for the study. It should be a true test of consumer sensory attributes, it should be easy to use and understand, and the researcher should have high and reasonable assurance that consumers can consistently apply or use the ballot across products. The ballot should consistently use the same size and type of scales, questions should be worded similarly, it should be easy to use and the most important questions should be asked first. The ballot should be structured in three parts. The first part will include concise and clear instructions to the consumer. The second part will ask demographic and usage questions and the third part contains the questions that are the measurement of sensory attributes after the consumer has looked at or eaten the product. An example of a ballot structure is presented in Table 1. The ballot should be in the native language of the consumer and the terminology should be based on consumer attributes usually defined in qualitative consumer evaluation. It is important that consumers do not know exactly what you are testing for, as people want to answer questions correctly. If they know what you are asking, they may try to give you the answer that they think you want instead of a true evaluation of their preferences or perceptions. Always remember, **if the ballot is biased, the data are biased even before the study is initiated!**

Development of the questions for a ballot is essential as it is easy to build in inherent bias if the ballot is not structured properly. For acceptance testing the ballot is divided into the primary and secondary questions. The primary question asks the degree of liking of the product and accounts for all sensory variables that effect acceptance. Secondary questions ask acceptance of specific sensory attributes using hedonic scales, intensity ratings for a specific sensory attribute, just right questions, or attribute diagnostics to understand the reasons for preference or acceptance of a product. Open-ended questions that ask why or what was liked or disliked about a sample provide a mechanism of determining general trends (i.e., too spicy, too tough, off-flavors).

Preference tests also can be used on a consumer sensory ballot. These questions force a choice. Primary questions include the selection of one product over others or the ranking of samples. Secondary questions include open-ended questions that ask why or what was preferred about the sample selected in the primary question. When a

consumer is asked to select the product that has the highest level of beefy flavor, this is an example of an attribute preference question.

The type of scales used for questions on the ballot is the measurement tool for each attribute. There are basically three different scale styles used in consumer sensory evaluation. Hedonic scales are commonly used as they are most similar to a consumer's initial response, they are easy to measure, but they are more susceptible to the halo effect and it is difficult to react to negative responses. Just right scales indicate the direction for changes, they are easy to understand and respond to, but data must be treated within cells and they do not indicate actual intensity, only relative intensity differences. Just right scales are bipolar and data can not be analyzed using Analysis of Variance. Intensity scales can be useful as they are directly related to descriptive analysis; but they must be related to liking for direction, they are difficult for some consumers to use, and there is some variation in scale usage across consumers. Three scale types are commonly used in consumer sensory evaluation. Category scales define the points or boxes along a continuum and are verbally anchored either at each point or are end- and/or center-anchored. Advantages of using category scales are that they are commonly used, they are easy to understand, and they are simple in structure. Disadvantages include that they may not have equal intervals, they may not have enough points of discrimination, and it can be difficult to anchor all categories verbally. Linear scales use a line and the ends are anchored to provide direction and depending on application, the middle point may be anchored. Advantages of linear scales are that they allow for several points of discrimination, they are simple in structure, and they are easy to understand and use. Disadvantages are that they may be used quite differently across subjects and they are difficult to tabulate. Magnitude Estimation scales are the third type. These scales use a control that is identified as "0" or a defined intensity for an attribute. The consumer is asked to evaluate the product and estimate the difference from the control and the sample. Advantages of magnitude estimation scales are that they allow for several points of discrimination and may be more quantitatively related to test variables. Disadvantages are that they are more difficult for consumers to learn and use and it can be difficult to normalize data.

Consumers. Unbiased, random selection and recruitment of consumer sensory panelists is key to the validity and success of consumer sensory evaluation. Prior to selection of consumer panelists, factors that may affect consumer perceptions must be considered. For example, geographic locations, ethnic or usage issues, and demographics (age, income, sex, and household size) may not or may play a role in consumer acceptance and preference. It must be assessed if any of the aforementioned factors are important. For example, will moderate or heavy users of beef have different preferences or acceptance than beef non-users to a new, pre-cooked, microwavable, 8 oz, seasoned beef pot roast? Will young and older people like

Table 1. An example of a quantitative, central-location consumer ballot using end-anchored, 9-point category scales with primary and secondary questions defined in *italics*.

Primary Question - 9-point, end and middle-anchored, hedonic scale.

1. Indicate by placing a mark in the box your **OVERALL LIKE/DISLIKE** of this sample.

☐	☐	☐	☐	☐	☐	☐	☐	☐
Like			Neither Like					Dislike
Extremely			nor Dislike					Extremely

Secondary Question - 9-point, end and middle-anchored, hedonic scale.

2. Indicate by placing a mark in the box your **OVERALL LIKE/DISLIKE** for the **FLAVOR** of this sample.

☐	☐	☐	☐	☐	☐	☐	☐	☐
Like			Neither Like					Dislike
Extremely			nor Dislike					Extremely

Secondary Questions - 9-point, end-anchored, intensity scales.

