Facts

National Pork Board

PORK QUALITY

American Meat Science Association

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Sensory Evaluation of Pork

Overview

Sensory evaluation of pork includes the use of either trained sensory panelists to rate eating quality differences or untrained, consumer sensory evaluation to determine consumer preference or acceptability of pork. This paper will discuss the fundamental considerations for conducting both types of sensory evaluation for pork. For trained sensory evaluation, the environmental, panel and product conditions must be standardized to remove any potential bias from the trained sensory panelist verdict. Trained sensory panelists should be selected using a prescreening interview to ascertain panelist interest and health followed by screening tests that determine the sensory panelists acuity and ability to listen and follow directions. After acceptance as sensory panelists, they will become familiar with the test procedures, they will recognize and identify the sensory attributes of the product, and exercises will be presented to improve their sensitivity and memory for test attributes so that their sensory judgements are precise and consistent. The trained sensory methods can be either difference or descriptive attribute testing. Types of difference testing used in pork are the triangle test, two-out-of-five, duo-trio, simple difference test, difference-from-control, sequential tests or directional difference test. Descriptive tests for pork are meat descriptive analysis, The Spectrum Method, the Quantitative Descriptive Analysis Method or the free-choice profile method. For consumer sensory evaluation, the study can either be conducted as a Central Location test or an In-Home Placement test. The hypothesis to be tested then must be defined and the study protocol design developed. Then the ballot can be determined. Selection of consumers may incluce consider ation of age, geographic location, usage rate, family members, usage types or styles, ethnic background, amount of exposure to like products, income level and special health considerations. After selection of consumers, the consumer sensory test can be conducted.

Introduction

Understanding the eating qualities of pork is a very important component of improving pork's competitiveness. As new pork products are produced, as new genetics and management and/or nutritional practices are developed, or as new technologies are implemented that may affect pork eating attributes, understanding the eating qualities and consumer acceptance of the end product is needed. Pork eating quality, also defined as pork palatability, can be identified using humans either as trained sensory panelists or as untrained consumers. Trained sensory panelists provide a measurable response to how much of an attribute or they can rate the level or intensity of a specific attribute, such as juiciness, tenderness or flavor. Whereas, consumer sensory panelists provide information on the acceptance or preference of the eating qualities of pork. The objective of this paper is to describe trained and consumer sensory evaluation techniques that can be used to test the eating characteristics of pork.

MEAT PALATABILITY EVALUATION OF PORK USING TRAINED SENSORY PANELISTS

The use of trained humans as instruments to quantitate or identify the sensory properties of pork is a common pratice. Trained sensory evaluation has been used to evaluate the eating quality differences in meat due to application of new technologies and in industry by quality control personnel to track and evaluate products on a day-to-day basis and over time. To conduct sensory evaluation, three specific areas have to be considered: 1) the environmental, product and panel conditions that will be used for sensory testing; 2) selection and training of

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sensory panelists; and 3) the type and structure of tests that will be used to address sensory properties in pork.

Environmental, panel and product conditions

The sensory analysis environment is extremely important as the environment can interfere or confound sensory perceptions. Removal of as many environmental factors as possible or minimizing and standardizing those factors that cannot be removed across treatments is important. This assures that the sensory response of a panelist is the result of the product characteristics, not a response confounded by the environment in which the response was evoked.

The panelist evaluation area should be separated from the food preparation area and should be free of extraneous odors, especially cooking odors. Optimally, air filtration and good ventilation systems should be used to remove odors from the evaluation area. The sensory evaluation area should contain a sample transfer mechanism where samples can be passed from the preparation area to the sensory evaluation area without transferring odors. Odors from other panelists should be minimized. For example, panelists should not use scented cosmetic or personal care products immediately prior to or during sensory evaluation. If a panelist uses tobacco products, they should be asked to not use these products on the day of evaluation as their hair and clothes carry tobacco odors. Panelists should wear lab coats that are washed in unscented detergent to minimize odors. If sinks are plumbed into the sensory evaluation area, removal of the effect of drain, pipe or water odors should be minimized. Water used to rinse between samples should be double-distilled, deionized water or passed through a filtration system that eliminates any flavors that could interfere in the evaluation of the product. Construction materials should be nonporous, not contain odors, be of a neutral color, off-white preferable, should not contain a pattern, and should not collect dirt or mold that would harbor odors. A constant room temperature between 22 to 24°C and a relative humidity of 45 to 55% should be maintained to assure comfort and a constant environment.

The noise level in the sensory evaluation area should be minimized. These sounds include noice associated with traffic flow in and out of the area, people serving samples or any other noise from external sources. There should be no communication, visual or oral, between panelists during sensory evaluation. If one panelist makes a comment indicating dislike or like of a product, other panelists may be influenced. For example, a panelist may indicate dislike of a product (a trained panelist should never indicate like/dislike of a product as this is a consumer response) by saying "oh, how terrible". Another panelist may have rated the product high for pork lean flavor, but upon hearing the remark, the panelist may reevaluate their response and rate the product lower for pork lean flavor due to the verbal influence of the other panelist.

Consistent and the appropriate type of lighting should be used during sensory evaluation. Generally, 70 to 80 foot-candles of shadow-free light should be used. For pork, red filtered lights are commonly used to reduce some visible effects due to cooking method, degree of doneness, or muscle effect. To minimize physical discomforts for panelists, comfortable seating and sufficient room per panelist should be provided.

Panelists should not be hungry at the time of evaluation and panel evaluations should be conducted when there is a greater probability that panelists are mentally alert (subjected to a minimum amount of mental fatigue). The use of oral cleansing products or teeth brushing should be at least one hour before panel starts. They should not have consumed food or chewed gum within 1 hour of conducting oral evaluations. They should not consume liquids except water within 1/2 hour of oral evaluation. These measures are important to minimize the effect of other foods and taste adaptation on their perception during sensory evaluation.

