PRODUCT MATCHING: A SENSORY EVALUATION CHALLENGE

By

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Bachelor of Science in Home Economics

Oklahoma State University

Stillwater, Oklahoma

1983

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
December, 1985

PRODUCT MATCHING: SENSORY

EVALUATION CHALLENGE

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PREFACE

An approved deviation from the standard thesis format will be followed in this thesis. Chapter Three will be written in the form of a journal article to be submitted to the Journal of Food Science.

In the first chapter, the basic purpose of the research is identified. The second chapter is a review of literature on sensory evaluation and its role in the food industry. Results are summarized and conclusions drawn in Chapter Four.

I would like to express my deepest appreciation to Dr. N. Sue Knight for her guidance as an advisor, professor and friend, throughout the course of this research and my college career. Appreciation is also expressed to my other committee member: Dr. Esther Winterfeldt, for her advice and support, and Dr. Larry Claypool, for his expertise in research design and statistical analyses.

Special thanks goes to my dedicated panelists, whom without I could not have conducted this study. Also, thanks is extended to Mr. Danny Head of Head Country Food Products for providing the materials and funding, and to Mr. Barry Bickle for his editing assistance.

Last but not least, I wish to give a very special thanks to my family: my husband Kevin, mother Joan, and in-laws R.L. and Ynona, for their love, support and encouragement during my education, to other family members and friends who lent a caring ear, and special thanks to my grandmother Rose, for her prayers and gentle guidance, which so influenced my life.

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CHAPTER I

INTRODUCTION

The world of sensory evaluation is a challenging one. Flavor not only affects our food selection, but the over-a-billion-dollar business of the food industry as well. Sensory evaluation is defined as "a scientific discipline used to evoke, measure, analyze, and interpret reactions to those characteristics of foods and materials as they are perceived by the senses of sight, small, taste, touch, and hearing (IFT Sensory Evaluation Division, 1981)." There are a variety of sensory testing procedures, each designed specifically to solve particular sensory problems. Flavor evaluation is used for product development, selection of new supply sources, quality control, storage stability, and product grading (Sneed, 1979). Economic conditions compel the food industry to develop more efficient, economical means of production in order to reduce costs and increase profits. Sensory testing can be used by the food industry to reduce cost without compromising quality.

There are three general categories of sensory tests. Preference tests measure which product is preferred or the acceptability of a product. Discrimination tests determine whether a difference exists between samples. When the nature and intensity of difference between products is in question, descriptive tests are used (Larmond, 1977).

A group of individuals function together as a sensory evaluation panel to acomplish a sensory task. A sensory evaluation panel is an analytical tool of which the value depends on the precision, objectivity, and reproducibility of judgements of the panel members (Larmond, 1977). Although sensory studies are of great importance to the food product developer, small industries often lack the expertise, facilities, and personnel to adequately train and conduct a taste panel and analyze the resulting data. Sensory evaluation in a university setting is an effective and useful alternative for product development for private industries that lack research facilities.

Purpose and Objectives

The purpose of this research is to demonstrate the effective use of a sensory panel, in a university setting, in the process of matching the flavor characteristics of a commercial catsup. Specific objectives are as follows:

1. Test the validity of the training procedures to be used for the product development process consisting of odor and flavor familiarization and acuity development.

To accomplish this objective panelists will be selected and trained to:

A. Identify standard solutions of the four basic tastes (ASTM, 1981).

B. Rank varying concentrations of standard basic taste solutions.

C. Identify 70% of presented food odors (ASTM, 1981).

D. Identify 75% of odors presented as an odor matching tests.

E. Rank a tomato paste-water-spice mixture in various levels of dilutions.

F. Perform Triangle Presence-Absence tests with a descriptive component on various catsup products.

2. Develop a combination of ingredients that will be very similar in flavor to a commercial catsup.

To accomplish this objective, panelist will:

A. Perform triangle tests on presented samples.

B. Perform Duo-Profile tests on presented samples.

3. Make recommendations for further research.

Hypotheses

The following hypotheses will be tested through this research:

Ho_1: In order to establish the validity of the taste panel methods as a product evaluation tool, there will be no significant differences among panelists' responses to ranking presented training samples for the following flavors: a) salt, b) vinegar, c) onion, d) garlic, e) mustard, f) paprika, g) celery, h) mace, i) black pepper, j) cloves, k) cinnamon, l) cumin, m) capsicum, and n) cornsyrup.

Ho_2: There will be no significant differences in the flavor characteristics between the product developed and the commercial catsup.

Assumptions

1. Sensory evaluation is useful in the process of product development and matching in a university setting.

2. Ingredient quality will remain stable throughout the product development process.

3. At least some of the spices selected for the training process, are those in the name brand product.

4. The panel selection process is valid and reliable.

5. Panelists will follow pre-testing guidelines identified by the researcher.

6. The design procedures are correct for the sample selection and research.

Limitations

1. The time available for research is limited.

2. No chemical analysis of the name brand product and the research product will be conducted for comparison purposes.

Definitions

Absolute Threshold: The lowest concentration of a substance or chemical that is recognizable to the senses (Sjostiom, 1972).

Acuity: The keenness of ability to detect and discriminate (ASTM, 1983).

Affective tests: Tests with the objective of evaluating preferences and/or acceptance of a product by consumers (IFT, 1981).

Analytical test: In sensory evaluation, laboratory evaluation of products in discrimination and descriptive terms; identifying differences or similarities, or identifying and quantifying sensory characteristics (IFT, 1981).

Aroma: Sensation perceived by the nose when an object is sniffed; (1) odors and (2) feeling factors such as cooling, burning, and pungency (Caul, 1957).

Basic Four Taste: Physiologists have shown taste buds are stimulated by these four tastes; sweet, sour, salty and bitter (Sjostion, 1972).

Carrier: Neutral soups, syrups, pectin jellies, crackers, frankfurters and other items that aid panelists in taste distinguishment and evaluation (Larmond, 1977, Heath, 1978).

Chemical Feeling Factors: Factors other than the basic four tastes such as astringence, cooling, bite, and burn (Sjostion, 1972).

Flavor: 1. A complex of sensations perceived with the ingestion of food or beverage (Heath, 1978). 2. The U.S. Society of Flavor Chemist defined flavor as a sensation resulting from properties of substances taken in the mouth which stimulate the senses of taste, smell, and tactile and temperature receptors in the mouth (Heath, 1978). 3. The sensations of taste, smell and feeling resulting from chemical stimulation of taste buds, olfactory organs, and feeling organs of the mouth, throat, and nose, when food is eaten (Sjostiom, 1972).

Intensity: A constant scale used for rating intenseness of a character note or characteristic (Caul, 1957).

Magnitude: The degree of intensity of a characteristic (ASTM, 1976).

Matching: An experimental process of equating stimulus to determine similarities and differences between a standard and an unknown (ASTM, 1983).

Optimization: A process of developing the best or most favorable product possible in its class (Sidel and Stone, 1983).

Perception: The awareness of the effect of stimuli (ASTM, 1983).

Preference: 1) an expression of the highest degree of liking; 2) the choice of one item over another; and/or 3) psychological continuum of pleasantness or unpleasantness which choices are based on (IFT, 1981).

Quality: The combination of characterists that differentiate among individual units of an item and have significance in determining the extent a product is accepted (ASTM, 1983).

Recognition Threshold: The lowest physical intensity at which a stimulus is correctly identified (ASTM, 1983).

Sensory Characteristic (Character Note): Individual taste or aroma properties perceived in a sample (Amerine, Pangborn, and Roessler, 1965).

Sensory Evaluation: A scientific technique used to measure, analyze, and interpret reaction to characteristics perceived by the senses of sight, smell, taste, touch, and hearing (IFT Sensory Evaluation Division, 1981).

Sensory/Taste/Attribute Panel: A group of persons representing a target population or specially selected and trained, for the purpose of conducting sensory evaluation tests (Amerine, Pangborn, and Roessler, 1965).

Standard Sample: A constant reference sample used for comparison with others (Amerine, Pangborn, and Roessler, 1965).

CHAPTER II

REVIEW OF LITERATURE

Overview

Sensory evaluation is a valuable tool available to the food industry for the purpose of product development, improvement, matching and grading; as well as process improvement, cost reduction, supply source maintenance, and quality assurance, and storage stability assessment (Sneed, 1977 and IFT Sensory Evaluation Division, 1981). The intent of this chapter is to establish a basic understanding and overview of sensory evaluation.

Consumer sensory impressions of food influence product selection and purchase. A goal of sensory evaluation is to accurately predict consumer preferences. It does this by:

1. Distinguishing between two or more samples in a defined way.

2. Establishing and characterizing, both qualitatively and quantitatively, any existing differences.

3. Ascertaining changes occurring after processing or during storage.

4. Establishing an acceptance standard.

5. Establishing quality assurance standards.

6. Ascertaining if the relative quality of a sample can be expressed as a numerical value.

7. Grading samples into prespecified classification systems.

8. Establishing relationships among instrumental and sensory data.

9. Establishing degrees of acceptability among sample (Heath, 1978).

According to Larmond (1977), sensory or flavor evaluation is a common experience to all persons, even though all may not realize it. When a new food is tested or the odor of bread baking is smelled, there is an immediate evaluation of what the senses are experiencing. A sensory 'experience' is an evaluation made by the senses of taste, smell, touch and hearing, resulting from a complex of interactions of food components, and evaluations can be conducted by one person or by many. Persons serving on a sensory panel are called sensory evaluation panelists. The two main types of panels are trained and untrained. Larmond divides panels further by including an additional separate category for the trained expert. Trained panels and experts can be used to evaluate quality for control purposes and to guide product development, matching, and improvement. Untrained or consumer panels are utilized to determine consumer reactions or acceptance to a product.

There are two classifications of sensory evaluation testing. They are analytical (objective) tests and affective tests (subjective) (Jellinek, 1964).

Sensory Evaluation and the Food Industry

Sensory evaluation has an important role in the fields of food science and food technology. The food industry is focusing substantial effort and resources on product improvement and new product development (Stone, 1971). This effort includes the use of sensory evaluation.