3. Indicate by placing a mark in the box how you feel about the **INTENSITY OF THE FLAVOR** of this sample.

☐	☐	☐	☐	☐	☐	☐	☐	☐
None								Extremely
								Intense

4. Indicate by placing a mark in the box how you rate the **INTENSITY OF THE SALTY FLAVOR** of this sample.

☐	☐	☐	☐	☐	☐	☐	☐	☐
None								Extremely
								Intense

Secondary Questions - Open-ended.

5. What did you **LIKE** about the **FLAVOR** of this sample?

6. What did you **DISLIKE** about the **FLAVOR** of this sample?

Secondary Question - 9-point, end-anchored, hedonic scale.

7. Indicate by placing a mark in the box your **OVERALL LIKE/DISLIKE** for the **TEXTURE** of this sample.

☐	☐	☐	☐	☐	☐	☐	☐	☐
Like			Neither Like					Dislike
Extremely			nor Dislike					Extremely

Secondary Question - 9-point, end-anchored, intensity scale.

8. Indicate by placing a mark in the box how you feel about the **LEVEL OF THE TENDERNESS** of this sample.

☐	☐	☐	☐	☐	☐	☐	☐	☐
Tough								Tender

Secondary Questions - Open ended.

9. What did you **LIKE** about the **TEXTURE** of this sample?

10. What did you **DISLIKE** about the **TEXTURE** of this sample?



meat cooked to the same degree of doneness and will the issues that drive acceptance be the same? Young individuals may not like rare meat as they relate the red color of the meat to blood while older individuals may prefer well done meat as they are more concerned with food safety issues or it may be what they always have eaten.

Consumers can be recruited through phone interviews, intercepted in a central location, or group pools such as church groups or social clubs in a community. A minimum of 50 to 100 panelists should be used per subclass in conducting consumer sensory tests as data from consumer tests are more variable and a larger number of respondents are needed to test if differences exist in products being tested. If the product to be tested is targeted toward a specific population, such as heavy meat eaters or a specific ethnic or age population, then a subset of that population should be selected. If strong regional differences in preference for the product are known, then consumers that represent the regional effects should be used in the study. For example, previous research documented that beef consumers living on the U.S. east coast are willing to purchase higher fat content beef steaks as they are very concerned with eating quality (considered a USDA Choice beef market) while consumers on the U.S. west coast are more diet/health conscience and want beef steaks with less visible fat (considered a USDA Select beef market) (Savell et al., 1987). Therefore, if you were conducting a consumer study on the acceptability and palatability of low fat meat products, consumers from both regions should be included in the test. Consumer age should be considered, depending on the product to be tested. If meat formulas for products used in the school lunch program are being tested, children that consume the product should be the consumers in the test. It is usually not recommended to use employees or local residents for all affective testing, as these populations may not represent the consumer for which the product is targeted. However, local residents can provide a means of defining general trends and narrowing the number of variables for a study that would include regional effects and larger numbers of consumers.

Product controls. Product controls are considered to assure that you are testing differences in the product and not differences induced by storage, preparation or serving. Storage conditions should be standardized across treatments and locations so that all products are handled similarly. Cooking procedures need to be standardized and all equipment tested prior to conducting the study. For example, we transported convection ovens and thermocouples to Japan to be assured that cooking procedures would be standardized. Utensils, food handling equipment and cooking equipment needs to be defined for each treatment to assure that treatments are not contaminated. The serving order needs to be defined prior to conducting the study. Usually treatments are randomly assigned to order presented across consumers as there are strong first order biases with short term studies and strong last order bias with long-term studies. How many samples

consumers can evaluate without losing interest or before they experience taste-bud fatigue needs to be defined. The coding system needs to be defined and products should be identified with random three-digit codes so that codes do not infer treatments or patterns to consumers that could lead to biased data.

Consumer Central Location Tests

Central location tests utilize a central location where the preparation and presentation of the samples are controlled. However, a central location is an artificial environment and consumers may be uncomfortable and unaccustomed to being seated in booths that could affect their sensory verdict. Central location tests can be conducted where a large room is used, such as a conference room, a community room at a church, or community center that removes the disadvantage of unfamiliarity with sensory booths. A Central Location Test should be conducted in a facility that is easy for consumer to locate and that has sufficient parking. These tests require more technicians and professional time, they can tie up laboratory facilities, they exclude the family's opinion, they are less suitable for repeated use responses, and they are conducted under less real conditions where time effects, packaging, performance, and preparation issues are not tested or do not interfere with the consumer response.

The first item to consider in a Central Location Test is the experimental controls for the subjects during the testing. The location selected to conduct the test should have low noise and limited distraction, it should be odor-free, comfortable, have correct and/or appropriate lighting, be temperature controlled, and the sample presentation area should be separate from the sample preparation area.