Unbiased presentation of samples to sensory panelists eliminates confounding effects on panelist responses. Preparation procedures of muscle foods affect the sensory attributes of the final product. Cooking method, service temperature and humidity of the cooking apparatus, internal degree of doneness, length of cooking, time from cooking to serving, effect of holding the cooked product at a standardized temperature between cooking and serving, types of containers used to store the product, and utensils used in preparing the product can influence the sensory attributes of muscle foods. Each of these parameters must be standardized and the effect of each parameter should be evaluated before initiation of the sensory study to assure minimal influence on the sensory attributes of the product being test-

ed. For whole muscle pork (chops or roasts), panelists are usually presented a standardized size or quantity of meat, a 1.27 cm cube, and they should be given at least two serving portions per sample. For a ground meat products, panelists are usually served either a .64, .42 or .32 cm wedge of the patty including the edges or a 1.27 or 2.54 cm square with the edges removed. Whereas for processed meat items, the product serving size is dependent on the type of product and the objectives of the test. If texture attributes are being evaluated for sausage-type products that are extruded into a casing, a whole sausage may be served to each panelist. However, if only flavor attributes are being evaluated on the sausage, a 2.54 cm section with the end pieces removed may be the serving size. The temperature of the sample when it is presented to sensory panelists can affect their sensory perception. Aromatic compounds volitalize at higher temperatures. Therefore, if temperature of the sample varies from panelist to panelists or from day to day, panelists receiving warmer samples may detect higher amounts of flavor attributes in a sample compared to when they evaluated the same product served at a colder temperature. Samples served to sensory panelists should be identified with three-digit random codes to prevent subconscious selection of a sample due to identification. Samples should be presented to sensory panelists in either glass or white glazed china to eliminate any aromatics associated with the container and to neutralize the visual attributes of the container on the sample. Plastic containers can be used if they are opaque or neutral in color and have been tested to assure that they do not impart odors. The order that samples are served to panelists should be random. In trained sensory evaluation tests, a strong first order bias is present or panelists tend to rank the first sample that they evaluate either higher or lower than samples evaluated later in the order. Therefore, it is important that the order effect is either randomized across treatments or controlled so that the effect can be removed statistically.

Guidelines for cookery and sensory analysis of meat from the American Meat Science Association (AMSA, 1995) should be used as standardized techniques for the sensory evaluation of pork.

Selection of sensory panel members

Selection of sensory panelists is critical to obtaining reliable sensory data. Panelists can be selected from internal sources within a company or program, or external panelists who have no other ties to the project or company can be recruited. The advantages to using internal panelists are that additional monetary reward is usually not provided as being a sensory panelist becomes part of their normal responsibilities. This method reduces the direct cost of conducting sensory analysis; panelists are already on location or at work and do not have to travel to the testing site; and the pool of individuals of which the sensory panelists will be selected from may be more diverse in demographics than external panelists. The disadvantages of using internal panelists are that panelists are not totally unbiased about the products as they most likely contribute to the manufacturing or are familiar with products being evaluated; and work responsibilities can often interfere with sensory panel duties. While use of external panelists is directly more expensive, it also can be difficult to find people who are willing to work only a few hours per day, and the selection of people may be heavily slanted toward retired people or people who work inside the home. On the other hand, external panelists have only one work commitment to the project or company that eliminates interference from other job responsibilities, and as long as panelists are adequately screened and trained, biases inherent in selecting people who are available at only specific times during the day are eliminated. In my laboratory external panelists are used. The advantage that they have only one work commitment to the program (to be a sensory panelist) which limits interference with other job related responsibilities and this outweighs the disadvantages previously discussed. Additionally, panel attendance is higher and turnover of panelists is lower.

After the determination of what type of panelists will be used, advertising for potential panelists in local newspapers, on bulletin boards, in company newsletters, by word of mouth, and with local organizations is conducted. As much information concerning the job requirements, total hours per week of work, and type of work should be communicated in the advertisement. Interested candidates should be given a prescreening interview where the following issues should be addressed: 1) Describe in great detail what the job entails (hours per day, tasting of meat products, making decisions using a standardized scale, role of a panelist in sensory evaluation, etc.); 2) Ascertain the person's availability on a daily, weekly, monthly and yearly basis (for example, an individual may be

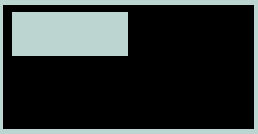
available every morning from 9 to 12 every day of the week, but they take a two month vacation every year... is that acceptable to you as the panel leader?); 3) Determine the individuals interest (do they like to eat different types of foods, do they like to cook, do they like meat, do they like to experiment with different food ideas, do they eat out a lot and why, would they like to be a sensory panelist); 4) Evaluate the general state of health of the individual (do they have food allergies, do they have frequent colds or sinus problems, do they suffer from dental or gum diseases or do they have frequent mouth sores, do they take medication such as antibiotics, are they diabetic or do they have kidney or coronary diseases, do they have any condition that effects any of their senses of sight, smell, taste or feel, do they miss work frequently due to illness, do they have false teeth); and 5) Communicate the importance of the sensory program to the company or institution. During the screening process the interviewer will be trying to determine the potential panelist's reliability, interest, availability and health. Panelists should be either disqualified or accepted for screening tests (the next step) at this point. Do not accept a panelist that does not fully fit into the requirements listed, even if you are desperate for panelists. If unacceptable or borderline individuals are accepted for further testing, issues related to why they were possibly unacceptable will resurface and could affect the efficacy of the sensory panel. For example, accepting an individual during the prescreening who shows only a mild interest in the program will many times results in a panelist who is repeatably absent.

Screening tests are conducted to determine panelist's sensory acuity and ability to listen and follow directions. Screening of potential panelists should be conducted in four phases: 1) Conduct scaling tests to determine if panelists can follow direction and make judgments; 2) Evaluate sensory acuity or the individual's ability to discriminate using sniff tests and triangle tests; 3) Conduct tests to determine an individual's ability to rank or rate sensory differences; and 4) Conduct a personal interview to ascertain a panelist's continued interest. During the screening process one of three decisions should be made at the completion of each of the four phases listed above: 1) accept the individual for the next phase of testing; 2) reject the individual; or 3) continue testing. An individual should be accepted for all four phases before acceptance for sensory training. If a potential panelist is late or does not show up for a screening session without calling or rescheduling ahead of time, immediately reject that individual. If individuals are not responsible and timely during the screening process, these behavior patterns will continue throughout sensory testing. Examples of exercises for each of the four phases are listed in Table 1. Do not accept an inferior panelist even if there is concern that you will not be able to recruit enough people, as it is much better to have fewer reliable, repeatable sensory panelists then to have more panelists who are not reliable and do not have the ability to discriminate.