Prior to World War II, the food industry was only concerned with safety and economics, not flavor (Schutz, 1979). However, it became apparent that some foods were rejected no matter how nutritious or safe they were (Schutz, 1979). This stimulated more interest in sensory evaluation (Pangborn, 1964).

Currently, food companies are using sensory techniques extensively. Brandt and Arnold's (1971) survey of 62 major food companies showed that the most commonly used sensory methods of that time were the triangle test, hedonic scaling, and paired comparisons. The Institute of Food Technologist (IFT), through the journal Food Technology present symposia on sensory testing, provide guidelines for sensory research, and regularly publish sensory research results. Sensory evaluation methods have been used for product optimization, (Sidel and Stone, 1983 and Fishken, 1983); quality assurance (Reece, 1979, Nakayama and Wessman, 1979, and Wolfe, 1979); and shelf life determination (Dethmers, 1979). The American Society for Testing and Material (ASTM), provides a manual on the use of sensory evaluation for analyzing consumer acceptance and preferences (ASTM, 1979).

Statistical Considerations in Sensory Evaluation

The experimental design and the sensory techniques chosen determine proper statistical methods to be used and the reliability and validity of the results obtained. Determining the correct methodology depends on the specific test objective as summarized by Sidel and Stone (1971):

The major purpose of any sensory evaluation study is to provide information regarding the effect of certain experimental treatments upon a particular population. That effect usually is described as changes or differences in a response which are measured and then analyzed using one or more mathematical operations. The accuracy of information provided by the sensory study will depend upon selection of an appropriate experimental design and appropriate analysis.

After the testing is complete, statistical analysis of data obtained aid in drawing conclusions. This is why choosing the correct analysis method is essential. Prell summarized statistical methods used to analyze many different sensory techniques. See Table I. Other researchers who have provided valuable information in this area are O'Mahony, (1982), Ennis, Boelems, Haring, and Bowman, (1982), Henika, (1982), and Cochran and Cox, (1957). Amerine, Pangborn, and Roessler (1965) also provide extensive discussion of statistical procedures for sensory evaluation.

Types of Sensory Evaluation Methods

As stated previously, there are two classifications of sensory evaluation, analytical and affective. Table II is an outline of sensory evaluation methods. Analytical tests involve discrimination and descriptive evaluation. The purpose is to evaluate products "in terms of differences or similarities and for identification and quantification of sensory characteristics (IFT Sensory Evaluation Division, 1981)." Affective tests are subjective and are used to evaluate preference or acceptance of test products (IFT Sensory Evaluation Division, 1981).

Analytical Testing Methods

Panelists functioning in analytical tests are selected by interest and ability to discriminate between characteristics (IFT Sensory

TABLE I

A SUMMARY OF STATISTICAL METHODS USED FOR SENSORY TESTING

Method	No. of samples per test	Analysis of data
Single sample (monadic)	1	Analysis of variance
Paired comparison	2	Binomial distribution
Duo-trio	3 (2 identical, 1 different)	Binomial distribution
Triangle	3 (2 identical, 1 different)	Binomial distribution
Rank order	2-7	Rank analysis Analysis of variance
Rating-difference (scalar difference from control)	1-18 (the larger number only if mild-flavored or rated for texture only)	Analysis of variance Rank analysis
Quality rating (scalar scoring)	1-18 (the larger number only if mild-flavored or rated for texture only)	Analysis of variance Rank analysis
Hedonic (verbal or facial)	1-18 (the larger number only if mild-flavored or rated for texture only)	Analysis of variance Rank analysis
Flavor profile	1-5	Graphic presentation
Texture profile	1-5	Graphic presentation
Threshold	5-15	Sequential analysis
Dilution	5-15	Sequential analysis
Food action scale	1-18 (the larger number only if mild-flavored or rated for texture only)	Analysis of variance Rank analysis
Magnitude estimation	1-48	Analysis of variance Economic analysis Factor analysis Graphic presentation Regression analysis
Quantitative descriptive analysis	1-5	Analysis of variance Factor analysis Regression analysis

Adapted from: Prell, Food Technology, 1976, pp. 43

TABLE II

OUTLINE OF SENSORY
EVALUATION METHODS

Classification	Type	Classification	Type
Analytical		Affective	
Discriminative			
Difference	Triangle		Preference
	Paired Comparisons		Ranking
	Sheffe' Test		Rating
	Duo-trio		Hedonic Scales
	Ranking		Food Action Scales
	Scoring		
	Rating/Scalar Difference		
Sensitivity	Threshold		
	Dilution		
Descriptive			
Descriptive Analysis	Flavor Profile		
	Texture Profile		
	Quantitative Descriptive Analysis		
Attribute Rating	Category Scaling		
	Ratio Scaling		

Source: IFT Sensory Evaluation Division, 1981, pg. 53

Evaluation Division, 1981). Panel sizes vary from 20 to as few as five, depending on testing goals and panel type. Analytical or objective evaluation methods are either discriminative or descriptive.

Discriminative Testing

The goal of a discriminative test is to identify whether samples differ. This can be accomplished by the use of difference tests (triangle test, paried comparison, duo-trio test, ranking, scoring, and rating/scalar difference test) or by sensitivity tests (threshold, dilution). Discrimination tests are often used to develop new products, improve or match old ones, change production processes, reduce costs and select new supply sources, assess quality control and shelf-life, and select and train panelists (IFT Sensory Evaluation Division, 1981).

Difference Tests. Panelists conducting triangle tests are asked to identify the different sample when given three samples, two of which are identical. Control and experimental treatments are randomized to prevent bias due to repetition of coding pattern. The odds of selecting the different sample by chance are one in three (IFT Sensory Evaluation Division, 1981 and Larmond, 1977). Appendix A gives an example of a triangle test evaluation form.

In simple-paired comparison tests, two coded samples are presented for comparison. "Paired comparisons, oldest of the recognized psychometric methods, are based on the simple act of making a choice between two alternatives (ASTM, 1968)." The simplified design allows adaptation to many situations depending on the experimental objective. Panel judges could be asked which is tastier, which is softer, or which they prefer. The advantage of a paired comparison is its' independence from scoring systems, memory, or prior subjective responses (ASTM, 1968$_a$). Comparison tests can also be altered to allow multiple comparisons, where more than two samples are compared. However, care must be taken that all samples are compared with every other sample. Nagai and Moy (1985) used a multiple comparison test to determine the sensory qualities of oranges. A seven point scale was employed to compare pulp color and texture, outer appearance, outer texture, aroma, and flavor. When the size of a difference is in question, a Scheffe' paired comparison test is indicated (Larmond, 1977). Below is a sample Scheffe' test questionnaire.

TABLE III

QUESTIONNAIRE FOR SCHEFFE
PAIRED COMPARISON

NAME________________________DATE ________________

Examine these two samples of barbecued chicken for juiciness.

1. Indicate the degree of difference in juiciness between the two samples by checking one of the following statements

    846 is extremely more juicy than 165 ___
    846 is much more juicy than 165 ___
    846 is slightly more juicy than 165 ___
    no difference ___
    165 is slightly more juicy than 846 ___
    165 is much more juicy than 846 ___
    165 is extremely more juicy than 846 ___

2. Rate the juiciness of each sample.

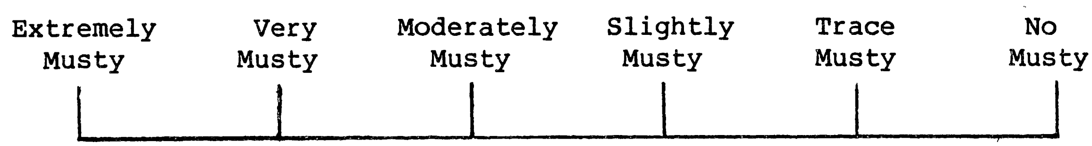
846	165
___ very dry	___ very dry
___ moderately dry	___ moderately dry
___ slightly dry	___ slightly dry
___ slightly juicy	___ slightly juicy
___ moderately juicy	___ moderately juicy
___ very juicy	___ very juicy

Comments:

Similar to triangle tests, Duo-trio tests involve the presentation of two samples, one identical with a standard sample. The standard is presented first, followed by the other two. Panelists are to identify which sample matches the standard. Applications are the same as the triangle test. It is helpful when strong flavors are being evaluated because few tastings are required (Larmond, 1977).

Ranking tests are extensions of the paired comparison tests, which involve presenting several samples to be ranked in order of intensity of some specified characteristic (IFT Sensory Evaluation Division, 1981). The number of samples presented at one time depends on the type of product being tested. For example, more samples of a sucrose solution could be tested at a time than solutions of tomato sauce and onion. Panelists might be asked to rank a group of samples in the order of preference, listing the most preferred first, and the least preferred last. This is an example of using ranking to learn consumer preferences. Ranking tests can be used for product development, storage stability, panel selection and training, and consumer preference testing (IFT Sensory Evaluation Division, 1981).

Because of its diversity, simplicity, and ease of statistical analysis, Scoring tests are used most frequently by food technologists (Amerine, Pangborn, and Roessler, 1965). Scoring attempts to determine the size and direction of intensity of differences between samples. A graduated scale with numerical or descriptive term intervals is used. Panelists must agree on specific meanings if descriptive terminology is utilized. Different scoring scales are described in detail by Amerine, Pangborn, and Roessler (1965). A numerical scale was used by Abo Gnah and Harris (1985) to score mustiness produced by Streptomyces griseus and Streptomyces odorifer. Panelists were asked to smell test samples and then score them in terms of degree of mustiness. Instead of a one to ten scale, one like below could have been adapted to form a descriptive term scale for the same study.



Scoring is effective when evaluating a single product characteristic (Larmond, 1977). It provides complete product information, but the scoring scale must be redesigned for each product. The test is particularly useful for quality control, product development, and quality index purposes.

Rating/Scalar Difference tests are very similar to scoring and measure perceived intensities of a specific characteristic or attribute. Intensity differences are measured by comparing samples with one or more control samples. Panelists are provided with a scale showing magnitude degrees (ASTM, 1968$_b$.). This method can also be considered an affective evaluation method when hedonic scaling is utilized. Applications are similar to paired comparisons, rank order (ASTM, 1968$_b$), and other types of descrimination testing. Additionally, this method can be used to correlate chemical, and physical measurements (IFT Sensory Evaluation Division, 1981).