Sample preparation has to be closely controlled and monitored so that you are assured that differences between samples are due to consumer preferences and acceptance and not preparation differences. Examples of issues to control are the amount of time required for cooking or preparation, the temperature of appliances used in meat preparation, the final cook temperature of the sample, the materials to be used in preparation of the sample (use of stainless steel spatula not plastic) and in monitoring temperatures, and the measurements to be taken during cooking, preparation or serving. To assure consistent sample presentation to consumers the serving temperature, holding time between cooking and serving, and whether samples will be served monadic or simultaneous should be defined. In Central Location Tests there is a strong first order bias, therefore, the serving order across treatments has to be randomized or blocked.

Price questions can be asked and attitudinal questions can be included on the ballot. While consumers provide answers, price and attitudinal behavior may vary from real life, but trends are usually valid.

An example of the type of data that can be obtained from a consumer Central Location test is presented in Table 2. In this study conducted with pork consumers in four U.S. cities, consumers were asked to evaluate 12 pork loin chops that varied in pH, lipid content and tenderness. Pork chops were evaluated for these three attributes the week prior to the consumer evaluation. The study was designed to understand how pH, lipid content and tenderness affected consumer perception of pork. The pork industry in the U.S. was interested in understanding if selection of these attributes could be used to improve consumer satisfaction. In this study, 5-point end-anchored hedonic scales were used to measure juiciness, tenderness, flavor and overall like/dislike. By analyzing these data using Analysis of Variance after testing for normality, it is obvious that tenderness affects consumer acceptance and that consumers liked the juiciness and tenderness of pork loin chops in the lowest shear force category and that flavor and overall like were similar for pork loin chops in the medium and low shear categories. pH also affected consumer acceptance, but lipid category had little effect on consumer acceptance of pork loin chops. Consumers liked the juiciness, tenderness and overall liked pork loin chops from the high pH category. These data provide direction of the pork industry in the U.S. They show that while pH is important, tenderness is also an issue for consumer perception. As meat scientists we know that there is a relationship between pH and tenderness as low pH pork may be tougher due to excessive moisture loss during cooking and concentration of meat proteins. This study does not address that issue, it only provides information on how consumers perceived the product. While this is very good information that can be used to direct quality issues in the pork industry, keep in mind that

the pork loin chops evaluated in this study were cooked using standardized procedures by trained personnel. Each pork loin chop was cooked in an electric convection oven to an internal temperature of 72°C and temperature was monitored using thermocouples. In real life, pork loin chops are not cooked using these controlled conditions. Therefore, these results give us differences in a controlled environment, but they don't tell us if these consumer perceptions hold true in real life situations where multiple factors such as cooking variations, ease of preparation, and the family response may alter these relationships.

Another example of use of Central Location Testing to direct meat science industry issues is a study conducted using Japanese consumers. The Japanese pork industry has developed color standards from one to six that are used to select pork imported into Japan. These color standards are used to select darker colored pork. The pork industry in the U.S. has invested large dollars into development of harvesting and chilling systems to assist in producing darker colored pork, genetic selection for hogs that inherently produce darker colored lean as occurred, and development of on-line systems for selection has occurred. However, there was not data relating color of pork to Japanese consumer perception. A Central Location consumer study was conducted in Japanese with only Japanese consumers where U.S. pork that varied in Japanese color score where presented visually and as cooked samples. Japanese consumers rated the pork chops in a standardized package in a simulated meat case. Then companion samples from the same samples that they rated visually were cooked and consumers rated acceptance. These data provide a method of assessing if Japanese color scores are a viable tool for selecting pork. Japanese color score impacted

Table 2 Least squares means for consumer sensory traits^a as effected by predetermined categories of lipid, Warner-Bratzer shear force, and pH from loin chops from the U.S. Pork Consumer Sensory Study from Miller et al. (2000).

Trait	n	Juiciness	Tenderness	Flavor	Overall Like
pH Category		.04	.0165	.06	.03
1 Low	648	3.3 ^d	3.3 ^d	3.2	3.2 ^d
2 Medium	620	3.3 ^d	3.3 ^d	3.2	3.2 ^d
3 High	498	3.5 ^e	3.4 ^e	3.4	3.4 ^e
RSD ^c		1.13	1.08	1.10	1.03
Lipid Category		.20	.19	.09	.18
1 Low	427	3.4	3.3	3.3	3.2
2 Medium	857	3.3	3.3	3.2	3.2
3 High	482	3.4	3.4	3.4	3.3
RSD ^c		1.3	1.08	1.05	1.03
Shear Category		.0004	.0001	.0004	.0001
1 High	379	3.2 ^d	3.1 ^d	3.1 ^d	3.0 ^d
2 Medium	844	3.4 ^d	3.3 ^e	3.3 ^e	3.3 ^e
3 Low	520	3.5 ^e	3.5 ^f	3.4 ^e	3.4 ^e
RSD ^c		1.12	1.07	1.05	1.03

^a Consumer attributes were evaluated using a 5-point hedonic, end-anchored sensory scale where 1=dislike extremely and 5=like extremely.

^bP-value from the Analysis of Variance table.