After the selection of sensory panelists, training begins. The overall goal of sensory panel training is to familiarize the individuals with the test procedures, to improve the individual's ability to recognize and identify sensory attributes, and to improve the individual's sensitivity to and memory for test attributes so that sensory judgments will be precise and consistent.

The number of panelists that comprise a trained panel depends on how well trained the panel is, how familiar the panelists are with the testing procedures and the product, and how small of differences are anticipated between products in the test. During training, panelists will drop out due to loss of interest, relocation, mortality, illness, and inability to grasp concepts, therefore, approximately 20% additional panelists should be trained. The first sessions of sensory training should be used to educate new panelists on the general biology of pork. As panelists will be evaluating the sensorial properties, it is important that they understand what muscle fiber structure is, what connective tissue is, how the olfactory senses work, where the basic tastes are located on the tongue, etc. The subsequent sessions should familiarize panelists with the test procedures. The techniques that should be presented in these sessions are: 1) how to chew a sample; 2) how to expectorate the sample versus to swallow; 3) how to rinse the mouth between each sample; and 4) to familiarize them to the methods of evaluation, such as the scales to be used in testing, anchor points for the scale, the score sheet, and the terminology or lexicon to be used. An example of a standard lexicon for pork flavor and pork palatability attributes are presented in Tables 2 and 3. During training sessions, references should be presented for each attribute that will be tested. The exercises should concentrate on one attribute each session until panelists are familiar with that

Table 1. Examples of excercises used in the four phases of screening potential sensory panelists.

Phase of screening	Example of excercises to be used
Scaling Tests	Directions: Mark on the line following each figure the proportion of the area that is shad ed.  None ⊢——————⊣ All  None ⊢——————⊣ All  None ⊢——————⊣ All
Sensory Acuity/ Discrimination	Sniff tests provide a good method of determining if panelists can describe or distinguish between attributes: Have panelists sniff different flavored oils that have been placed on a cotton ball or absorbant paper in a glass jar (i.e., baby food jar). Ask panelists to describe the aromatic. Examples of oils: **Cedar, Cherry, Vanilla, Lemon, Lavender** Triangle Tests are used to evaluate a potential panelists ability to discriminate. Examples of triangle tests (note differences between samples in a triangle test should differ by at least 2 units on the scales used in trained testing). 1. Pork loin chop cooked to 70°C and a pork loin chop cooked to 80°C and juices pressed out to get differences in juiciness. 2. Pork chop with a pH of 5.4 cooked to 70°C and a pork chop with a pH of 6.0 cooked to 70°C to get differences in tenderness. 3. Uncured, inside ham steak and a pork loin chop both cooked to 70°C to get differences in flavor intensity.
Rank or Rating	Examples of ranking tests: 1. Sip the solution of each cup and evaluate for sweet taste; rank the samples from least intense to most intense for sweet taste. (Solutions containing varying concentration of sugar.) Least intense _____ _____ _____ Most intense _____
Personal Interview	Examples of questions for a personal interview are as follows: **A.** Interest - essential Expectations - time, pay, social contact, commitment **B.** Availability - essential Travel, family, other commitments **C.** Health Generally good Allergies, especially to the food(s) you are testing Colds/sinus problems - decreased acuity, increased absences High blood pressure - salty products Diabetes - sweet products Dentures **D.** Attitude/motivation **E.** Inform candidates of: Demands of time Commitment requirements Value to your program

Adapted from Cross et al. (1978) and Meilgaard, Civille and Carr (1991).

Table 2. Lexicon for flavors in pork.

Descriptors	Definitions of Descriptors
Aromatics	
Cooked pork lean	The aromatic associated with cooked pork muscle meat
Cooked pork fat	The aromatic associated with cooked pork fat
Browned	The aromatic associated with the outside of grilled or broiled beef
Serum/bloody	The aromatic associated with raw beef lean
Grainy	The aromatic associated with pork meat having a grain/feed character
Cardboard	The aromatic assoicated with slightly stale pork, refrigerated for a few days only and assoicated with wet carboard and stale oils and fats
Painty	The aromatic associated with rancid oil and fat
Fishy	The aromatic associated with some rancid fats and oils
Livery/organy	The aromatic associated with liver and/or kidney
Tastes	
Sweet	Taste on the tongue associated with sugars
Sour	Taste on the tongue associated with acids
Salty	Taste on the tongue associated with sodium ions
Bitter	Taste on the tongue associated with bitter agents such as caffeine, quinine, etc.

Modified from the beef lexicon presented by Johnsen and Civille (1986).

Table 3. Meat descriptive attributes for whole-pork products.