Sensitivity Tests. A second category of descriminative tests are termed Sensitivity tests. The two basic forms are threshold and dilution tests.

Threshold tests are measurements of detection of a substance. The different types of threshold measurements are: detection or difference threshold, which is the awareness of a change, recognition or absolute threshold, which is the point where a stimulus is identifiable (IFT Sensory Evaluation Division, 1981 and ASTM, 1968_b). Panelists are presented samples randomly and asked if they are able to detect any difference from a control sample. According to the Sensory Evaluation Division of IFT, threshold determination is helpful in panel selection and training. Larmond disagrees with this. She suggests "sensitivity to primary tastes may not be related to ability to detect differences in foods" (Larmond, 1977).

Dilution tests are used to determine the smallest amount detectable of a test material when mixed with a standard (IFT Sensory Evaluation Division, 1981). A series of solutions of a test product are prepared in varying dilutions. Panelists are asked to identify the weakest concentration perceived (ASTM, 1968_b). This test can also be used to obtain threshold levels. Paired-comparison, triangle, and ranking tests can all be used as dilution tests to measure panelists' ability to detect concentration changes of a sample (IFT Sensory Evaluation Division, 1981). Dilution tests are useful for panel training and selection and the determination of minimum acceptance.

Descriptive Testing

The second division of analytical evaluation is composed of the descriptive tests. The purpose of descriptive methods is to provide a detailed, quantifiable analysis of a product characteristic or the product as a whole (IFT Sensory Evaluation Division, 1981). Two categories of descriptive tests exist. They are descriptive analysis and attribute rating.

Descriptive Analysis. This type of descriptive testing includes flavor profile, texture profile, and quantitative descriptive analysis.

The flavor profile method was first developed by Arthur D. Little Company. "The flavor profile was founded on the natural process of evaluating and comparing flavors by describing their impressions---either as a whole or individual characteristics" (Caul, 1957). This method of sensory evaluation is used to describe aroma and flavor characteristics of food products. It can provide a complete description of a sample, demonstrate differences among sample groups, or identify a specific character note, such as an off-flavor. Intensity changes of certain qualities can also be shown (ASTM, 1968_b). Flavor profile panelists are trained but unspecialized and have normal taste and smell abilities. Panel sessions begin with the panelists individually examining a sample and recording their results. After panelists have done this, an open session is held with a group discussion of individual findings. The panel as a whole then develops one final profile for the test product. A profile consists of descriptive terms and corresponding quantitative intensity values. Table IV provides an example of a profile analysis.

TABLE IV

EXAMPLE OF A FLAVOR PROFILE
ANALYSIS OF CATSUP

	Components	Intensities
Aroma:	sour	3
	cinnamon	)(
	clove	2
	sweet	1
	pepper	)(
Flavor:	smooth	3
	sour	3,4
	sweet	2
	salty	1
	burning	)(
Aftertaste:	sour	2
	burning	)(

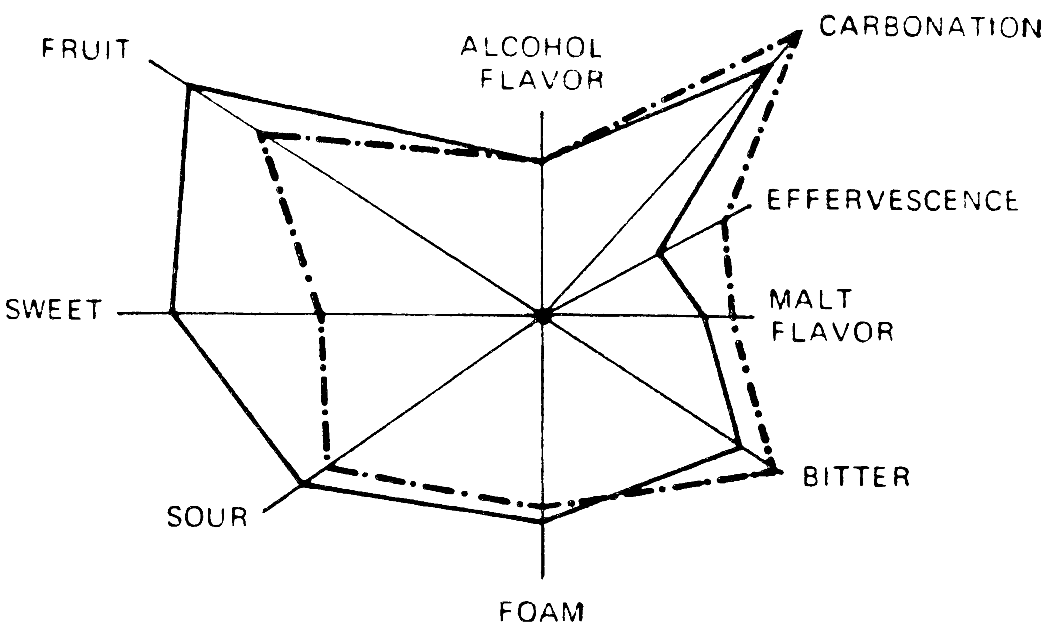
)(=threshold or very weak, 1=weak, 2=medium, 3=strong, 4=very strong

Source: Jellinek, 1964 pg. 237.

Texture profile is similar to flavor profile, except it is an attempt to measure texture and mouthfeel of a product. "It provides a systematic approach to measuring the textural dimensions of food in terms of its mechanical, geometrical, fat, and moisture characteristic; the degree to which each is present; and the order in which they appear from first bite through masticatory and residual phases" (IFT Sensory Evaluation Division, 1981).

Quantitative descriptive analysis identifies and quantifies in order of occurrence, a product or ingredients' sensory properties

(Stone, Sidel, Oliver, Woolsey, and Singleton, 1974). An unstructured category scale is used to obtain repeated judgements of a test sample (IFT Sensory Evaluation Division, 1981). Developed at the Stanford Research Institute (Stone, Sidel, Oliver, Woolsey, and Singleton, 1974), it like the flavor and texture profiles, reflects graphic representation depicting the evaluated characteristics (IFT Sensory Evaluation Division, 1981).



Source: Stone, Sidel, Oliver, Woolsey, and Singleton, 1974, pg. 32.

Figure 1. Quantitative Descriptive Analysis of Two Competitive Products

Applications are also the same as the flavor and texture profiling methods (IFT Sensory Evaluation Division, 1981).

Attribute Rating. Attribute rating is the second type of descriptive analytical sensory evaluation. Its general purpose is to identify the dimensions to be evaluated and then determine their intensities (ASTM, 1968_b). Attribute rating methods involve category scaling and ratio scaling.

Category scaling uses a structured or unstructured limited scale consisting of a series of phrases in ascending or descending order of intensity (ASTM, 1968_b and IFT Sensory Evaluation Division, 1981). Coded samples are simultaneously presented to measure a specific attribute, such as sweetness, flakiness, or sourness. This method is rarely used for single sample evaluation. Successive digits are assigned to each point on the scale, beginning with the end representing a zero intensity, for the purpose of analysis (IFT Sensory Evaluation Division, 1981). Below are examples of structure and unstructured limited scales which might be used during a categoring scaling tests. An unlimited scale is one with open or unspecified ends.

Structured Scale

Extremely hard	Very hard	Moderately hard	Slightly hard	Slightly soft	Very soft	Moderately soft

Unstructured Scale

Extremely hard | Extremely soft

1 2 3 4 5 6 7 8 9 10

(Adapted from Amerine, Pangborn, and Roessler, 1965, pg. 360.)

Category scaling provides information on the magnitude of differences, whereas ratio scaling provides the ratios of the differences as well (Moskowitz, 1974). Also known as magnitude estimation, ratio scaling attempts to estimate the relationship among physical and sensory magnitudes (IFT Sensory Evaluation Division, 1981). An example of magnitude estimation is when panelists are asked to give a specific score to the first test sample. The second sample is given a ratio score. If saltiness is the variable being judged and sample two is twice as salty as the first, it would be given a score twice that of the first. The scale used is open ended, that is it has "no arbitarily limited endpoints" (Moskowitz, 1974). Scaling methods are used for new product development, product matching, product improvement, process change, cost reduction and new supply source selection, quality control, storage stability, product grading, and correlation of sensory, chemical, and physical measurements (IFT Sensory Evaluation Division, 1981).

Affective Testing Methods

As previously mentioned, affective testing is subjective. The purpose is to determine consumer preferences and acceptance of a product, whereas preference tests identify consumer likes and dislikes. Both estimates are useful since one can like a product but have other reasons for not using it (Campbell, Penfield, and Griswold, 1979). Panelists serving on affective taste panels are untrained and selected randomly. Their purpose is to be a representative population. Panel size varies, but the IFT sensory evaluation guidelines suggests 50 to 100 panelists is often adequate (IFT Sensory Evaluation Division, 1981). Affective preference/acceptance testing can utilize a variety of test methods. This type of testing is much more relaxed in setting and structure than analytical methods. Affective evaluation includes ranking, paired-comparisons, and rating.

Preference Tests

"Preference testing refers to all affective tests based on a measurement of preference, or a measure from which relative preference may be determined, e.g., pleasure-displeasure, like-dislike" (IFT Sensory Evaluation Division, 1981). Panelists are asked which sample they prefer, and are sometimes also instructed to rank them.

Ranking Tests

When ranking tests are used for affective testing, panelists rank samples in order of preference or acceptance. The number of samples presented at a time depends on product type and testing factors such as panelists' attention span (IFT Sensory Evaluation Division, 1981).

Instead of only identifying a preference between samples, ranking tests also ask order to be specified, such as most desirable to least desirable.

Rating Tests

Rating methods reflect perceptions or opinions of a sample or sample attribute under a given set of conditions (IFT Sensory Evaluation Division, 1981). Different rating scales are applicable for subjective evaluation. One of these, the Hedonic rating scale can employ numerical, non-numerical facial, or descriptive term scales. When using the facial hedonic scale, the panel members are asked to identify the facial expression, such as a smiley face, which best reflects their opinion. For example, if the salty flavor of a catsup was being evaluated and a panelist preferred sample three they would check the smiley face on sample three. Table V depicts this example.