^cRSD=Residual Standard Deviation from the Analysis of Variance table.

^dLeast squares means within a column and a trait lacking a common superscript differ ($P < .05$).



visual consumer assessment more than eating acceptability assessments (Table 3). Japanese consumers liked the color of pork loin chops with Japanese color scores of 2 and higher. They identified the color in pork loins with Japanese color scores of 3 and higher as darker and pork loins with Japanese color scores of 1 as lighter. Overall, Japanese consumers like the overall visual appearance of pork chops from pork loins with Japanese color scores of 3 or higher. However, when Japanese consumers ate the pork loin chops, tenderness like/dislike was the only consumer attribute affected by Japanese color score. These results provide evidence and direction to the pork industry as to how much visual appearance affects consumer perception of acceptability, but note that these data have not addressed the question of intent to purchase.

Central Location Tests provide valid, controlled environment consumer information that can be used to direct a meat company or industry as to the major factors affecting consumer preference, but these studies do not provide all the information. As previously discussed, other factors such as preparation, cooking, and the family opinion, are not a component of these tests. In-Home Consumer Testing is usually used in combination with Central Location Testing to understand consumer perceptions of products and to give direction.

Consumer In-Home Use Tests

In-Home Use Tests are where products are delivered to consumers and the consumers prepare and evaluate the product in their home. Ballots are usually very similar

between Central Location and In-Home Use Tests. In this type of test how the product performs during preparation and the family opinions influence consumers' perceptions. The major strength of this type of testing is that as the testing environment is the home, the results are more closely related to consumer perceptions in real conditions. The greatest disadvantage is that the handling and preparation of the product is not controlled and therefore cooking and preparation methods may confound or induce higher amounts of variation in these data. While detailed instructions can be given to consumers to minimize this issue, care must be taken to not bias consumers and consumers still have the ability to prepare the product as they wish. Also, if preference or ranking data is included in the study, last order bias can be strong. Additional information that can be obtained during this testing is how consumers handle and prepare products. In Beef Customer Satisfaction, a national U.S. consumer in-home placement study, we were able to gather information on what cooking methods consumers prepared for three cuts (top loin, top round and top sirloin steaks) (Lorenzen et al., 1999) (Table 4). We also were able to gain information on consumer preferred degree of doneness and we could then relate degree of doneness to overall acceptability, tenderness, juiciness and flavor attributes. While the study was originally designed to assess if consumers perceived differences in USDA Quality Grades across the cuts in an in-home environment to examine if changes in the USDS Beef Quality Grading System were warranted, the information on cooking and degree of doneness was extremely important in understanding the role of beef in the U.S. diet.

Table 3. Least squares means for consumer sensory scores segmented by Japanese color scores from the 10th rib Longissimus muscle from Miller et al. (2000).

Consumer Attribute	Japanese Color Score ^c						P. Value
	1	2	3	4	5	6	
Visual Consumer Assessment							
Appearance Like/Dislike ^a	2.54	3.02	3.11	3.14	3.13	3.35	0.06
Color Like/Dislike ^a	2.67 ^d	3.02 ^{de}	3.18 ^e	3.23 ^e	3.09 ^e	3.15 ^e	0.0469
Color Intensity ^b	2.50 ^d	2.88 ^e	3.04 ^e	3.33 ^f	3.51 ^f	3.60 ^f	0.001
Amount of fat Like/Dislike ^a	2.83	3.08	3.18	3.19	3.25	3.10	0.39
Overall Visual Like/Dislike ^a	2.46 ^d	2.91 ^e	3.11 ^{ef}	3.18 ^f	3.16 ^f	3.25 ^f	0.0023
Cooked Consumer Assessment							
Aroma Like/Dislike ^a	2.87	3.13	3.21	3.19	3.23	3.50	0.21
Juiciness Like/Dislike ^a	2.83	2.88	3.11	3.14	3.05	3.25	0.26
Tenderness Like/Dislike ^a	3.29 ^{de}	3.02 ^d	3.33 ^e	3.41 ^e	3.37 ^e	3.75 ^e	0.03
Flavor Like/Dislike ^a	3.04	3.01	3.20	3.2	3.17	3.40	0.33
Overall Taste Like/Dislike ^a	2.87	2.94	3.20	3.26	3.22	3.45	0.07

^a Consumer attributes were evaluated using a 5-point scale where 1=dislike extremely and 5=like extremely.

^b Consumer attributes were evaluated using a 5-point scale where 1=light and 5=dark.

^c Japanese color scores where 1=very pale, light pink and 6=very dark red.

^{def} Least squares means within a row lacking a common superscript differ ($P < .05$).

Table 4. Least squares means for U.S. Beef Customer Satisfaction consumer sensory attributes^a for top loin steaks as effected by degree of doneness and cooking method from Lorenzen et al. (1999).

