ASTM

MANUAL ON

DESCRIPTIVE ANALYSIS TESTING

FOR SENSORY EVALUATION

ROBERT C. HOOTMAN

EDITOR

Manual on Descriptive Analysis Testing for Sensory Evaluation

Robert C. Hootman, editor

ASTM Manual Series: MNL 13

**NOTE: The Society is not responsible, as a body,
for statements and opinions advanced in this publication.**

Foreword

The Manual on Descriptive Analysis Testing for Sensory Evaluation was sponsored by Committee E-18 on Sensory Evaluation. Descriptive analysis is a sensory method by which the attributes of a food or product are identified and quantified, using human subjects who have been specifically trained for this purpose. The analysis can include all parameters of the product, or it can be limited to certain aspects, for example, aroma, taste, texture, and aftertaste. Many descriptive analysis methods and method variations are currently employed by sensory professionals. This forthcoming book will only be concerned with four, which have been published and are widely used: flavor profile, quantitative descriptive analysis (QDA), Spectrum, and texture profile. An overview of each method will be presented, with examples and differences among the methods and how they are used.

Committee E-18 believes this manual will be unique in that these four descriptive analysis methods have never before been put together in one book. We hope it is a useful reference for sensory professionals, laboratories, and management.

Contents

Introduction

Descriptive analysis is the sensory method by which the attributes of a food or product are identified and quantified using human subjects who have been specifically trained for this purpose. The analysis can include all parameters of the product, or it can be limited to certain aspects, for example, aroma, taste, texture, and aftertaste. While the principles of descriptive analysis are applied by many sensory professionals, overviews of four currently published methods will be presented. Many variations of these methods are in current use. This publication will be concerned only with the following: flavor profile, quantitative descriptive analysis (QDA), spectrum, and texture profile (Table 1). The following information is intended as a description of each method, not as a manual to be used for training of this type of panel.

Descriptive analysis is appropriate for use when detailed information is required on individual characteristics of the product or material or both. Some examples of application of descriptive analysis are as follows:

- Documenting product sensory characteristics
- Identifying and quantifying sensory characteristics for research guidance, product maintenance, and matching
- Correlating instrumental and chemical measurements with sensory responses
- Monitoring product quality
- Interpreting consumer responses

In many cases this sensitive method of descriptive analysis provides information that cannot be obtained by other analytical means. For example, analysis of salt content or pH does not indicate how salty or how sour a product may taste. Nor is it usually possible to monitor subtle changes in shelf life or package stability using analytical instruments. The only effective way to monitor complex changes in oxidation, rancidity, or flavor intensity, as well as the introduction of new attributes that so often occur with storage, is by using descriptive analysis methods.

Establishing a trained panel to perform descriptive analysis is not a casual matter. This method requires that the panel be carefully trained and maintained under the supervision of a sensory professional who has training and experience in the analytical method being applied. Because of the expense (in actual dollars and personnel time) of training and maintaining a panel, as well as the possible need for capital investment of a special facility, company management must provide a long-term commitment. Without such support it is almost impossible to successfully develop and maintain the panel. However, the benefits of having this important analytical method usually outweigh the disadvantages. For this reason, many companies have found the method of descriptive analysis to be an essential part of their sensory evaluation program.

TABLE 1—*Differences among four descriptive analysis methods.*

Method	Panel Leader	Number of Panelists	Facilities	Screening	Time Required Training/Test
Flavor profile	Selected from the trained panel. Results are included in final consensus flavor profile if leader also acts as panelist.	min of 4	Quite, well-lit, odor-free panel room; round table suggested to facilitate discussion.	Basic taste, odors, ranking, and integrative discrimination skills plus a personal interview to determine interest and availability.	For training, ~6 months with daily practice. For product, 1 to 3 sessions. For testing, ~15 min/sample
QDA[a]	Sensory professional functions as panel administrator and discussion coordinator, but is not a subject.	10–12; however, some tests may use as few as 8 or as many as 15	Language development/ training done in conference-style room with appropriate lighting and environmental controls. Data collection in sensory test booths.	Product/product category users/ likers; discrimination testing with products, progressively more difficult (20 to 30 trials maximum).	Total: 2 weeks, 8 to 10 h, 3 to 5 min/ product
Spectrum method	Sensory professional trained in descriptive analysis and as a panelist. Or, a skilled panelist trained as a panel leader.	12 to 15	Booths for evaluation. Room with round table for discussion. Quiet, controlled atmosphere and apropriate lighting.	Prescreening, acuity screening, and interview to screen for availability, interest, good health, acuity in sensory dimension, scaling, and positive attitude.	One modality (for example, flavor) 3 to 4 months total (60 to 80 h). Testing 5 to 15 min/ product.
Texture profile	Sensory professional trained as a texture profilist with necessary skills to schedule and conduct panels.	6 to 10	Quiet room with appropriate lighting. Round table for discussion and evaluation.	Tests to discriminate textural attributes and an interview.	4 to 6 months (90 to 100 h). Testing 5 to 15 min/ product.