TABLE V

AN EXAMPLE OF A HEDONIC SCALE USING FACIAL EXPRESSIONS

Check the facial expression which best describes your opinion for each sample.

Sample

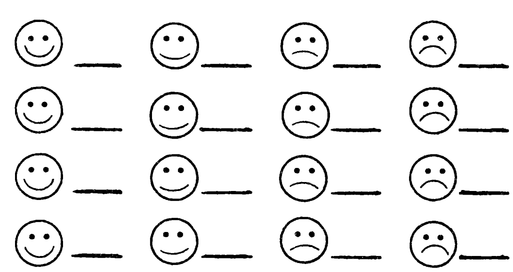
1

2

3

4

Saltiness



Another rating test is the Food Action Rating Scale, which does not measure specific perceptions of a test sample, but examines the attitude toward it (IFT Sensory Evaluation Division, 1981). Panelists select the statement which best matches their feelings toward the sample ranging from, 'I would always buy this product' to 'I would never buy this product'. Affective tests can be used for new product development, product matching, product improvement, process change, new supply source selection, storage stability, consumer acceptance and consumer preference (IFT Sensory Evaluation Division, 1981).

Preparing for Sensory Testing

Elimination of distractions is the key goal in preparing for a sensory evaluation test. Odors, noises, testing utensils, and panelist seating arrangement are influencing factors, because they can influence a panelist's response. For instance, distracting odors and noises may result in a panelist making hurried decisions; eating utensils can possess a distracting flavor; and the seating arrangements might allow one panelist to observe other's actions. The testing technique used also influences results. The technique adopted for a particular evaluation depends on the nature of the sample and complexity of information desired (Heath, 1978). These factors are in turn affected by the existing facilities, manpower, and budget. While a large corporation may have a sensory evaluation room especially built for testing, a small company may adapt a corner of a room for this purpose. Either way, precautions can be taken to minimize bias and increase evaluation validity.

Physical Considerations

Physical considerations include location, layout, odor control, temperature, and general atmosphere. The site should be accessible to panelists. It should not be located near an odor source like a cafeteria or the production area. Efficient test area layout provides separate preparation and presentation areas (ASTM, 1968_b). Partitioned booths are used to avoid distraction and ensure independence of judgements among panel members because bias can be communicated verbally or by non-verbal expressions. These influences are well described by Foster et al. (1955).

A constant humidity around 62 percent and temperature of about $70^{o}F$ is recommended for testing (Amerine, Pangborn, and Roessler, 1965 and Caul, 1957). Other temperature factors such as air flow and purity have been identified by Helm and Trolle (1946), and Laue, Ishler, and Bullman, (1954). Ideally, the testing area should be clean, neutral colored, well lighted, noiseless, free from vibrations or distracting odors, and provide comfortable seating (Caul, 1957, and Skelton, 1984).

Sample Preparation and Presentation

As with the test environment, sample preparation and serving methods have control factors also. Samples must not be prepared in front of panelist nor in the testing area, because presentation sights, sound, and odors can influence judgments. Samples should be served in an identical manner. Utensils should be the same size, shape, color, and impart no odors or taste (Bengtsson and Helm, 1946, Boggs and Hanson, 1949, Cartwright, et al. 1952). Colorless or white containers preferably made of glass are suggested (Larmond, 1977). The sample amount presented is also important as panelists should receive equal portions of each sample. The amount depends on the quantity of sample available, type of sample and preparation difficulty. A one-half serving of a liquid and a one ounce serving of a solid are usually adequate (ASTM, 1968_b). Sather and Calvin (1960), Ehrenberg and Shewan (1960), and Boggs and Hanson (1949) researched the effects of the number of samples presented at a setting on panel results. They concluded that the number of samples presented at a time affects test results, since too many samples can cause taste fatigue. However, the type of product tested also affects the number of samples that can be presented. Sather and Calvin found panelists' discrimination abilities of tomato juice improved after five samples. Their results corroborates other research reporting a warm-up session is helpful. As many as twenty samples were presented at a time with no reductions in discriminatory preference ability (Sather and Calvin, 1960). While Bliss, et al. (1953) and Filipello (1957) found no effects from presentation order, Klemmer (1968) disagreed. He was the first to identify contrast effect. This occurs when a high quality sample precedes a low quality sample and results in a lower rating for the second sample than it would normally received (Larmond, 1977). Sample randomization can be used to equalize contrast effect and other similar types of bias. Bias and other influencing factors will be discussed later. One way of randomizing is by using a table of random numbers. Three-digit numbers randomly identified are recommended to use as sample codes (Larmond, 1977). This way panelists are unable to associate a quality rating with any particular sample. If a code 'A' was used, a panelist may associate it with the best or first in an order.

The time of day a sensory test is held is important. Late-morning (10 to 11 a.m.) and mid-afternoon (2 to 3 p.m.) sessions are the best times for testing (Larmond, 1977). A taste panel session should not be conducted when panelists have fasted, just eaten, or are fatigued. A test item should be served at the temperature that item is normally eaten. Recommended temperatures for hot food is 60° to 66°C, ice cream is -1° to 2°C, and other food 4° to 10°C (Larmond, 1977). Other specific temperatures for different foods are suggested by Caul (1957) and the Sensory Evaluation Committee of ASTM (1968_b).

Influencing Factors

Other factors can affect sensory test results and must be controlled. These include expectation error, stimulus error, logical error, halo effect, suggestion, motivation, contract effect, and positional bias. Expectation error simply means a panelist will find what they expect to find. Results are based on preconceived impressions (Larmond, 1977). Random coding and providing panelists with only the needed information prior to testing can reduce this form of error. Stimulus error occurs when a panelist uses irrelevant characteristics, such as size, color, or firmness, in determining a judgement. Uniformity of samples eliminates stimulus error (Larmond, 1977). Logical error is rating a characteristic because it appears to be logically associated with another characteristic (Larmond, 1977), as when an off color of a food is associated with a bad flavor. Sample uniformity and masking color differences aid in controlling logical errors. The halo effect occurs when multiple characteristics are evaluated at once and one shadows the other. An overall high impression of a product can cause a panelist to also rate specific characteristics, such as odor or texture, high as well. Evaluating one characteristic at a time eliminates this effect (Larmond, 1977). When one judge's reaction influences another, suggestion occurs. This is why separate tasting booths are used and panelists are instructed to avoid verbal expression. Maintaining panelist motivation is essential to the quality of judgements. Lack of motivation produces "hasty, careless testing, apparently poor discrimination, and lessened willingness to participate" (ASTM, 1968_b). Motivation is kept high by having a well organized and administered test with a relaxed atmosphere and by maintaining good interpersonal relationship between the investigator and the panel judges (Pangborn and Dunkley, 1964). Feed back information such as posting test results increases performance and decreases training time (Pfaffman, Schlosber, and Cornsweet, 1954). Reward systems like providing refreshments or monetary rewards aid in maintaining judges interest also. The level of training affects motivation. Research indicates trained panelists are generally more motivated than untrained ones (Ellis, 1967).

Panel Selection and Training

Meticulous procedures should be followed when selecting and training sensory evaluators.

> The use of panelists as measuring devices is analogous to the use of any scientific instrument to elicit measurements of specific parameter of products under study. The instrument is selected for its capability of providing the desired measurements as accurately and consistently as possible. Instruments must be calibrated to give standardized measurements that can be universally reproduced and interpreted (ASTM, 1981).

The selection process identifies panelists and their individual abilities, whereas panel training develops and sharpens those abilities. These processes are vital for effective analytical sensory panels, but affective or consumer testing often has no specific selection or training procedures.

Selection Processes

Panel selection involves recruitment, interview, and screening. Panel recruitment may be conducted in numerous ways. Panelists can be obtained from within an organization or outside. Many companies select and train their own employees, while in a university setting panelists are selected from students, faculty, and staff. Consumer panelists are usually randomly selected from a target population. Recruitment tactics include advertisements, personal contacts, seminars, and questionnaires. The ASTM offers seven recruitment criteria. The first is interest. If a panelist is not interested in the test product and sensory evaluation, motivation is poor. A second criterion is availability. The time commitment must be spelled out before hand, stressing at least an 80 percent attendance record (ASTM, 1981). Promptness is the third criterion, because tardiness results in loss of time, money, and experimental design integrity. Reminder notices are helpful. The fourth criterion is health. Panelists must be in good physical and emotional health, free from allergies, colds, and fatigue (Larmond, 1977). Articulateness, a fifth criterion identified by ASTM is more important for descriptive testing since verbal communication of defining and describing characteristics are required. Attitude toward the test product is another criterion. Panelists should like the type of foods they are testing. The last criterion identified is a group listed as other factors. These factors are employment, education, work experience, past sensory experience, age, smoking, and sex. Krum (1955) recommended panel members be between the ages of 20 and 50 years because he believes sensory ability decreases with age. Amerine, Pangborn, and Roessler (1956) provide discussion on these factors and other. Larmond (1977) states emotional factors, interest, and motivation are more important than the factors of age and sex.

Interviewing prospective panelists identifies health factors, interests, and motivation. Discussion on the demands and requirements of being a sensory evaluation judge should be included with the interview. The quality and usefulness of this information depends on the interviewer and the type of evaluation conducted. Some information may be of little value due to conflicting reports on the effects of the factors (age, smoking habit, etc.) identified by interviews on taste testing (Amerine, Pangborn, and Roessler, 1965). The interview should be organized, conducted in a relaxed atmosphere, and follow logical order (ASTM, 1981).

Screening is the final step in panel selection. Procedures vary depending on the testing method and the product being tested. The basic objective of screening is to select prospective panelists meeting minimal qualifications: 1) normal sensory acuity, 2) interest in sensory evaluation, 3) ability to discriminate and reproduce results, and 4) process proper panel behavior (ASTM, 1981). Caul (1957) identifies normal taste-smell abilities, interest, and intellectual integrity for panel membership.

Discrimination Test Screening

Discrimination test panelists are screened for their ability to perceive differences.

> "The philosophy of selection judges with superior discrimination abilities is justified on an economic basis. That is, if a panel of judges screened for a particular acuity, and therefore capable of finding small differences, does not find a significant difference between products on the dimension in question, it is highly unlikely that the average consumer will do so" (Bressan and Behling, 1977).