Attribute	Overall Like/Dislike	Juiciness	Tenderness Like/Dislike	Flavor Intensity	Flavor Like/Dislike
Degree of Doneness^b					
Medium rare or less	18.8	18.7	18.7	18.7	18.6
Medium	18.4	18.5	18.1	18.5	18.4
Medium well	18.2	18.2	17.5	18.4	18.2
Well done or more	18.6	18.5	17.1	18.7	18.5
Cooking Method					
Outdoor grill	18.7	18.5	18.1	18.8	18.6
Broil	18.2	18.1	17.4	18.2	18.0
Indoor grill	18.4	18.5	17.9	18.6	18.5
Pan-fry	18.6	18.7	17.9	18.7	18.6
Other	18.6	18.7	17.6	18.6	18.4

^a Consumers attributes were rated as 1=dislike extremely, not at all juicy, not at all tender, dislike extremely, and no flavor at all, respectively and 23=like extremely, extremely tender, extremely juicy, like extremely, and an extreme amount of flavor, respectively.

In-Home Use Tests can use the same ballots as Central Location Tests and the data is often presented in the same format. The biggest difference in interpretation of data from these two test types, is that inference of the data from the In-Home Test is usually closer to reality. In-Home Use tests also are excellent ways to test packaging concepts and consumer products that may require preparation instructions. This provides consumer evaluation that encompasses all aspects of the product. Data from In-Home Use Tests is usually more variable and trends may not be as statistically strong or apparent. That is most likely more reflective of reality. Again, note that the issue of intent to purchase, while it can be a component of these tests, these type of tests do not assess intent to purchase with strong likelihood.

Experimental Auctions to Assess Acceptability and Intent to Purchase

Experimental Auctions are a research tool that can be used to determine consumer acceptability in combination with their intent to purchase. These type of tests help to assess how visual or palatability attributes affect intent to purchase. The intent to purchase information is considered more "real world" as consumers are being asked to make a purchase decision even though the situation is not the same as purchasing product from a retail meat case. Experimental Auctions are used commonly by agricultural economist and there are variations on the concept. A recently completed study at the University of Nebraska Lincoln used a Vickery auction. A Vickery auction uses a silent, sealed-bid. Consumers usually receive a monetary compensation for participating and the monies used to bid and purchase product may or may not be supplied. To understand what type of information can be obtained from Experimental Auction the results of this study will be discussed.

Killinger et al. (2001) used a Vickery auction to determine the effect of visual appearance of marbling on consumer intent to purchase. Consumers ate pairs of beef that differed in marbling (one steak was from the upper 2/3rds of USDA Choice and the other steak was USDA Select). Then consumers were given the opportunity to bid during the auction on the sample that they were willing to purchase. This process was repeated for the marbling comparison. A third comparison used U.S. beef and Argentinian beef that was from the USDA Select grade. The auction procedures were explained to consumer and two practice auctions were conducted to familiarize consumers to the procedures. If proper training and explanations are not provided in auction studies, biases may occur due to lack of familiarity with the procedures.

Killinger et al. (2001) found that 72.6% of consumers preferred the low marbled steak during visual evaluation. Of the consumers who selected the low marbled steaks, 61.6% indicated that fat was used as their main selection criteria. For consumers who selected high marbling steaks, 65.4% indicated that they selected these steaks due to the visual marbling. When asked to bid on steaks based on visual appearance, consumer who preferred high marbled beef were will to pay \$0.75/lb for it when compared to the low marbled steak. Interestingly, consumers who preferred the low marbled steak were willing to pay \$1.12/lb more for the low marbled steak than the high marbled steak. These data show the value of visual appearance of marbling on purchase intent.

Consumers evaluated the high and low marbled steaks and were asked to rate the overall like, flavor, juiciness and tenderness of these steaks. Consumers rated the high marbled steaks as more desirable in flavor, juicier, more tender and the liked the higher marbled steaks when compared to the low marbled steaks (Table 5). When asked the value of these differences, consumers in Chicago valued the high marbled steaks as \$0.23/lb more and the

San Francisco consumers valued the high marbled steaks as \$0.09/lb more than low marbled steaks. Steaks, while differing in marbling, were similar in Warner-Bratzler shear force.

When asked to rate the consumer sensory traits of Argentine and U.S. beef, consumers rated the U.S. steaks as more desirable in flavor, juicier, more tender and more acceptable than steaks from Argentina (Table 6). The Argentine steaks were from a grass-fed supplier where the U.S. steaks were from grain-fed cattle. Chicago consumers were willing to pay \$0.89/lb more for U.S. steaks and San Francisco consumers were willing to pay \$0.48/lb more for U.S. steaks.

It is obvious from these data that the value of quality differences can be more easily ascertained using this experimental design tool. However, experimental auctions may or may not ask consumers to use their own money and are still considered to be somewhat of an artificial situation. As they measure how much a consumer is willing to pay, they are valuable in determining relative price differences.