[a] QDA is quantitative descriptive analysis.

Training	Product Tested	Scales/Score Cards	Data Handling
Basic instructions on taste and odor, terminology development, product evaluations with reference standards, and interpretation and use of data.	Food, beverages, pharmaceuticals, cosmetics and household products, tobacco, packing materials, pet foods, environmental odors and any product that can be smelled or tasted.	Each panelist independently evaluates using a blank sheet: amplitude rating, character notes, intensities (7 point scale ranging from threshold to strong), order of appearance, aftertaste, texture, and appearance.	Final consensus profile in tabular form, principle component analysis, ANOVA.
Subjects develop terminology, explanations/definitions, evaluation procedure. References provided as needed.	Foods and beverages including fermented and distilled, tobacco, paper products, nonwoven/woven fabrics, health, and beauty aids	Graphic rating scales, attributes listed in order of occurrence, repeated trials design (min of 3 reps)	Scale marks converted to numerical values and analyzed: means, standard deviations, one-way analysis of variance for each subject/attribute; treatment-by-subject repeated measures, mixed model ANOVA, Duncan and SNK multiple range tests, pairwise correlations, rank order, Kendall coefficient of concordance, PCA, and other multivariate analyses.
Basic principles of sensory evaluation, physiology, and descriptive analysis. Development of terminology, use of references, selection of evaluation techniques, product evaluation, and discussion of results.	All consumer products (for example, foods, personal, and health care, household, woven/nonwoven fabrics).	150 point scale. Score card lists detailed attributes (anchored to references). Detailed evaluation procedures attached to score card.	Individual scores collected. Graphic representation and statistical analysis on data. Variety of ANOVA and other statistical analysis (uni- and multivariate) depending on design and test characteristics.
Training on texture definitions, evaluation procedures, and standard reference scales. Evaluation of specific products and discussion of results.	Food and beverages	Intensity from 0,)(, →3. Written evaluation procedures. Glossary of attribute definitions.	Panel discussion to reach consensus on each attribute.
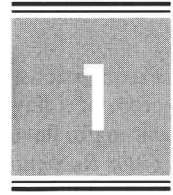
The Flavor Profile

by Patricia Keane[1]

Principle

The flavor profile method is based on the concept that flavor consists of identifiable taste, odor, and chemical feeling factors plus an underlying complex of sensory impressions not separately identifiable. The method consists of formal procedures for describing and assessing the aroma and flavor of a product in a reproducible manner. The separate characteristics contributing to the overall sensory impression of the product are identified, and their intensity assessed in order to build a description of the aroma, flavor, and aftertaste of the product.

This descriptive sensory analysis usually includes:

1. Overall impression (amplitude).
2. Identification of perceptible aroma and flavor character notes.
3. Intensity of each character note.
4. Order in which these character notes are perceived (order of appearance).
5. Aftertaste.

Panelists

Selection of Panelists

Panelists are selected according to their abilities to discriminate odor and flavor differences and communicate their perceptions. Their abilities to identify the basic tastes, rank intensities, and identify common odorants are determined through the following series of tests.

Identification Test—Independence of judgment is such a sufficiently important attribute for a flavor profile panelist to possess that it requires a separate test. Candidates are asked to taste a solution and then answer a related question. Solutions consist of sucrose and sodium chloride at low concentrations and plain water. Both correct and false suggestions are given to the candidates to test their independence of perceptual judgment.