The following are screening guidelines for discrimination tests according to ASTM:

1. Screen two to three times more panelists than required.
2. Use a product similar to the one to be tested.
3. Use similar test methods to those to be used during actual testing to allow panelists to become familiar with procedures.
4. Progressively vary the difficulty of the screening tests.
5. Thoroughly explain test methods and score sheets.
6. Establish reproducibility by repeating tests.

Triangle tests are often used as screening tests for discrimination testing. The group of prospective panelists should not score above 80 percent, while individuals scoring less than 60 percent should not be retained (ASTM, 1968_b and ASTM, 1981).

Descriptive Test Screening

Screening for descriptive tests also depends on the type of test conducted. For example a flavor profile panelist would be selected on a different basis than a texture profile panelist. Recommended screening tests are basic taste recognition, odor identification, intensity rankings and evaluation of individual textural properties (ASTM, 1981). Persons should identify 100 percent of the four tastes (sweet, sour, salty, and bitter) and score a 70 percent on the odor identification test (ASTM, 1981). Zook and Wessman (1977) suggest between 65 and 75 percent correct identification is adequate.

Training Procedures

Training establishes panel validity and reliability if carefully designed and carried out. Often training is an extension of the screening process and should be continuous throughout the evaluation period. Training is designed to familiarize panelists with test procedures, improve individual sensory abilities, improve sensitivity and taste memory, and to standardize sensory values which are reproducible (ASTM, 1981). Harper (1955) defined training as the "steps which may be taken deliberately to increase the effectiveness and the rate at which the individual assimilates new knowledge or new techniques." As with panel selection, training procedure chosen depends on the type of test being conducted. Panelists should be trained on the actual tests to be used and with products of a similar class. Panelists must become familiar with testing methods and trained to disregard any personal preferences as well as agree upon exact meanings of descriptive terms for descriptive tests (Larmond, 1977). Guidelines for training panels, both affective and analytical methods, are provided by ASTM (1981). They suggest including orientation, practice, and training steps. Arthur D. Little, Inc., known for the development of the flavor profile method, has an extensive six phase training program which spans a 12 month period (Sjostiom, 1972). The steps are: 1) selection of trainees, 2) basic course of instruction, 3) basic work program, 4) advance course of instruction, 5) advanced work program, and 6) post-instructional guidance.

Pretesting Instructions

Pretesting instructions provide last minute information vital for panelists, as it applies to any testing method. If not adhered to, results will be affected. Examples of basic pretesting instructions follows.

Panelists should not eat in the hour prior to testing and should be instructed not to smoke, chew gum, or drink anything except water, within 30 minutes of testing. Panel members who are ill, especially with a cold or sinus problem, should excuse themselves from tasting. As a general rule panelists need to rinse out their mouths with water before testing. Each type of test may deviate slightly from these guidelines, depending on test item. Amerine, Pangborn, and Roessler (1965) discuss the need for providing pretesting instructions and the depth of information required by panelists. Appendix B is a sample of a pretesting instructions manual.

CHAPTER III

PRODUCT DEVELOPMENT BY SENSORY EVALUATION IN A UNIVERSITY SETTING

Introduction

The economic climate has sparked competition in the food industry to develop more efficient, economic means of production in order to reduce cost and increase profits. Sensory evaluation plays a role in this competition. More effort and resources are being focused on product development and improvement today than ever before (Stone, 1971, and Brandt and Arnold, 1971). Sensory techniques, along with chemical analyses, are being used by large corporations to aid in cost reduction without compromising quality (Sinclair, 1984). However, small industries often lack the expertise, facilities, and staff to adequately train personnel and conduct sensory testing. For these companies, a university setting can be used as an effective product development tool. In this study, a small barbeque sauce company wanted to reduce production costs by producing its own catsup base rather than purchasing a commercial one. To accomplish this without altering the flavor of the barbecue sauce, the flavor of the catsup base developed needed to be very similar to that of the commercial catsup. Because of the multiplicity of flavor notes in catsup, the commonly used triangle test, hedonic scaling test, or comparison test (Brandt and Arnold, 1971), did not fit the unique circumstances of this study. Therefore, variations of the standard tests were developed to aid with the product development. Table I provides an outline of the research phases.

The objectives of this investigation were to demonstrate the effective use of a sensory evaluation panel in a university setting in the process of product development by matching the flavor characteristics of a commercial catsup; and to test the validity of the training procedures used for the product development process.

Methods and Materials

Tomato paste, vinegar, sugar and spices were provided by the barbecue sauce manufacturer in quantities sufficient for the entire study and were stored separately in storage facilities identified for research only. The sensory testing was conducted in a controlled sensory environment at Oklahoma State University.

Selection Process

Panel selection included gathering approximately 15 persons interested in sensory evaluation research. These prospective panelists were chosen from university faculty, staff and students, and local residents. The Basic Four Taste Identification and the Basic Ranking and Odor Identification tests were conducted following the American Society for Testing and Materials (ASTM) procedures to evaluate propsective judges' taste and odor acquity (ASTM, 1968_b and ASTM, 1981). The odor test, in addition to the more commonly used odors, included spices and condiments often found in catsup. (See Appendix D for a listing of odors used.) Final product testing was completed with eleven panelists.

Panel Training

Following the selection process, the panelists underwent training. The objective of the panel training was to 'teach' specific flavors and odors commonly found in catsup in varying concentrations and to determine panel validity. Panel training methods employed were odor matching tests, ranking tests, and triangle presence/absence (TP/A) tests especially designed for this study.

The odor matching test was designed to help panelists become familiar with the specific odor components of catsup. Panelists matched a coded sample to the correct odor listed. An odor matching form is in Appendix A with a discussion of procedures in Appendix D. In the ranking test, panel judges ranked tomato paste and water mixtures with varying levels of a single spice or flavoring. The individual spices and flavorings used were salt, vinegar, onion, garlic, mustard, paprika, celery, cumin, capsicum, and cornsyrup. A sample test form is also in Appendix A.

The triangle presence/absence (TP/A) test was conducted using a tomato catsup product. Similar to a regular triangle test, the TP/A test differs in that panelists not only identify the odd sample, but also identify or describe the difference. The test is termed TP/A test, because each test included two variations of catsup, one of which was formulated with a missing ingredient. It was repeated with ten different missing ingredients. Its purpose was to develop panelists' taste acuity for each recipe ingredient and the flavor that ingredient imparted on the final formula. Appendix D contains a detailed description of the TP/A test. The form used was the standard triangle test form, which can be seen in Appendix A.

Development Process

To develop a catsup similar in flavor characteristics to the commercial catsup, a triangle test was used and a form of quantitative descriptive analysis, termed Duo-Profile, was developed. The triangle test following standard procedures (ASTM, 1968_b and Larmond, 1977) was used to guide recipe alteration during the product development phase.

In the Duo-Profile test, panelists rated a reference catsup and an experimental product concurrently. For instance, for the variable sweetness, panelists ranked two coded samples, R and Q, on an unstructured 10 centimeter hedonic scale. Panel members compared the samples by placing a vertical line across the horizontal scale at the point best describing the flavor note perceived. The purpose of the test was to access similarities and differences between two samples. The twelve flavor variables rated were tomatoe flavor, sweetness, saltiness, tartness, burning flavor, overall spice flavor, onion, garlic, celery, pepper, mustard and mace. See Table II. Appendix A contains sample test forms.

Research Design

A Freidmans test was used to determine any significant difference among panelists' responses to ranking flavor characteristics in the training samples presented (Steel and Torrie, 1980). After the Freidmans test indicated the difference, a Least Significant Difference (LSD) test demonstrated if the intensity levels were ordered correctly, from most concentrated to least. Flavor characteristics used were salt, vinegar, onion, garlic, mustard, paprika, celery, mace, black pepper, cloves, cinnamon, cumin, capsicum, and cornsyrup. A different design was used during the product development phase. The experimental design for the Duo-Profile test was a randomized complete block with two treatments, the developed product and the commercial one, with each panelist serving as a block. Hence a paired t-test was used (Sidel and Stone, 1976). Flavor notes identified for the profiling were tomato, sweet, salty, tart, burn, overall spice, onion, garlic, celery, mustard, and mace.

Results and Discussion

The selection process yielded twelve panelists, nine females and three males, ranging in age from 24 to 56 years. One panelist dropped out before testing was completed. Of the training processes, only the flavor ranking tests data were analyzed in support of the research objectives. However, the results of the odor tests are discussed in Appendix D. In the ranking tests where panelists were asked to rank four different levels of a single flavor added to a tomato base, the mean panel results showed that the panel correctly ranked salt, celery, black pepper, cloves, and cinnamon. For the flavors onion, garlic, and mace, mean values were ordered correctly but not significantly for all levels, indicating that some panelists were unable to discriminate among the levels, particularly lower levels. For vinegar, mustard, paprika, cumin, capsicum, and cornsyrup there was less ability to rank the various levels. The panel was able to identify the strongest concentration levels of all the variables except for vinegar and cornsyrup. See Table III.

Triangle tests were utilized to alter the recipe proportions during the development phase. Table IV reflects how the recipe was changed after each triangle test. When the test product became closer to the commercial one, the Duo-Profile test, which compares two products' individual flavor characteristics, was used to fine tune the recipe. Probability values for the Duo-Profile test are listed in Table V. Duo-Profiles one and two were conducted on the same recipe variation at the same evaluation session. Both tests contrasted the same experimental formulation with the commercial catsup, with more variability being seen among panelist's ratings on the second Duo-Profile. These differences could be due to taste fatigue since the Duo-Profile test is quite lengthly as compared to most sensory tests. Duo-Profile four demonstrates no significant differences between the developed catsup and the commercial one. It is important to note that only the flavor characteristics were matched. Color, consistency and mouthfeel factors were not considered.

Conclusions

During the training process the ranking test, where individual catsup seasonings were ranked in a tomato base, was shown to be an effective way of developing panel taste familiarization and acuity. A new method of assessing similarities and differences between two samples termed the Duo-Profile test was developed. Results of this study indicate the Duo-Profile test can be used as a flavor matching procedure.