Purchase Simulations to Assess Acceptability and Intent to Purchase

Purchase simulations can be valuable in assessing consumer preference as intent to purchase or price and visual appearance are combined. Consumers are recruited as previously described and they are asked to come to a central location. Consumers use either real money or play money and they purchase product from a simulated meat case. Product is usually presented to that varies in price within categories and across categories. Questions can be asked at the point of purchase or after the consumer has prepared and eaten the product or at both time frames. Also, consumers can be asked to make repeat purchases

and information on factors influencing repeat purchases can be ascertained. This type of consumer assessment model can also be used in a foodservice application where consumers are asked to order a meal and consume it. Again, consumers could be asked to make repeat visits so that purchase behavior could be determined. The greatest advantage of this model is that the influence of price or value can be determined in combination with other factors. Some researchers prefer using real money and then reimbursing consumers later to provide a more realistic purchase environment. The amount of money that consumers can use in the study can either be controlled (most common application) or not controlled.

This consumer sensory model can be used to determine the influences of packaging, product visual attributes such as portion size, color, and amount of fat and price. A study by Boleman et al. (1997) used a purchase simulation model to determine the value of beef tenderness for consumers in Bryan-College Station, TX. In this study, strip loins were preselected using Warner-Bratzler shear force to determine tenderness categories. From each strip loin, the center, 2.54 cm steak was broiled to 70°C, cooled to room temperature and six, 1.27 cm cores were removed parallel to the muscle fiber orientation. Each core was sheared once with a Warner-Bratzler shearing device and the average of the six cores was used to classify the strip loin into three tenderness categories of: 1) tender (2.27 to 3.58 kg of shear force); 2) intermediate (4.08 to 5.40 kg of shear force); and 3) tough (5.90 to 7.21 kg of shear force). Steaks were fabricated from the loins to contain .32 cm of subcutaneous fat and to have 1.27 cm tails. The three categories were labeled for identification so that category 1 steaks had a red label; category 2 steaks had white labels; and category 3 steaks had blue labels. Two steaks from each category (six total steaks) were delivered in a in-home testing to two adult households. The consumers were

Table 5. Consumer taste panel rating for high and low marbled steaks from Killinger et al. (2001).

Variable ^a	High marbled steak	Low marbled steak	P-value
Flavor rating	5.60	5.30	<0.01
Juiciness rating	4.94	4.47	<0.01
Tenderness rating	5.45	5.26	<0.05
Overall acceptability rating	5.37	5.06	<0.01

^aSamples rated using an 8-point hedonic scale (8=extremely desirable, juicy, tender, desirable; 1=extremely undesirable, dry, tough, undesirable).

Table 6. Consumer taste panel rating for U.S and Argentine steaks from Killinger et al. (2001).

Variable ^a	U.S. steak	Argentine steak	P-value
Flavor rating	5.82	4.60	<0.01
Juiciness rating	4.94	4.47	<0.01
Tenderness rating	5.79	5.14	<0.01
Overall acceptability rating	5.64	4.57	<0.01

^aSamples rated using an 8-point hedonic scale (8=extremely desirable, juicy, tender, desirable; 1=extremely undesirable, dry, tough, undesirable).

asked to eat the steaks and rate each steak as to overall, tenderness, juiciness and flavor like/dislike using 23-point, end-anchored hedonic scales. Consumers also rated the tenderness, juiciness and flavor intensities where 1 = very tender, very juicy or very flavorful and 23 = not at all tender, not at all juicy or no flavor, respectively. This was defined as Phase I of the study and would be classified as a traditional in-home use study. The authors intent were to introduce consumers to the three categories of beef steaks and to have consumers with some familiarization with the visual and eating characteristics of steaks in each of the three categories.

Phase II of Boleman et al. (1997) was a Purchase Simulation test and was conducted within 2 weeks of completing Phase I. Consumers were asked to purchase steaks from one of the three categories in a simulated meat retail case where all steaks were priced equally. Consumers were not given money, but had to purchase the steaks with their own money. The only incentive was that the price of steaks was 30% lower than the current market. The data collected in this phase was the number of steaks purchased from the three categories. The purpose of this phase was to see if previous eating experience would be equated into purchase intent based on differences in tenderness.

Phase III evaluated the effect of price on purchase intent for top loin steaks differing in tenderness. Three weeks after completion of Phase II, consumers were asked to return and purchase with their own money steaks from the same three categories, expect the meat was now priced \$1.10/kg

differentially by tenderness category with the most tender being the highest priced. Additionally, consumers were informed of the tenderness differences. The purpose of this phase was to ascertain if price and tenderness expectation influenced consumer intent to purchase.

The information that can be extracted from this experiment is multifold. In Phase I, the traditional in-home use study, the data showed that consumers rated the tender or red category strip steaks as highest for overall like, tenderness like, juiciness like and flavor like (Table 7). Consumers indicated that steaks from the tender category were more tender, juicier and had more flavor (Table 8). While this information is extremely valuable, it indicates that tenderness categories as defined by Warner-Bratzler shear force equates to differences in palatability by consumers in Bryan-College Station, TX. However, the data do not indicate if consumers are willing to pay for these differences. Data from Phase II and III are useful in ascertaining the impact of price and purchase intent. In Phase II, 55.3% of consumers purchased the tender steaks when price was held constant and they only had their previous eating experience as a basis for purchase (Table 8). It was interesting that 32% of the purchases in Phase II were for blue category or tough steaks. Use the color blue to designate steak packages, in the US the blue color is used to designate first place or the best, and that designation may have influenced consumers. In Phase III, where consumers knew the tenderness designation and had had two eating experiences, 94.6% of steaks were purchased from the red or tender category.