JUICINESS	MUSCLE FIBER AND OVERALL TENDERNESS	CONNECTIVE TISSUE AMOUNT
8 Extremely Juicy	8 Extremely Tender	8 None
7 Very Juicy	7 Very Tender	7 Practically None
6 Moderately Juicy	6 Moderately Tender	6 Traces
5 Slightly Juicy	5 Slightly Tender	5 Slight
4 Slightly Dry	4 Slightly Tough	4 Moderate
3 Moderately Dry	3 Moderately Tough	3 Slightly Abundant
2 Very Dry	2 Very Tough	2 Moderately Abundant
1 Extremely Dry	1 Extremely Tough	1 Abundant
FLAVOR INTENSITY	**OFF-FLAVOR CHARACTERISTIC**	**OFF-FLAVOR INTENSITY**
8 Extremely Intense	A Acid	8 Extermely Intense
7 Very Intense	L Liver	7 Very Intese
6 Moderately Intense	M Metallic	6 Moderately Intense
5 Slightly Intense	F Fish-like	5 Slightly Intense
4 Slightly Bland	O Old(Freezer Burned)	4 Slightly Bland
3 Moderately Bland	U Rancid	3 Moderately Bland
2 Very Bland	B Bitter	2 Very Bland
1 Extremely Bland	SO Sour	1 Extremely Bland
	X Other (describe)	

attribute. Anchor points on the scale for each attribute should be presented to assure a concise understanding of what each attribute is and how to scale within that attribute. Panelists should score samples individually, then the results should be discussed as a group. The panel leader should determine the overall score for each sample and panelists should reevaluate their sample to familiarize themselves with the score and the response in the sample. Training should proceed until consistent results are obtained between panelists and by each panelist. An example of the steps used to train a meat descriptive attribute pork panel is presented in Table 4. The degree or length of training depends on the type of panel, the number of attributes, and previous panel experience. Some panels may take up to one year of training if panelists have no prior experience and a large number of attributes are used. However, an existing panel may only require two, three or four weeks to train on the evaluation of pork after having evaluated beef using similar procedures. Training never ends. A panel leader must use verification and performance evaluation procedures to determine when panel retraining is needed.

Verification and performance evaluation of a sensory panel is an on-going, continuous process that identifies problems among individual panelists and identifies areas of further training requirements for the entire panel. The purpose of verification and performance are to determine consistency over time and to determine the ability of panelists to discriminate among samples. To accomplish this, select up to nine samples that vary in sensory attributes, but are within the testing parameters of the panel. Evaluate these samples in several sessions over several days. For example, each of the nine samples would be evaluated each day with the samples served in 3 sessions per day with 3 samples served per session. The nine samples would be presented to panelists over 4 days with the order of samples served randomized across sessions and order within session. The data can be analyzed by Analysis of Variance (ANOVA) where there are nine treatments and four observations per cell or the data can be analyzed as a two-way ANOVA where session and day effects also can be studied. From the ANOVA table, the F-ratio can be calculated as the Mean Square treatment divided by the Mean Square error. The larger the F-ratio, the more consistent a panelist is. A larger F-ratio means that a panelist has the ability to differentiate between samples and they evaluated the same sample similarly on each of the four days. Panelists should be retrained and reevaluated as needed.

The first step in evaluating the sensory properties of muscle foods is to determine the type of trained sensory panel needed to meet the objectives of the study. Two basic types of sensory panels are used in the evaluation of muscle foods -- difference and descriptive attribute testing.

Difference testing

Difference testing can be categorized into overall difference tests and attribute difference tests. Overall difference tests provide an avenue to evaluate if a sensory difference exists between samples whereas attribute difference tests ask if a specified attribute differs between samples. Commonly used overall difference tests are triangle tests, two-out-of-five test, duo-trio test, simple difference test, "A" - "not A" test, difference-from-control test, sequential test, and similarity tests. Attribute difference tests include directional difference test, pairwise ranking test, simple ranking tests, multisample difference test – rating approach, and multisample difference test -- BIB ranking test.

A triangle test involves presenting three coded samples (using three digit, random numbers) to the sensory panelist where one sample is different from the other two samples. The panelist is asked to identify the sample that is different. The number of correct responses is counted and the probability (the probability level has to be determined) that the sensory panelists can determine a difference is identified (see Meilgaard, Civille and Carr 1991 for statistical tables).

In a two-out-of-five test, sensory panelists are presented with five coded samples and are asked to identify the two samples that are similar. As with the triangle test, the number of correct responses is counted and the probability that the two samples differ is determined (see Meilgaard, Civille and Carr 1991 for statistical tables). The two-out-of-five test is very effective when sensory fatigue is not an issue. With meat samples sensory fatigue usually occurs fairly rapidly as meat samples consist of moderate levels of flavor attributes and lingering aftertastes can be apparent. Therefore, the two-out-of-five test is not commonly used to discriminate flavor differences between two meat samples.

The Duo-Trio test provides the sensory panelists a 1 in 2 chance of identifying the correct sample. The sensory panelists are given a reference sample to evaluate. Then two coded samples are presented and the sensory panelists are asked to identify the coded sample

Table 4. Sequencial steps during ballot developement of the descriptive flavor attributes for a pre-cooked pork roast containing a new ingredient.

Session	Session goal	Exercises Used in the Session
1	To familiarize panelists with the product being used in the study To initiate and stimulate identification of the flavor attributes in the product	1. Presentation of a baseline pre-cooked pork roast - stimulate discussion on the flavor attributes that can be identified
2	To continue initiation and stimulation of the flavor attributes in the product. To introduce one to two products that are variations from the baseline product	1. Presentation of the baseline product. Ask panelists to describe the flavor. Begin to narrow down the descriptors into categories that are similar between panelists and to get concensus on some attributes. 2. Begin using attributes that are being defined to evalu ate one or two products that are variations from the baseline. Continue to incourage and provide a free discussion of the attributes of the products.
3	Continue with identification of the flavor attributes in the product as in. Session 2. Introduce the baseline product and the new ingredient in its pure form and begin identifying the flavor attributes of the ingredient.	1. Present the baseline product. Ask panelists to describe the flavor. Utilize the descriptors identified in Session 2. Continue to fine tune these descriptors. 2. Examine one or two additional products that are variations from the baseline. Continue to discuss flavor descriptors, identifying new descriptors or altering existing descriptors. 3. Taste the new ingredient in its pure form. Begin identifying the flavor descriptors for the ingredient.
4	Repeat session 3 until panelists are familiar and comfortable with the attributes as defined.	Same as Session 3. Examine the new ingredient that is being used in the study
5	Identify references for the flavor descriptors being defined.	1. Present the baseline product. Review the current list of descriptors. 2. Introduce and examine baseline examples of each descriptor and begin anchoring the descriptor for each panelist.
6	Introduce scaling for each descriptor. current list of descriptors.	1. Present the baseline product. Review the 2. Utilize references of each descriptor to continue anchoring for panelists. 3. Introduce product with the varying concentrations of the ingredient and begin scaling with the descrip tors as defined. 4. Continue identification of alternate descriptors.
7	Development of a final ballot	1. Progressively continue sessions until a final ballot is defined and panelists are familiar with the descriptors and the scale.

that is the same as the reference. The correct number of replies is determined and the probability that the two samples are different is determined (see Meilgaard, Civille and Carr 1991 for statistical tables).