A variation of the triangle test, termed Triangle P/A test was developed to acquaint panelists with the effect of the removal of a single flavor on the product. This appeared to be a worthwhile training tool. However since only limited work was done using this test, a true measurement of its effectiveness was not determined.

Also it can be concluded that a sensory evaluation panel in a university setting can be an effective product development tool for the small food manufacturer, and the training procedures used were determined to be valid. With the current competitive economic climate the small manufacturer can look to universities to aid with their research and development needs.

TABLE I

AN OUTLINE OF THE RESEARCH PHASES

Phase	Test	Source
Panel Selection		
	Basic Four Tastes	ASTM, 1981
	Basic Taste Rankings	ASTM, 1968_b
	Odor Identification	Larmond, 1977; ASTM, 1981
Panel Training		
	Odor Matching	Developed
	Ranking	ASTM, 1968_b; ASTM, 1981
	Triangle Presence/Absence	Developed
Development Process		
	Triangle Test	ASTM, 1968_b; Larmond, 1977
	Duo-Profile Test	Developed

TABLE II

SAMPLE DUO-PROFILE EVALUATION FORM

Name:______________________________Date:_____________Test #_______

DUO-PROFILE

Instructions: Compare the samples provided by placing a vertical line across the horizontal line at the point that best describes the flavor note of that sample. Be sure to label each vertical line with its' sample code. List character notes when requested. Thank you.

I. Initial impact:____
(list notes in order of appearance)

II. Tomato flavor ____
weak strong

Sweetness ____
weak strong

Saltiness ____
weak strong

Tartness (vinegary) ____
weak strong

Burning Flavor ____
weak strong

Overall Spice Flavor ____
weak strong

Onion Flavor ____
weak strong

Garlic flavor ____
weak strong

Celery Flavor ____
weak strong

Pepper Flavor ____
weak strong

Mustard Flavor ____
weak strong

Mace Flavor ____
weak strong

Other:____________ ____
weak strong

Appearance ____
alike different

III. Aftertaste:____

TABLE III

RANKING TEST RESULTS

Variable	Trt**	Grouping	Variable	Trt	Grouping
Salt*	4	A	Mace	4	A
	3	B		3	B
	2	C		2	B
	1	D		1	C
Vinegar	3	A	Black Pepper*	4	A
	4	A		3	B
	2	B		2	C
	1	C		1	D
Onion	4	A	Cloves*	4	A
	3	B		3	B
	2	B		2	C
	1	B		1	D
Garlic	4	A	Cinnamon*	4	A
	3	B		3	B
	2	CB		2	C
	1	C		1	D
Mustard	4	A	Cumin	4	A
	3	B		2	B
	1	C		1	B
	2	D		3	B
Paprika	4	A	Capsicum	4	A
	3	A		2	BA
	1	B		3	BA
	2	B		1	B
Celery*	4	A	Cornsyrup	1	A
	3	B		4	A
	2	C		3	A
	1	D		2	A

* Indicates variables which panel significantly ranked correctly

** Trt indicates the treatment (concentration level) order. Treatments with the identical groupings among the same variable showed no significant difference among them.

TABLE IV

A SUMMARY OF RECIPE
ALTERATIONS BASED
ON TRIANGLE
TEST RESULTS

Recipe	Consistency	Sweetness	Saltiness	Tanginess	Overall Spice	Pepper	Onion	Vinegar	Mace	Mustard	Tomato Flavor	Celery	Garlic	Aftertaste
1	↓	↑		↑	↓			↑			↑			
2			↓		↓				↓					
3	↑		↓			↓								
4											↑		↓	
5								↓						↓
6		↓			↑									
7	↓		↓			↑				↓				
8		↑	↑			↓		↑			↑			
9		↑	↓		↓									
10			↑						↑					
11				↑	↓									
12			↑					↑	↓					
13				↑						↓				
14				↑		↓	↓							

TABLE V

PROBABILITY VALUES FOR PAIRED T-TEST

Character Note	Profile # 1	Profile # 2	Profile # 3	Profile # 4
Tomato	.2118	.5698	.3945	.6251
Sweetness	.6642	.6820	.0464*	.3642
Saltiness	.5294	.8761	.7563	.2060
Tartness	.0094*	.4619	.1856	.2149
Burning	.4084	.0083*	.0050*	.9300
Overall Spice	.2979	.7847	.0189*	.9632
Onion	.1109	.5682	.1677	.5839
Garlic	.7357	.7509	.2316	.9165
Celery	.1262	.6172	.1335	.8565
Pepper	.3917	.0611**	.0120*	.6277
Mustard	.9850	.8177	.8183	.1698
Mace	.9309	.0760**	.7123	.2087

Alpha = .05

* Significant difference

** Near significant difference

REFERENCES

ASTM Committee E-18. 1968_b. "Manual on Sensory Testing Methods." STP 434. Am. Soc. for Testing and Materials, Philadelphia, PA.

ASTM Committee E-18. 1981. Guidelines for the selection and training of sensory panel members. STP 758. Am. Soc. for Testing and Materials, Philadelphia, PA.

Brandt, F. I. and Arnold, R. G. 1971. Sensory tests used in food development. Food Product Development, 11: 56.

Larmond, E. 1977. "Laboratory Methods for Sensory Evaluation of Foods," Publ. 1637, Rev. Ed., Food Res. Inst., Canada Dept. of Agriculture, Ottawa, Canada

Sidel, J. L. and Stone, H. 1976. Experimental design and analysis of sensory tests. Food Technol. 30(11): 32.

Sinclair, W. 1984. Safeway's 'secret recipe' strategy. The Denver Post, 1-I, Aug. 19.

Steel, R. G. D. and Torrie, J. H. 1980. "Principles and Procedures of Statistics A Biometrical Approach," McGraw-Hill Book Company, New York.

Stone, H. 1971. The role of sensory evaluation in the food industry. Food Technol., 25(3): 50.

ACKNOWLEDGEMENTS

The author would like to thank Head Country Foods Products for funding this research. Appreciation is also expressed to the twelve panelists who volunteered their time.

CHAPTER IV

HYPOTHESES TESTING, SUMMARY, AND RECOMMENDATIONS

The purpose of this research was to develop a catsup product with flavor characteristics similar to a commercial product. In order to accomplish this, a sensory evaluation panel was selected and trained. The research involved panel selection, panel training, and product development.

Panel selection utilized Basic Four Taste Test, Basic Taste Rankings, and Odor Identification procedures (ASTM, 1968_b, ASTM, 1981, and Larmond, 1977). Panel training used an Odor Matching Test, Ranking Tests (ASTM, 1968_b and 1981, and Triangle Presence/Absence Tests. The Odor Matching and Triangle Presence/Absence tests were developed especially for this research. Although these two tests were not analyzed in support of this research, they were used as viable tools during the training process. Appendix D contains a discussion of these tests along with their results.

The details and results of the Ranking Tests are discussed in Chapter III, and data from the Ranking Tests were used to test Hypothesis One. The development process employed Triangle Tests (ASTM, 1968_b, Larmond, 1977) to guide recipe alteration, and a Duo-Profile Test, as discussed in Chapter III, to access the similarities and differences between the commercial and test products. The Duo-Profile data was used to test the second hypothesis. (Sample scoring forms used for all the sensory evaluation tests are found in Appendix A.

Hypotheses Testing and Summary

Although many types of sensory evaluation were used during this research, only the Ranking Test and Duo-Profiles Tests were analyzed in support of this research. The first hypothesis states there are no significant differences among panelists' responses to ranking presented training samples for the following flavors: a) salt, b) vinegar, c) onion, d) garlic, e) mustard, f) paprika, g) celery, h) mace, i) black pepper, j) cloves, k) cinnamon, l) cumin, m) capsicum, and n) cornsyrup. Panelists were able to rank in the exact order of concentration the perceptions of salt, celery, black pepper, cloves, and cinnamon. The other nine variables were ranked with different levels of accuracy, as discussed in Chapter III. For example, for the variable vinegar, the panel could not differentiate between treatments three and four, and the mean responses were not in correct order; whereas, with the onion flavor the panel as a whole was able to correctly order all four treatments, yet was unable to significantly differentiate between samples one, two, and three. Even though differences existed among panelists, the Least Significant Difference (LSD) values suggest the hypothesis cannot be rejected. See Appendix C for the LSD values for the ranking tests.

The second hypothesis states there will be no significant differences in flavor characteristics between the product developed and the commercial catsup. There were four Duo-Profile tests conducted on three recipe variations. Profiles one and two conducted on the same products during the same session produced different results. There was a significant difference in flavor between the experimental recipe and the commercial product for tartness on profile one, but not on profile two. On profile two, the panel indicated a significant difference in the burning perception and a near significant difference for pepper and mace that was not indicated on profile one between the same two products. One possible reason for the different profiles could be taste fatigue since both were conducted during the same session. In Duo-Profile three, character notes sweetness, burning, overall spice, and pepper were shown to be significantly different between the commercial catsup and the test catsup. This information along with the results of a triangle test on the same recipe lead to profile number four. Duo-Profile four demonstrates no significant differences between the test product and the commercial one, thus supporting the second hypothesis. Although not analyzed in support of this research, the odor matching and triangle presence/absence tests were considered viable tools during the training process.

Based on data collected from the ranking tests and related LSD values, hypothesis one cannot be rejected. Probability values for the Duo-Profile test four support the conclusion that hypothesis two also cannot be rejected. The selected and trained sensory evaluation panel was shown to be a valid tool for product development. The flavor characteristics of the test product and the commercial one were also shown to be similar. This does not mean the developed product is identical to the commercial product because consistency, color, and mouthfeel factors were not considered.

Recommendations

Further study on the odor matching and triangle P/A test is required to determine their validity as training procedures. The triangle P/A test raises many questions about the interaction among recipe components.

Many repeated trials are needed for the Duo-Profile test to further establish it as an acceptable product development tool. A study using the Duo-Profile test on two products with known flavor differences would further its reliability and validity.

This type of research in a university setting should be encouraged because it is actually solving problems of industry instead of setting up a hypothetical situation.

A SELECTED BIBLIOGRAPHY

Abo Grah, Y. S. and Harris, N. D. 1985. Determination of musty odor compounds produced by Streptomyces griseus and Streptomyces odorifers. J. Food Sci., 50(1): 132.