Table 7. Mean scores for palatability evaluations of beef top loin steaks segmented according to Warner-Bratzler shear force from Boleman et al. (1997).

Variable	Red (Tender)	White (Intermediate)	Blue (Tough)
Overall like/dislike ^a	16.91 ^c	14.06 ^d	12.90 ^d
Tenderness ^b	16.61 ^c	13.66 ^d	11.61 ^e
Tenderness like/dislike ^a	16.51 ^c	13.53 ^d	11.53 ^e
Juiciness ^b	16.40 ^c	13.24 ^d	12.51 ^d
Juiciness like/dislike ^a	16.43 ^c	13.29 ^d	12.53 ^d
Flavor ^b	15.81 ^c	14.43 ^{cd}	12.98 ^d
Flavor like/dislike ^a	16.07 ^c	14.47 ^d	13.34 ^d

^aBased on a 23-point scale where 1 = dislike extremely and 23 = like extremely.

^bBased on a 23-point scale where 1 = not at all tender, not at all juicy and no flavor at all and 23 = very tender, very juicy, or very flavorful, respectively.

^{cde}Means within rows with different superscripts differ ($P < .05$).

Table 8. Percentages of beef top loin steaks purchased by consumers during initial purchase (Phase II) and repurchase (Phase III) from Boleman et al. (1997).

Category ^a	Phase II	Phase III
Red (Tender)	55.3 ^b	94.6 ^b
White (Intermediate)	12.6 ^d	3.6 ^c
Blue (Tough)	32.0 ^c	1.8 ^c

^aDetermined by Warner-Bratzler shear force.

^{bcd}Means within columns with different superscripts differ ($P < .05$).



The strength of this study was that consumers used their own monies in Phases II and III to make their purchases and when consumers use their own money they are more discerning. Also, repeat purchases or experience with the product was included in the model to more closely emulate real life. The weaknesses of the study were that the product was coded with colors that may have imparted their own meaning or they may have influenced consumers' perception and the consumer base was a limited population. Therefore, the application of these results was limited to the geographical area of the study.

This type of consumer model provides additional information on purchase intent. When weakness of asking intent to purchase questions during central location and in-home use studies, consumers are more willing to indicate that they are willing to pay a price differential as they are not really having to use their own money. This is considered an artifact in this type of data. In the Purchase Simulation model, this artifact is reduced. It should be noted that only actual data from retail stores will have this artifact removed to the greatest extent.

Multivariate Statistics to Assess Intent to Purchase

There are multiple statistical tools other than Analysis of Variance that can be used to understand relationships between meat product attributes and consumer acceptance. The advantage of using multivariate analyses is that these tools account for more than one attribute and consumer acceptance is most likely the result of multiple variables, not the consideration of one attribute at a time. Principle component analysis has been a commonly applied statistical tool to consumer data. This analysis provides information on what attributes that account for greater amounts of variation or it segments out the attributes that impacts consumer perception. Another multivariate tool is Probit Models. We used this tool to help assess the combination of consumer sensory perception with price or value of pork loin chops in the U.S. consumer pork study from Table 2. In addition to the consumer sensory attributes of juiciness, tenderness, flavor and overall like/dislike, we asked a purchase question. It was: "Suppose the piece of meat you just tasted were available in your local supermarket. The price per pound is x . Thinking about the **taste** and **price** of the meat you just tasted, how likely would you be to buy it?" Consumers answered this question by marking very unlikely (0) to very likely (4) using a 5 point scale. Five retail prices were randomly assigned to either boneless loin or fresh ham chops. For the loin cuts the prices (\$/lb) were \$1.99, \$2.74, \$3.49, \$4.24, and \$4.99. Demographic data was collected. These data were used to determine the relationships between price, demographic information and meat quality characteristics. Also, these data were used to examine how changing meat quality characteristics impacted consumers' intent to purchase. For Probit models, a standard or dummy variable must be defined and statistically the values for these