To conduct a Simple Difference Test, sensory panelists are given two samples and asked whether the samples are different or similar. Sensory panelist can be presented with either a single pair or any combination of the two pairs (1 then 2, 2 then 1, 1 then 1, or 2 then 2) for the two products being evaluated. The number of responses identified as the same and different are counted for matched and unmatched pairs, giving a total of four numbers. The placebo effect is compared to the treatment effect using x2-analysis. The x2-statistic is calculated by:

$$x2 = \sum \frac{(O - E)2}{E},$$

were O is the observed value and E is the expected number. The determined x2-value is compared to a x2 table at a probability of 0.05. If the calculated value is greater than the table value, a significant difference exists between the two samples.

The Difference-from-Control test determines if the sample(s) are different from the control and what the magnitude of the difference is in the test sample(s) from the control. Sensory panelists are presented with a control and the test sample(s). Then, they are asked to evaluate the difference in the test sample(s) from the control using a scale. The mean is calculated from the difference-from-control and the blind controls. A paired t-test can be used to compare the means if only one sample is compared, but if two or more samples are compared to the control, analysis of variance should be used to test for treatment differences.

Sequential tests are a method of utilizing difference tests (such as Triangle and Duo-Trio tests) while minimizing the number of evaluations needed to make a decision on the difference or similarity of two products. For example, utilizing the Triangle Test to determine if a prospective sensory panelist has the sensory acuity to be on a trained panel based on the number of correct responses was proposed by AMSA (1978). Similarity testing should be used to test if no perceivable differences exist between two samples, instead of testing if two samples are different. The Triangle, Duo-Trio, and Two-out-of-five tests can be used in Similarity testing.

The Directional Difference test is a paired comparison test that asks if sensory panelists can determine a difference in the intensity of an attribute. The correct number of responses is counted. If the null hypothesis is that the control differs from the treatment sample, the test is one-sided. Test for significance is the same as used for the duo-trio test. A two-sided directional difference test is defined when the null hypothesis asks which sample has a lower or higher intensity of the attribute of interest or which product is preferred.

Descriptive attribute testing

Descriptive attribute sensory evaluation is a method of quantifying specific sensory attributes of pork. A family of attributes, called a lexicon, describe the specific sensory attributes in pork that can be used to evaluate the development or change in these attributes. A lexicon of descriptive attributes can be developed for any pork product. Therefore, descriptive attribute sensory evaluation is very useful in identifying the sensory attributes of a product and then monitoring how each attribute is altered with treatment or time. The descriptive attributes of pork can be defined by a trained sensory panel through: 1) Ballot development sessions where a trained panel comes to a consensus as to the attributes of pork; 2) Established lexicons; or 3) Free profiling where individual trained panelists develop their own descriptors for a muscle food.

Meat Descriptive Analysis.

Meat descriptive analysis has been described and standardized by AMSA (1994) and are presented in Table 3. For whole-muscle meat products, the major descriptive attributes are juiciness, muscle fiber tenderness, connective tissue amount or chewiness in pork, overall tenderness (the combined effect of muscle fiber tenderness and connective tissue amount) and flavor intensity.

Juiciness is defined as the amount of perceived juice that is released from the product during mastication. Muscle fiber tenderness is the ease in which the muscle fiber fragments during mastication. Connective tissue amount or chewiness is the structural component of the muscle surrounding the muscle fiber that will not break down during mastication. The connective tissue component can be described as an initial popping during the first chews and the bubble-gum-like substance remaining after chewing and immediately prior to swallowing. Overall tenderness is the average of muscle fiber tenderness and

connective tissue amount when connective tissue amount is 6 or less. When connective tissue amount is a 7 or 8, overall tenderness is the same as muscle fiber tenderness. Flavor intensity should be defined as pork meat flavor. For the identification and training of sensory panelists in the detection of off-flavor characteristics, the following compounds can provide character references. Examples of off-flavor character references are: concentrated lemon juice for acid; cooked beef liver for liver; cooked beef blood or liver for metallic; cooked perch fillets or fish species having a strong fish-like aromatic; cooked meat stored for greater than one year that showed visible dehydration from freezer burn for old (freezer burnt); cooked turkey or beef patties stored in a refrigerator for 2 to 3 days for rancid; caffeine for bitter; and soured milk for sour. Quantification of flavor intensity using the Meat Descriptive Attribute method is not as sensitive as using the Spectrum Method for Descriptive Flavor Attributes, the Tragon Quantitative Descriptive Analysis Method, or the Free Profiling Method, but the Meat Descriptive Attribute Method provides an indication of the flavor differences between treatments. If a greater understanding of changes in specific flavor attributes is needed, one of the three aforemented methods would be the preferred sensory method.

For processed meat products, the aforementioned Meat Descriptive Attribute method can be used, but the ballot should be modified to reflect the characteristics of the product being tested. The Spectrum Method, the Quantitative Descriptive Analysis Method, or the Free-Choice Profiling Method are more commonly used for processed meats.

The Spectrum Method.