Amerine, M. A., Pangborn, R. M., and Roessler, E. B. 1965. "Principles of Sensory Evaluation of Food." Academic Press, New York.

Anonymous. 1984. IFT Style Guide for Research Papers. J. Food Sci., 49(5): 1401.

ASTM Committee E-18. 1968_a. "Basic Principles of Sensory Evaluation." STP 433. Am. Soc. for Testing and Materials, Philadelphia, PA.

ASTM Committee E-18. 1968_b. "Manual on Sensory Testing Methods." STP 434. Am. Soc. for Testing and Materials, Philadelphia, PA.

ASTM Committee E-18. 1983. Standard definitions of terms relating to sensory evaluation of materials and products. In "Annual Book of ASTM Standards," 15.07, E253.

ASTM Committee E-18. 1979. "ASTM Manual on Consumer Sensory Evaluation." STP 682. Am. Soc. for Testing and Materials, Philadelphia, PA.

ASTM Committee E-18. 1981. Guidelines for the selection and training of sensory panel members. STP 758. Am. Soc. for Testing and Materials, Philadelphia, PA.

ASTM Committee E-18. 1976. Tentative definitions of terms relating to sensory evaluation of materials and products. E253. In "1975 Annual Book of ASTM Standards," Part 46, p. 177.

Bengtsson, K. and Helm, E. 1946. Principles of taste testing. Wallerstein Lab. Commun., 9: 171.

Bliss, C., Greenwood, M. and McKenrick, M. 1953. A comparison of scoring methods for taste tests with mealiness of potatoes. Food Technol., II(7): 491.

Boggs, M. and Hanson, H. 1949. Analysis of foods by sensory difference tests. Adv. in Food Research, 2: 219.

Brandt, F. I. and Arnold, R. G. 1971. Sensory tests used in food development. Food Product Development, 11: 56.

Bressan, L. P. and Bekling, R. W. 1977. The selection and training of judges for discrimination testing. Food Technol., (11): 62.

Campbell, A., Penfield, M., and Griswold, R. 1979. "The Experimental Study of Food." Houghton Mifflin Co., Boston.

Cartwright, L., Snell, C., and Kelley, P. 1952. Organoleptic panel testing as a research tool. Anal. Chem., 24: 503.

Caul, J. F. 1957. The profile method of flavor analysis. Adv. in Food Research, 7: 1.

Cox, D. R. 1958. "Planning of Experiments." John Wiley and Sons, Inc., New York.

Dethmers, A. E. 1979. Utilizing sensory evaluation to determine product shelf life. Food Technol., 33(a): 40.

Ehrenberg, A. and Shewan, J. 1960. The development and use of a taste panel technique - a review. Occupational Psychol., 34: 241.

Ennis, D. M., Boelens, H., Haring, H., and Bowman, P. 1982. Multivariate analysis in sensory evaluation. Food Technol., 36(11): 83.

Ellis, B. H. 1966. "Guide Book for Sensory Testing." Continental Can Co., Inc., Chicago, IL.

Filipello, F. 1957. Organoleptic wine - quality evaluation. II. Performance of judges. Food Technol., 11: 51.

Fishken, D. 1983. Consumer-oriented product optimization. Food Technol., 37(11): 49.

Foster, D., Pratt, C., and Schwartz, N. 1955. Variations in flavor judgements in a group situation. Food Research, 20: 539.

Hardin, D. K. 1981. Use of market research in the food industry. Food Technol., 35(11): 75.

Harper, R. 1955. Fundamental problems in the subjective appraisal of foodstuffs. Appl. Stat., 4: 141.

Heath, H. B. 1978. "Flavor Technology: Profiles, Products, Applications." AVJ Publishing Company, Inc., Connecticut.

Helm, E. and Trolle, B. 1946. Selection of a taste panel. Wallerstein Lab. Commun., 9:181.

Henika, R. G. 1982. Use of response - surface methodology in sensory evaluation. Food Technol., 36(11): 96.

Hopkins, J. 1954. Some observations on sensitivity and repeatability of trial taste difference tests. Biometrics, 10: 521.

IFT Sensory Evaluation Division: 1981. Sensory evaluation guide for testing food and beverage products. Food Tech., 35(11): 50.

Jellinek, G. 1964. Introduction to and critical review of modern methods of sensory analysis (odour, taste, and flavour evaluation) with special emphasis on descriptive sensory analysis (flavour profile method). J. Nutr. Diet., 1: 219.

Klemmer, E. T. 1968. Psychological principles of sensory evaluation. pp. 51. In Basic Principles of Sensory Evaluation, ASTM STP 433. Amer. Society for Testing and Materials, Philadelphia, PA.

Kraft, L. 1981. Focus groups: Letting consumers think about your new product idea. Food Technol., 35(11): 70.

Kroth, B. 1982. Use of regression in sensory evaluation. Food Technol., 36(11): 91.

Krum, J. K. 1955. Sensory panel testing. Food Eng., 27: 74.

Larmond, E. 1977. "Laboratory Methods for Sensory Evaluation of Foods." Pub. 1637, *rev. ed., Food Res. Inst., Canada Dept. of Agriculture, Ottawa, Canada.

Laue, E., Ishler, N., and Bullman, G. 1954. Reliability of taste testing and consumer testing methods. I. Fatigue in taste testing. Food Technol., 8: 387.

Moskowitz, H. R. 1974. Sensory evaluation by magnitude estimation. Food Technol., 28(11): 16.

Moskowitz, H. 1976. "Unevariate Psychophysical Functions. Correlating Sensory Objective Measurements - New Methods for Answering Old Problems." STP 594. American Society for Testing and Materials, Philadelphia.

Nagai, N. Y. and Moy, J. H. 1985. Quality of gamma irradiated California Valencia oranges. J. Food Sci., 50(1): 215.

Nakayama, M. and Wessman, C. 1979. Application of sensory evaluation to the routine maintenance of product quality. Food Technol., 33(a): 38.

O'Mahony, M. 1982. Some assumptions and difficulties with common statistics for sensory analysis. Food Technol., 36(11): 75.

Pangborn, R. 1964. Sensory evaluation of foods: a look backward and forward. Food Technol., 18(a): 63.

Pangborn, R. M. and Dunkley, W. L. 1964. Laboratory procedures for evaluating the sensory properties of milk. Dairy Sci. Abstract, 26: 55.

Pfaffman, C., Schlosberg, and Cornsweet, J. 1954. Variables affecting difference tests. In "Food Acceptance Testing Methodology." pp. 115. Advisory Board on Quartermaster Research and Development, Committee on Foods, Natl. Acad. Sci., Natl. Research Council, Chicago, IL.

Prell, P. A. 1976. Preparation of reports and manuscripts which include sensory evaluation data. Food Technol., 30(11): 40.

Radtke, L. H. and Rodriquez, N. C. 1981. In-house preference testing: an R&D resource. Food Technol., 35(11): 67.

Reece, R. N. 1979. A quality assurance perspective of sensory evaluation. Food Technol., 33(a): 37.

Rose, S. 1981. The laboratory test market: an approach to estimating product potential. Food Technol., 35(11): 73.

Sather, L. and Calvin, L. 1960. The effect of numbers of judgements in a test on flavor evaluations for preference. Food Technol., 16: 613.

Sawyer, F. J. 1971. Interaction of sensory panels and instrument measurement. Food Technol., 25(3): 51.

Schaefer, E. E. 1981. Sensory discovery, sensory scale-up, and sensory cycles. Food Technol., 35(11): 65.

Schutz, H. G. 1971. Sources of invalidity in the sensory evaluation of food. Food Technol., 25(3): 53.

Schutz, H. G. 1979. Scope and importance of sensory evaluation in research and development; Quality control/quality assurance - production, marketing/sales. ,In Sensory Evaluation Methods for the Practicing Food Technologist, Institute of Food Technologists, short course..

Sidel, J. L. and Stone, H. 1976. Experimental design and analysis of sensory tests. Food Technol., 30(11): 32.

Sidel, J. L. and Stone, H. 1983. An introduction to optimization research. Food Technol., 37(11): 36.

Sinclair, W. 1984. Safeway's 'secret recipe' strategy. The Denver Post, 1-I, Aug. 19.

Sjostiom, L. 1972. "The Flavor Profile." Arthur D. Little, Inc., Mass.

Skelton, M. 1984. Sensory evaluation of food. The Cornell H.R.A. Quarterly, Feb.: 51.

Sneed, P. J. 1979. Training a flavor profile panel. Thesis. Oklahoma State University, Stillwater.

Steel, R. G. D. and Torrie, J. H. 1980. "Principles and Procedures of Statistics A Biometrical Approach." McGraw-Hill Book Company, New York.

Stone, H. 1971. The role of sensory evaluation in the food industry. Food Technol., 25(3): 50.

Stone, J., Sidel, J., Oliver, S., Woolsey, A., and Singleton, R. 1974. Sensory evaluation by quantitative descriptive analysis. Food Technol., 28(11): 24.

Wolfe, K. 1979. Use of reference standards for sensory evaluation of product quality. Food Technol., 33(9): 43.

Zook, K. and Wessman, C. 1977. The selection and use of judges for descriptive panels. Food Technol., 11(31): 56.

APPENDIXES

APPENDIX A

TEST EVALUATION FORMS

PANELIST INFORMATION SHEET

Name: ______________________________ Phone: ______________

Address: ____

Occupation: __________________________ Sex: ______ Age: ______

Do you smoke? ______________________ How much? ______________

Are you Diabetic? ____________________ Type: ______________

Reasons for participating in this study? _______________________

____

____

Do not write below this line.

Test	Score
Triangle Test	
Odor Recognition Test	
Ranking Test	
Basic-Taste Test	

Comments:

BASIC TASTE IDENTIFICATION

Name:________________________________ Date:__________________

Instructions: In front of you are 5 cups containing water solutions representing the basic taste sensations. Your task is to identify the dominant taste in each cup. Please rinse your mouth with water between each sample. For each sample, record on the ballot below if the sample is tasteless, sweet, salty, sour, or bitter. Try to taste the same amount of each sample and use all parts of the mouth to taste.