attributes are set at 0 in the model. The base category was defined as a non-married male, living in Boston, not having any health problems influencing his diet, of some other ethnic origin than those listed, and with some post college education. The average participant was about 46 years old, with an income around \$51,000, with 3 people in the household. The means of the dummy variables indicated that the percentage of the sample with those characteristics or about 80% of the participants had at least a high school education, 86% had no health problems, 40% were female, 71% were married, and 93% were Caucasian. The results of the Probit model are presented in Table 9. If a consumer had more than a college degree then the probability that the consumer was very unlikely (likely) to purchase a loin cut decreased (increased) by .049 (.043). If the consumer had a health problem affecting their diet, then the probability that the consumer was very unlikely (likely) to purchase a loin cut decreased (increased) by .047 (.041). If the consumer was in Chicago then the probability that the consumer was very unlikely (likely) to purchase a loin cut increased (decreased) by .067 (.059). If the consumer was in the married category then the probability that the consumer was very unlikely (likely) to purchase a loin cut increased (decreased) by .039 (.034). If the shear level was increased by one unit then the probability that the consumer was very unlikely (likely) to purchase a loin cut increased (decreased) by .017 (.014). If the drip loss increased by one unit then the probability that the consumer was very unlikely (likely) to purchase a loin cut increased (decreased) by 1.105 (.967). Finally, as the price of the loin cut increases by one unit, then the probability that consumer was very unlikely (likely) to purchase a loin cut increased (decreased) by .088 (.077).

Another way to examine these data are to use the marginal effects to answer the question about what is the value of changing shear or drip loss to the consumer. Using an average price of a loin of \$3.52 per pound, the marginal revenue associated with an additional unit of shear is $\$3.52 \times -.014 = -\0.05 and the marginal revenue associated with drip is $\$3.52 \times -.967 = -\3.40 . So increasing the shear factor by one unit cost about 5 cents whereas increasing the drip factor by one unit cost about 3.4 dollars in relationship to what consumers indicated that they were willing to pay.

Marginal rates of substitution for intent to purchase can also be determined. Three margin rates of substitution were evaluated: drip/shear, drip/price, and shear/price. These substitution relationships could be examined as they accounted for variation in the Probit model. The marginal rate of substitution between drip and shear was about -67 , which means that if drip was increased by one unit then shear would have to be decreased by 67 units to keep the probabilities unchanged. The marginal rate of substitution between drip and prices was about $-.08$, which means that if price was increased by one unit then drip would have to be decreased by .08 units to keep the probabilities unchanged. The marginal rate of substitution between shear and prices was about -5.4 , which means that if price was increased by one unit then shear would have to be decreased by 5.4 units to keep the probabilities unchanged.

Table 9. Order Probit for loin for the intent to buy question from Miller et al. (2002).

Variable	Estimate	P-Value	Marginal Effects			
			Low	P-Value	High	P-Value
Intercept	1.920	.009				
Age	0.003	.232	-0.001	0.233	0.001	0.232
Education 1	0.269	.257	-0.067	0.256	0.059	0.259
Education 2	0.127	.234	-0.032	0.235	0.028	0.235
Education 3	0.195	.085	-0.049	0.086	0.043	0.085
Income	0.000	.800	0.000	0.800	0.000	0.800
No. household	0.030	.529	-0.008	0.529	0.007	0.529
No. children	-0.006	.905	0.002	0.905	-0.001	0.905
Health	0.190	.039	-0.047	0.039	0.041	0.040
City 3	0.086	.308	-0.021	0.308	0.019	0.311
City 4	-0.269	.002	0.067	0.002	-0.059	0.002
Gender	0.049	.517	-0.012	0.516	0.011	0.519
Ethnic 1	0.069	.815	-0.017	0.815	0.015	0.815
Ethnic 2	-0.043	.908	0.011	0.908	-0.009	0.908
Ethnic 3	0.273	.439	-0.068	0.439	0.060	0.440
Ethnic 4	-0.349	.625	0.087	0.625	-0.076	0.625
Married	-0.155	.099	0.039	0.100	-0.034	0.100
Order	-0.056	.400	0.014	0.401	-0.012	0.400
Shear	-0.066	.000	0.017	0.000	-0.014	0.000
Drip	-4.431	.006	1.105	0.006	-0.967	0.006
Percent fat	-0.001	.965	0.000	0.965	0.000	0.965
pH level	0.034	.734	-0.008	0.734	0.007	0.734
Cook time	-0.001	.874	0.000	0.874	0.000	0.874
Cook temperature	0.001	.827	0.000	0.827	0.000	0.827
Price	-0.354	.000	0.088	0.000	-0.077	0.000
Threshold 1	0.645	.000				
Threshold 2	1.284	.000				
Threshold 3	2.067	.000				

An alternative way to understand these last two would be to take the inverses: if drip was increased by one unit then price would have to be decreased by 125 dollars to keep the probabilities unchanged and if shear was increased by one unit then price would have to be decreased by .19 units to keep the probabilities unchanged. Clearly, price and drip are very important and changes in the drip level require large changes in prices to offset the drip changes.

CONCLUSIONS

In assessing consumer preferences it is imperative that first the objective and hypothesis of the study or the information that is needed be defined. It is obvious from the aforementioned information, that there are a lot of options and tools that can be used to assess consumer acceptance and preferences. There is not one tool that answers all the questions, but each tool has strengths and weaknesses.

Each tool can assist in understanding consumer preference, but not one tool provides all the answers on consumer acceptance of a meat product.

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