Basic Taste Test—Prospective panelists are not tested for threshold acuity, but rather for their ability to differentiate among the basic tastes at above threshold levels. Solutions representing sweet (sucrose), sour (citric acid), salty (sodium chloride), and bitter (caffeine) tastes are used. None of the solutions are intense enough to influence the taste of succeeding samples so all may be tasted at a single session. The samples are presented along with one blank and one duplicate. The duplicate sample and blank sample are included to test consistency of response and discourage guessing.

Ranking Test—The candidates are asked to rank a series of four solutions for intensity of sweet basic taste. The solutions are a complex mixture of caffeine, phosphoric acid, and cola flavoring with supraliminal levels of sweetness. This test simulates actual flavor panel performance where panelists have to isolate and quantify elements from a complex whole.

Arrangement Test—An important part of the flavor profile method is the concept of amplitude, the initial overall impression of the balance and fullness of a product. The arrangement test seeks to measure a candidate's ability to perform this integrative measurement.

[1]Senior consultant, Arthur D. Little, Inc., 15W-107, 20 Acorn Pike, Cambridge, MA 02140.

Five versions of orange breakfast drink are presented. Some are diluted and may have sucrose or a flavor modifier added. The candidates are asked to rank the solutions in some meaningful flavor order and describe the basis for such ordering.

Odor Recognition Series—The odor recognition series is given to determine a candidate's aptitude for identifying and describing 20 different odorants, most of which have been encountered by the candidate. Some commonly used odorants are: vanillin, benzaldehyde, anise, amyl acetate, methyl salicylate, and so forth. Odorants should be perceptible but not overwhelming.

The odor recognition test is presented in two parts, each using 10 different odorants. In the first part of the test the candidates are instructed to identify the odorant or associate it with some product. The second part of the test is multiple choice, and the candidates choose the word that best identifies the odorant. Time limits are imposed to minimize fatigue.

Analysis and Interpretation of Screening Tests—Administration and evaluation of the screening tests should be performed by someone thoroughly experienced in the flavor profile method. A suggested system follows:

Identification Test

Candidates are not expected to answer all questions correctly but points are awarded for each correct answer. Susceptibility to false suggestion however serves to disqualify an individual from consideration.

Basic Taste Test

Candidates should be able to identify the four basic tastes. Points are awarded for each correct answer.

Ranking Test

The maximum number of points is awarded for ranking the solutions in the correct order. Fewer points are awarded if the two lower or intermediate solutions are reversed. Other combinations receive proportionately fewer points.

Arrangement Test

Candidates who correctly rank the solutions using blend or fullness as their criterion receive the maximum score. Other acceptable criteria might be: sweetness, sourness, orange identity, and so forth. Points are awarded based on correctness of response for whatever criterion is chosen.

Odor Recognition Test

In the odor recognition test maximum points are awarded for correctly identifying the odorant. Fewer points are awarded for product associations or characterizations.

Other Criteria—During the screening tests the candidates are also rated on other qualities. These include how they apply themselves in taking the tests, response to directions, level of confidence, and interest in and attitude toward the tests. Since the tests are given to a group of six candidates at a time, group interaction can also be observed.

Personal Interview—After the candidates have taken the screening tests, they are interviewed about their work, academic or personal experiences in sensory or associated areas. The

interviewer uses the candidate's screening test experience to initiate discussion. Candidates are evaluated and rated on the following attributes:

1. Interest in flavor and odor evaluation.
2. Ability to function cooperatively in a group.
3. Ability to effectively communicate opinions.
4. Confidence to report what one perceives.
5. Personal experiences that may contribute to flavor and odor analysis.
6. Availability for panel work.

The interviewer also discusses factors, such as allergies to or moral constraints about any food or beverage products, and addresses any health concerns that the candidate may have.

Summary—Test scores and data from the interviews are the usual criteria for panelist selection. The interviewer must rely on judgment, common sense, and experience to identify candidate potential. Lack of interest or availability, or both, for panel work serves to disqualify individuals from further consideration.