The Spectrum Method is a descriptive attribute method that uses a 0 to 15 point universal scale where 0 = none and 15 = extremely intense to evaluate the sensory attributes of muscle foods. The intensity ratings of the universal scale are anchored so that equal distance exists between points of the scale and intensity for a given point does not change across attributes. For example, a 2 on the universal scale equals the soda flavor in saltless saltine crackers; a 5 equals the apple flavor in Mott's apple sauce; a 7 on the universal scale equals the orange flavor in Minute Maid frozen orange juice; a 10 equals the grape flavor in Welch's grape juice; and a 12 equals the initial cinnamon flavor in Big Red Gum. The specific attributes of a product or the attributes of interest are identified either through ballot development sessions or using a standard lexicon. On the ballot the product attribute of "Other" should be included on the ballot. Panelists should be continually encouraged and given the opportunity to identify attributes that are detected in a product, but that are not listed on the lexicon. During training and ballot development sessions, products that represent the extremes, the average product and all possible variation should be presented to assure inclusion of all attributes on the ballot and assure familiarization of all products used in the study by panelists. As a study proceeds, unknown attributes may become apparent. If panelists do not have the opportunity or are not looking for other attributes, important information may not be recorded. Sample ballots used to evaluate the flavor attributes of cooked pork roasts containing sodium lactate and the flavor and texture attributes of low-fat ground pork patties are presented (Table 5 and 6, respectively). These data are analyzed using ANOVA and common mean separation techniques. Multivariate analysis of variance also can be used to examine the effect of combinations of attributes on treatments.

The Quantitative Descriptive Analysis Method.

The Quantitative Descriptive Analysis (QDA) Method was developed by the Tragon Corporation as a method to determine differences in sensory attributes of food products. From a large pool of trained panelists, panelists who can discriminate differences in sensory attributes of a specific product are selected. Panelists are trained similarly as described for descriptive panelists where the product and ingredient references are used to generate descriptive terms. The panel leader acts as a facilitator, not an instructor. In the QDA sensory method, a 15-cm line scale is used to quantitate each sensory attribute. Panelists are free to develop their own approach to scoring, scoring is not anchored as in the Spectrum Method. Panelists independently evaluate each product. Panelists do not discuss data, terminology, or samples after each taste session. The only feedback on performance relative to other panel members or on any differences between samples that a panelist will receive is from the panel leader. Data are entered into a computer, are analyzed statistically, and reported in graphic representation in the form of a "spider web"

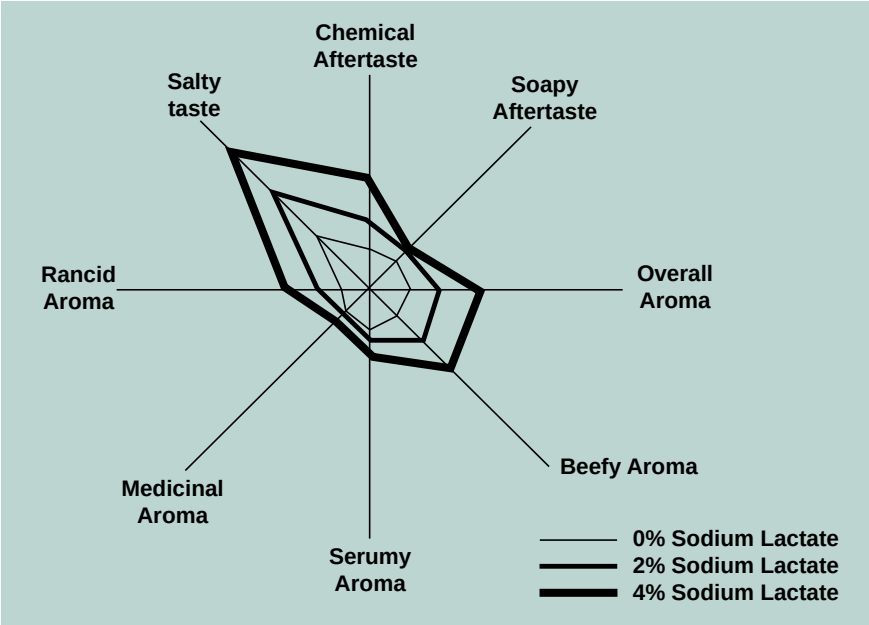
Table 5. A ballot used to evaluate the flavor attributes of cooked pork roasts containing sodium lactate when using the Spectrum Method for quantitating flavor attributes.

Week _____	Name _____			
Day _____	Date _____			
Sample Number	_____	_____	_____	_____
AROMATICS:				
Cooked Pork/Brothy	_____	_____	_____	_____
Cooked Pork Fat	_____	_____	_____	_____
Serumy/Bloody	_____	_____	_____	_____
Grainy	_____	_____	_____	_____
Cardboardy	_____	_____	_____	_____
Painty	_____	_____	_____	_____
Fishy	_____	_____	_____	_____
Livery/Organy	_____	_____	_____	_____
Soured	_____	_____	_____	_____
Medicinal	_____	_____	_____	_____
Other	_____	_____	_____	_____
FEELING FACTORS:	_____	_____	_____	_____
Metallic	_____	_____	_____	_____
Astringent	_____	_____	_____	_____
Throat Irritation	_____	_____	_____	_____
Chemical burn	_____	_____	_____	_____
BASIC TASTES:				
Salty	_____	_____	_____	_____
Sour	_____	_____	_____	_____
Bitter	_____	_____	_____	_____
AFTER TASTES:				
Metallic Aftertaste	_____	_____	_____	_____
Soapy Aftertaste	_____	_____	_____	_____
Other Aftertaste	_____	_____	_____	_____

Table 6. The ballot used to evaluate the flavor and texture attributes of low-fat, cooked ground pork patties using the Spectrum Method for quantitating texture and flavor attributes.

Week _____	Name _____			
Day _____	Date _____			
Sample Number	_____	_____	_____	_____
AROMATICS:				
Cooked Pork/Brothy	_____	_____	_____	_____
Cooked Pork Fat	_____	_____	_____	_____
Serumy/Bloody	_____	_____	_____	_____
Grainy	_____	_____	_____	_____
Cardboardy	_____	_____	_____	_____
Painty	_____	_____	_____	_____
Fishy	_____	_____	_____	_____
Livery/Organy	_____	_____	_____	_____
Soured	_____	_____	_____	_____
Browned	_____	_____	_____	_____
Burnt	_____	_____	_____	_____
Other	_____	_____	_____	_____
FEELING FACTORS:				
Metallic	_____	_____	_____	_____
Astringent	_____	_____	_____	_____
BASIC TASTES:				
Salty	_____	_____	_____	_____
Sour	_____	_____	_____	_____
Bitter	_____	_____	_____	_____
Sweet	_____	_____	_____	_____
TEXTURE:				
Springiness	_____	_____	_____	_____
Cohesiveness	_____	_____	_____	_____
Juiciness	_____	_____	_____	_____
Hardness	_____	_____	_____	_____
Denseness	_____	_____	_____	_____
Fracturability	_____	_____	_____	_____

Figure 1. An example of a spider-web graphic representation of sensory data generated from the Tragon Quantitative Descriptive Analysis Method of sensory evaluation.



where a branch from the center point in the spider web represents the intensity of that attribute (Figure 1.).