Sample Code	Taste Description

Comments:

RANKING TEST

Name:______________________________________Date:__________________

<u>Instructions</u>: In front of you are 4 cups containing different sugar solutions. Your task is to put them in order from least to most sweet. Please rinse your mouth with water between samples. Record your results below.

<u>Sample Code</u>

____

____

____

____

In the same manner as above, rank the solutions in front of you according to saltiness. Remember to rinse your mouth between samples.

<u>Sample Code</u>

____

____

____

____

ODOR IDENTIFICATION

Name____

Instructions: Ten bottles are presented which contain a common household odor. Please sniff each sample. Record the name or description of the odor below. Wait approximately 15 seconds between samples.

Sample Code	Odor Description

ODOR MATCHING TEST

After completing the practice session to become familiar with the specified odors, complete the matching test below. Write the sample code number opposite the correct ingredient.

<u>CODE</u>	<u>INGREDIENT</u>
____	Cinnamon
____	Mustard
____	Mace
____	Pepper
____	Onion
____	Garlic
____	Paprika
____	Celery
____	Vinegar
____	Tomato Paste

RANKING TEST

Name:____Date:______________________

Instructions: In front of you are a set of cups containing different concentrations of a solution. Your task is to put them in order from least to most. Please rinse your mouth with water between each sample. Record your results below. Thank you.

Variable:_______________
Test #_____ Sample Code

____
____
____
____
____

Variable:_______________
Test #_____ Sample Code

____
____
____
____
____

Variable:_______________
Test #_____ Sample Code

____
____
____
____
____

Variable:_______________
Test #_____ Sample Code

____
____
____
____
____

Comments:____

____

____

TRIANGLE TEST

Name______________________________________Date_____________________

Product__________________________________

Two of the samples are identical, one is different. Taste the samples and identify the one that is different.

Code	Check the odd sample
________	________
________	________
________	________

Describe the difference.____

____

____

Product__________________________________

Two of the samples are identical, one is different. Taste the samples and identify the one that is different.

Code	Check the odd sample
________	________
________	________
________	________

Describe the difference.____

____

____

Name:______________________________ Date:______________ Test #_______

DUO-PROFILE

Instructions: Compare the samples provided by placing a vertical line across the horizontal line at the point that best describes the flavor note of that sample. Be sure to label each vertical line with its' sample code. List character notes when requested. Thank you.

I. Initial impact: ____
(list notes in order of appearance)

II. Tomato flavor ____
weak strong

Sweetness ____
weak strong

Saltiness ____
weak strong

Tartness (vinegary) ____
weak strong

Burning Flavor ____
weak strong

Overall Spice Flavor ____
weak strong

Onion Flavor ____
weak strong

Garlic flavor ____
weak strong

Celery Flavor ____
weak strong

Pepper Flavor ____
weak strong

Mustard Flavor ____
weak strong

Mace Flavor ____
weak strong

Other:____________ ____
weak strong

Appearance ____
alike different

III. Aftertaste:____

RESEARCH EVALUATION FORM

Please evaluate the researcher and research by filling in the appropriate circle. Add any additional comments as desired.

	1	2	3	4	5
1. Research Topic	O	O	O	O	O
Research Design	O	O	O	O	O
Researchers' Knowledge of Subject	O	O	O	O	O
Researchers' Preparation	O	O	O	O	O
Researchers' Ability to Explain Subject subject and type of testing	O	O	O	O	O

2. Do you feel this project was a realistic and worth while one?
   O Yes   O No
   Comments:____
   ____

3. Do you feel you were adequately trained for this project? O Yes   O No
   Comments:____
   ____

4. What was the goal of this project?______________________________
   ____
   ____

5. Would you consider participating on other taste panels?
   O Yes   O No

Additional comments and suggestions:______________________________

____

____

____

____

____

THANK YOU

APPENDIX B

GUIDELINES FOR THE SENSORY EVALUATION JUDGE

Guideline For the Sensory Evaluation Judge

Guidelines for the Sensory Evaluation Judge

Welcome to the exciting and challenging world of sensory evaluation. This type of evaluation testing is used for product development, product improvement, process improvement, cost reduction, selection of new supply sources, quality maintenance, storage stability and product grading.[1] A sensory evaluation panel is an 'analytical tool'. The value of this tool depends on the precision, objectivity, and reproducibility of judgments of the panel members.[2] "Sensory testing requires special controls of various kinds."[3] Some of these controls for the panelist are:

1. Do not eat in the hour before testing is to occur.
2. Do not smoke, chew gum or drink anything, except water within 30 minutes of the testing time. Also avoid eating highly spiced foods on test day for they may affect your taste perception.
3. If ill, especially with a cold or sinus troubles, inform the panel leader and do not participate in that session.
4. Avoid using strong perfumes, aftershaves, lotions, and cosmetics on test days, they may alter odor perception.
5. As a general rule panelist should rinse out their mouth with water between samples and wash hands prior to testing.[1,2,3] This applies to all types of sensory testing. Each test also has its' own specific set of rules and instructions.

A variety of testing methods will be used. Each will be explained prior to being used in a session. Basically, there are three types of sensory test. They are Preference/Acceptance test, Discriminatory test, and Descriptive test.

The preference/acceptance test are based on the measure of preference of a product. Discrimination test are used to determine whether a difference exist between samples. When the nature and intensity of differences is in question, descriptive tests are used.[2] Descriptive type testing is the only method where there is collaberation among the panelist.

"Flavor detection is the result of chemical stimuli emitted by foods and other materials to the end organs of taste, smell, and feeling in both the mouth and nose."[1] There are four primary tastes. They are sweet, sour, salty, and bitter. The human senses interact together to collect and recognize these sensations. It has been determined the tongue is divided into taste areas. See Figure I.[4] Because the tongue is divided into taste areas it is important to adequately stimulate all

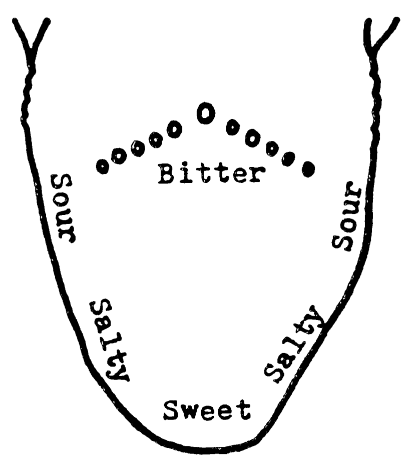


Figure I. Distribution of taste buds on the tongue.

areas of the tongue during sensory testing. When testing odors, the nose should be treated in the same manner, by allowing the nasal cavity to become completely full.

REFERENCES

1. Sneed, P. J. 1977. Thesis.

2. Larmond, E. 1977. Laboratory Methods for Sensory Evaluation of Food. Canada Department of Agriculture.

3. American Society for Testing and Materials. 1968. Manual on Sensory Testing Methods, #434, Philadelphia.

4. Jellinek, G. 1964. Introduction to and critical review of modern methods of sensory analysis (odour, taste and flavour evaluation) with special emphasis on descriptive sensory analysis (flavour profile method). J. Nutr. Dietet., 1: 219.

APPENDIX C

LSD VALUES FROM

RANKING DATA

LSD VALUES OF FLAVOR VARIABLES
IN THE RANKING TESTS

Variable	LSD	Variable	LSD
Salt	0.439167	Mace	0.611294
Vinegar	0.574705	Black Pepper	0.162847
Onion	0.653238	Cloves	0.219583
Garlic	0.685869	Cinnamon	0.450012
Mustard	0.419514	Cumin	0.775568
Paprika	0.568378	Capsicum	0.874379
Celery	0.336614	Cornsyrup	0.939505

Critical Value of T = 1.69236, = 0.1

APPENDIX D

DISCUSSION OF NON-ANALYZED TESTS

Odor Training

A list of six criterion were originally set for prospective panelists in order to progress through the selection and training processes into the development phase of the research. Panelists were selected based on their ability to correctly identify the basic four tastes, complete a series of ranking tests, and identify with 70% accuracy odors in an odor matching test. Prospective panel members were all able to identify and rank the basic taste at an acceptable level, but were not able to in the odor identification test. The 70% accuracy level (ASTM, 1981) was set for standard odor identification tests. In this study panelists were given two tests consisting of six common odors and 11 odors associated with catsup. The ordants used were lemon, orange, vanilla, cocoanut, cinnamon, peppermint, molasses, clove, paprika, onion, garlic, vinegar, celery, capsicum, mace, black pepper, and a blank sample. This increased the difficulty of the task, thus all prospective panelists were retained and the odor matching test was devised to reinforce the ability to recognize the odors associated with catsup. Results from the odor identification and odor matching tests are shown below. The goal of the two tests was to teach the commonly known to be associated with catsup, thus all panelists eventually correctly identified all odor samples presented during the odor matching test. The 75% accuracy level identified in the research objectives for the odor matching test is a rough estimate on the researchers part.

BEFORE AND AFTER COMPARISON
OF ODOR TRAINING

Panelists	Odor Identification	Odor Matching %
1	53%	100%
2	53%	100%
3	64%	100%
4	58%	100%
5	41%	100%
6	35%	100%
7	64%	100%
8	76%	100%
9	41%	100%
10	41%	100%
11	58%	100%
12	47%	100%

TRIANGLE PRESENCE/ABSENCE TEST RESULTS

The test was conducted once for each variable.

Variable	% Correctly Identified Odd Sample	% Correctly Identified Variable
Without Salt	30%	50%
Without Cornsyrup	90%	-
Without Vinegar	40%	60%
Without Mace	40%	40%
Without Celery	50%	10%
Without Mustard	50%	-
Without Onion	90%	-
Without Black Pepper	40%	-
Without Garlic	80%	10%
Without Paprika	60%	-
Total	57%	17%

Approximately 60% of the panel could identify the odd sample with the missing ingredient at a 50% accuracy level. Only 20% of the time could they also correctly identify the missing variable, at a 50% accuracy level. Although not based on scientific fact, it is believed this test has potential in the training process. Panelists felt it aided them in learning differences imposed by the spices on the tomato paste. It is believed the test helped clarify their acquity to recognize specific flavors. Further research with a larger panel or many repetitions on the test is required to establish its validity statistically. Another important factor to be considered is the thresholds of each test variable and their interaction with other flavors.

VITA

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