Training of Panelists

The selected candidates receive training to improve their abilities to describe aroma and flavor attributes using the flavor profile method. Training increases reliability. The duration of training will vary depending on the purpose of the panel. If the panel is expected to be capable of describing any food or beverage product, a training period of approximately six months is required. This includes approximately 60 h of training and 100 h of practice per person. Training for a single type of product can be accomplished in a shorter time.

The structured training consists of the following:

- A basic course of instruction that includes lectures and demonstrations on the nature of taste and smell, basic requirements for panel work, techniques and procedures for reproducible odor and taste work, and the development of terminology through the use of sensory exercises and reference standards. This usually requires three full days.
- Evaluation of products of increasing difficulty that have been selected for their particular teaching values. Approximately 1 h per day is spent on the evaluation of these products, and each panelist takes a turn at being panel leader.
- An advanced course that covers additional aspects of sensory evaluation, flavor situations of a more complex nature, and the interpretation and utilization of panel data. This usually requires three full days.
- Additional practice using products similar to those the panel will work with after training. During these sessions, the panel also practices application and interpretation of results.

Panel Leader

The panel must eventually have a panel leader who is responsible for conducting panel discussions, recording and compiling data, and interpreting and reporting results. The panel leader participates fully in the product evaluation and may also have responsibility for scheduling panels and preparing samples. The leader is usually chosen near the end of the training period on the basis of demonstrated ability, availability, and other considerations such as job responsibilities, and so forth.

Panel Operation

General Considerations for Panel Operation

For effective descriptive analysis, the panelists should be provided with seating in a quiet, well-lighted, odor-free area removed from external distractions. All utensils must be clean and odor-free.

Samples should be presented to the panel under identical conditions and should be evaluated by all panel members in an identical manner at the same time. A product's aroma is analyzed first, then the flavor, and finally the aftertaste.

Procedure

Four or more panelists work as a group to arrive at a consensus description of the sensory properties of the product. The panel members first independently evaluate the sample using standardized flavor profile techniques and record their findings on a blank sheet. An essential element of the procedure is the panel leader who is also one of the panelists. This person has each panelist present his/her findings, records them, and leads the panel's discussion in order to reach consensus on each component of the description. Reference materials are used to help the group reach agreement on terminology and intensity. The final composite profile typically takes three to five sessions. The panel leader interprets and reports the results. The abilities of panelists to function cooperatively within the group and communicate opinions effectively are important factors in the successful conduct of the consensus procedure.

Product Orientation

Product orientation takes place before the formal panel and involves one or more informal sessions depending on the experience of the group. At this time the panel leader outlines the objectives of the project and introduces the samples to be evaluated along with other products of the same or similar type. This helps to establish a framework for comparison. During this period, the panelists draw up a list of character notes for the samples, decide on reference materials (pure compounds or products that demonstrate particular odor or flavor notes), and develop the vocabulary necessary to describe these character notes. The panel also establishes at this time the best method for presenting and examining the samples.

Components of the Flavor Profile

The following are the components of the flavor profile:

1. Overall impression of aroma and flavor, called amplitude.
2. Identification of perceptible aroma and flavor notes.
3. Intensity of each character note.
4. Order in which these character notes are perceived, called order of appearance.
5. Aftertaste.

Additionally, when texture and color are important to the product's description, they are also noted during the panel session.

Amplitude—Amplitude is defined as the initial overall impression of the aroma and flavor of a product. It is an integrative measurement of the balance (blend) and body (fullness) in each case. Amplitude is measured on a seven-point scale composed of four major ratings with three intermediate (½ units) ratings between them:

0 = no blending or fullness.
1 = low degree of blend and fullness.
2 = moderate degree of blend and fullness.
3 = high degree of blend and fullness.

Character Notes—The perceptible aroma and flavor components are called character notes and are defined in descriptive or associative terms. These terms are objective rather than subjective (for example, a flavor note may be characterized as "vanilla" but not "good") and can be referenced. Character notes may include aromatics, basic tastes, and chemical sensations or feeling factors.

Occasionally, some panelists will describe a character note that others do not perceive. In the case where less than half of the panelists perceive a note, it is referred to as an "other" and listed as such at the bottom of the profile.

Intensity Scale—The degree to which each character note is perceived is called "intensity." The scale is constant over all product categories:

0 = not present.
1 = slight.
2 = moderate.
3 = strong.