Free-Choice Profile Method.

In the Free-Choice Profiling Method, panelists are given the freedom to develop their own sensory descriptors for a product to use the sensory scale at their preferred range. This method eliminates the concerns of uniformly anchoring panelists to a scale and assuring that all panelists are using the scale in the same manner. Panelist training entails a short session where the sensory procedures are explained. Panelists are served the samples and they describe the sensory attributes. The sensory verdicts are analyzed using the Generalized Procrustes analysis. This method adjusts the data for how the panelists used different parts of the scale and it collates sensory terms that are similar. Sensory terms grouped as being similar then are evaluated by the sensory professional and the meaning or what was being descripted is determined. The advantages of this method are that sensory panelists have not been biased by training and are considered still "consumers" and the time required for training, panel performance evaluation and retaining are almost eliminated. However, the disadvantages are that the sensory professional plays a signficant role in interpreting the data and biases can be introduced into the results. Free-Choice Profiling is not commonly used in the sensory evaluation of pork, but it is currently used for sensory evaluation of other foods.

EVALUATION OF SENSORY CHARACTERISTICS USING CONSUMER SENSORY PANELS

While trained sesnory techniques provide data on differencs in sensory attributes of pork products, trained sensory analysis does not define consumer acceptance or preference. Many sensory programs use a combination of trained and consumer sensory evaluation. Consumer sensory evaluation provides information as to consumer's preferences and acceptance of pork products.

Major factors to be considered in the determination of consumer perceptions of sensory characteristics of foods are: 1) consumer evaluation is not a pure marketing test, it is an evaluation of the sensory properties of the muscle food (taste, smell, sight, feel or sound); 2) do not use trained descriptive attribute terms when conducting consumer sensory tests; consumer terms can be identified in focus groups; 3) strict attention must be given to ballot design and development; it is important that the sensory test examines consumer's sensory perception and not if the consumer can properly interpret your directions or questions; and 4) strict attention must be given to the project protocol that defines product handling, preparation and presentation.

The first decision for consumer sensory tests is whether the test will be an In-home or Central Location Test. 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 effect 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 sen-

sory 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 next step in designing a consumer sensory study is to: 1) determine the hypothesis to be tested; 2) define the protocol design; and 3) develop the ballot.

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, a measurement of like to dislike. 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 used. A clearly defined hypothesis states what is to be tested in the study. An example of a hypothesis would be that consumers can not detect a difference in flavor of pork from PSE meat versus normal pork.

After the hypothesis has been clarified, the protocol design needs to be defined. The protocol design includes how the samples used in the study will be obtained, handled, packaged, and presented to consumers. 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. The protocol design should define the sample preparation instructions in great detail. An example of a protocol design worksheet for a Central Location consumer test is presented in Table 7. These preparation instructions should include the amount of time required for cooking or preparation, the temperature of appliances used in meat preparation, the final cook temperature of the sample, if applicable, the materials to be used in preparation of the sample and in monitoring temperatures, and the measurements to be taken during cooking, preparation or serving. The equipment used in the preparation of the sample should be non-contaminated and compatible. Optimally, each treatment should be prepared using separate cooking materials or roasts from different treatments should be cooked on different pans or ground pork patties should be pan-fried in separate electric skillets across treatments. Separate utensils should be used to handle meat from different treatments or the utensils should be washed between uses and the washing procedure for the utensils should be defined. To assure consistent sample presentation, the serving temperature, holding time between cooking and serving, and whether samples will be served as a single sample or simultaneous should be defined in the sample protocol. The protocol design should define the order that the samples will be served. In Central Location Tests there is a strong first order bias, therefore, the serving order has to be randomize or blocked. The number of samples that consumers can evaluate in a session prior to the development of taste adaptation needs to be addressed. Samples should be identified with three digit random codes. The source of the samples should be identified and whether the samples are to be hand carried, shipped by mail, or shipped by truck to the central location. The test parameters need to be defined, such as how many samples will be in the test; how much sample variability is allowed; storage conditions; effects of storage on sample quality or presentation; the time of day that the study will be conducted; and if testing is under normal usage or extended usage conditions.

Factors related to consumer selection should also be included in the protocol design. For example, if consumers are going to be requested to not wear perfume, brush their teeth within 1 hour of evaluation, not smoke within 1 hour of evaluation, not wear lipstick, etc., then it should be defined in the protocol to assure consistent communication to all consumers. The protocol design should include the detailed orientation and instructions that will be given to consumers. The orientation and instructions should not include information that would bias consumer responses such as extensive details on what the objectives of the study are or what attributes are of major importance. The orientation and instructions should include the introduction of the moderator, approximately how much time will be required to conduct the study, how many samples will be presented, and any specific instructions concerning handling or evaluation of the product.

Table 7. Example of a protocol design for a Central Location consumer sensory test.

Research Samples

Sample Source (Lot, Production Considerations, Production Day, Raw Materials)_____

_____

Storage Conditions (Packaging, Temperature, Lighting) _____

Special Considerations _____

Sample Preparation

Portion size _____

Added Ingredients _____

Storage and Preparation Temperature of the Meat_____

Preparation Instructions _____

Holding Conditions (Length, Temperature, Holding Containers, Oven Model)

_____

Packaging and Containers _____

Special Instructions or Considerations _____

Sample Presentation to Consumers

Total Amount of Product Needed_____

Packaging and Method/Conditions of Transporation_____

_____

Containers and Utensils _____

Coding of Samples _____

Serving Size and Shape _____

Serving Temperature _____

Presentation Procedure _____

Order of Serving _____

Special Instructions _____

Consumers

Age _____

Sex_____

Product Usage (Light, Moderate or Heavy Users of Product)_____

Availability _____

Other _____

Adapted from Civille, Munoz and Chambers (1989).

The protocol design for In-Home Use Tests should include the aforementioned points on detailed orientation and instructions to consumers, the sample presentation protocol, the order that samples are to be consumed in the test, the number of samples to be consumed, the source of the samples, whether the samples are to be hand carried or ship by mail or truck to a central location, and how the samples will be delivered to consumers. In addition, recipe clarity, specific additives to be used, and any equipment for preparation should be provided, when needed. The orientation and instructions used to communicate to consumers by individuals delivering the product should be standardized to assure consistent communication to all consumers. Depending on the design of the study, a last order bias can be present in In-Home Use Tests. Randomization of the order to which samples will be consumed is needed to remove and/or control this effect.

Ballot Design

Defining the ballot or sensory instrument is critical as the ballot defines the independent variables that will be measured in the study. 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 affect 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.

Terminology development for acceptance and preference questions should not use trained panel attributes, but qualitative tests, such as focus groups or one-on-one consumer interviews, are the best way to define consumer attributes. Consumers may not understand what myofibrillar tenderness or connective tissue amount are, but they may understand what the tenderness of a meat sample is. Attributes other then those of primary interest should be included on the ballot. It is important that consumers do not know exactly what you are testing for, as in general, 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.

The type of scales used for questions on the ballot is the measurement tool for each attribute. There are many different scale types and styles (Table 8). 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, 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 directly related to input variables and they can be 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 can verbally anchored at any point along the scale. It is common for category scales to be anchored either at each point or at the end and center. 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, may not have enough points of discrimination, and it can be difficult to anchor all categories verbally. Linear scales are where a line is used 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 of scales used. Magnitude Estimation scales are where a control is provided which is identified as "0" or a defined intensity for an

Table 8. Examples of the styles and types scales used in consumer sensory evaluation.

Scale styles

1) Hedonic scales - measures acceptance

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

❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒

EXTREMELY TENDER — **NEUTRAL** — **EXTREMELY TOUGH**

Example of a 9-point, end-anchored, hedonic scale for like and dislike with a neutral point.

2) Just right scales - have a negative and positive pole from a central just-right point.
Please indicate your evaluation of the salty flavor in the product presented.

❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒

TOO LOW — **JUST RIGHT** — **TOO HIGH**

Example of a 7-point Just-Right Scale for salty flavor.

3) Intensity scales - measures the level or strength of an attribute.
Please rate how strong or intense the salty flavor is in the product presented.

❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒

NONE — **EXTREMELY INTENSE OR STRONG**

Examle of an 9-point, end-anchored intensity scale for salty flavor.

Scale types

1) Category scales

❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒

EXTREMELY TENDER — **NEUTRAL** — **EXTREMELY TOUGH**

Example of an 11-point, end and central anchored category scale for tenderness.

2) Linear scales

EXTREMELY TENDER I——————————————————I **EXTREMELY TOUGH**

Example of a 15 cm end-anchored linear scale for tenderness.

3) Magnitude Estimation scales

The first sample that you evaluated had a tenderness rating of 50. Rate the second sample for tenderness in proportion to 50.

First sample 50

Second sample _____

Adapted from Meilgaard, Civille, and Carr (1991).

attribute. The consumer is asked to evaluate the product and estimate the difference from the control and the sample. Magnitude estimation scales are not normally used in consumer sensory evaluation. 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 the data.

After the questions and the scales have been defined, the questionnaire design should be addressed. The ballot should have a simple structure, have a defined, logical order, and clarity of instructions and terminology should be considered. The ballot should use a uniform style of terms and scales, the terms should be related to sensory properties. The sequential format should be as follows: 1) Instructions; 2) Primary Questions; 3) Secondary Questions; 4) Questions should follow in sequence so that the attribute will be evaluated by hedonics and then diagnostic questions; 5) Open-ended questions; and 6) Other questions such as preference questions.

The general instructions should include: 1) follow the instructions of the test monitor; 2) do not read ahead; 3) do not communicate with others in the room; and 4) to ask the test monitor quietly if you have a question. Specific instructions should include: 1) the overall test objective; 2) that you are requesting their honest opinion and their cooperation; 3) instruction on how to respond to the words; 4) how to use the scales; and 5) how and when to handle, use, apply, or taste the product. An example of a consumer ballot is presented in Table 9.

Selection of consumers

The recruitment of sensory panelists is very important in a consumer sensory test. The age, geographic location (urban to rural, east/west; north/south), usage rate (whether they are light, medium, heavy users of the product), will individuals or families be included in the test, any specific usage types or styles, ethnic background, amount of exposure to like products, income level (usually not a big issue), and any special problems such as allergies, dentures, or medications that could interfere in the evaluation should be included in the consumer screening questionnaire. 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 can be used. A minimum of 50 to 100 panelists should be used 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, 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, in the National Consumer Retail Beef Study it was determined that consumers on the west coast were more concerned about the amount of fat contained in beef and were willing to sacrifice palatability (USDA Choice) for meat containing less fat (USDA Select); whereas consumers on the east coast in Philadelphia were more concerned with the palatability of the meat that they consumed (USDA Choice) and that they were willing to purchase meat with a higher fat content to assure palatability. 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 effective 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.

Table 9. Example of a Consumer Sensory Ballot used to evaluate cooked pork. The use of primary and secondary questions are in italics.

CONSUMER SENSORY EVALUATION BALLOT

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

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

❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒

LIKE **DISLIKE**

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

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

❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒

LIKE **DISLIKE**

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

3. Indicate by placing a mark in the box how you feel about the I**NTENSITY 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 **DISLIKE**

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.

❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒ ❒

TENDER **TOUGH**

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