This scale is further refined into ½ units to show narrower ranges.

Threshold, signified by the symbol,) (, is a statistic rather than a single point. It is used to represent a range of concentration which is barely detectable or detectable only half of the time.

Order of Appearance—The tabular profile lists the character notes in the order in which they are perceived. This is made possible through the use of standardized techniques for smelling and tasting since order of appearance is influenced by location of taste buds on the tongue, volatility of aromatics, and texture of the product. Also differences in the time of appearance of character notes are more apparent in unblended flavors.

Aftertaste—Aftertaste is a definite and important part of the flavor of a product. Aftertaste sensations can include basic tastes, aromatics, or feeling factors, or all of these. These sensations are noted at a predetermined time after completion of tasting, usually 1 min. Generally intensity ratings are not given, but for specific studies where aftertaste is important, intensity ratings add further definition.

Data Collection

Initially, the panelists work alone with a blank sheet recording amplitude, and character notes with their intensities and order of appearance, as well as aftertaste. When all of the panelists have completed their profile, the individual panelists recite their results, and the panel leader records them and compiles them. The oral review of findings gives panel members immediate feedback as to their ability to describe what they have perceived and indicates where practice may be necessary. It enables them to clarify terms and select suitable references. Most importantly, it permits panelists to draw on and learn from the experiences of others. At the conclusion of the first panel session a preliminary profile is generated. This profile is continually refined during subsequent sessions until all panelists agree a final composite judgment has been reached. This then becomes the final flavor profile. Three to five sessions are generally needed to produce a final composite. An example of a format for writing a flavor profile is shown in Fig. 1. Figure 2 illustrates a comparison of the flavor profiles of two similar product types.

AROMA

    Amplitude Rating

Character note   (in order of appearance)   Intensity
    "   "   "   "
    "   "   "   "
    "   "   "   "
    "   "   "   "
    "   "   "   "

Etc.

Others:

Flavor

    Amplitude Rating

Character note   (in order of appearance)   Intensity
    "   "   "   "
    "   "   "   "
    "   "   "   "
    "   "   "   "
    "   "   "   "

Etc.

Others:

Aftertaste (Time of measurement if not one minute)

Character notes (intensities optional)

Footnotes

Color, Appearance, Texture (optional)

                                          _____
                                          Signature of Panel Leader

                                          _____
                                          Date

FIG. 1—*Format for a flavor profile.*

Data Analysis

The flavor profile method was not designed as a numerical system for statistical analysis of data. Most applications are based on interpretation of the composite profile terms and intensities. The method provides a detailed blueprint of a product or products. The strength of the method rests on the ability of a group of highly trained individuals to work as a team to reach consensus.

The method can however provide multivariate data, which can be summarized to provide a statistically treatable comparison of several like products.

The process involves making a transformation to an expanded scale by assigning numbers to an aroma note index and flavor note index, summarizing the indexes, and using principal

component analysis and analysis of variance to treat the data. A case study where this was done for fluid milk products is discussed in detail by Dr. Irwin Miller (1978). Other studies employing statistics have also been reported.

Test Report

The flavor profile report should include complete identification of the sample(s) studied, and the objectives and duration of the study.

The body of the report should include the techniques used to examine the products, such as preparation methods and serving temperatures, so that the evaluation can be repeated accurately in the future. The report should also identify the reference standards used to reach agree-

MODERN REAL MAYONNAISE		YANKEE MAYONNAISE	
AROMA	AROMA	AROMA	
Amplitude 2		Amplitude 1 1/2	
Oily, vegetable	1 1/2	Sour, vinegar	2
Eggy, cooked	1	Oily, oxidized	1 1/2
Sour, vinegar	1 1/2	Pungent	1
Spice complex(onion,	1/2	Garlic	1
garlic,mustard)		Briny	1
Briny	1		
Other: Black Pepper, Citrus		Other: Eggy	
FLAVOR		FLAVOR	
Amplitude 2		Amplitude 1	
Sweet	1/2	Sweet	1 1/2
Oily, vegetable	1 1/2	Sour	2 1/2
Sour	2	Vinegar	2
Salty	2	Oily,oxidized	1
Salivating	1 1/2	plus mouthfeel	
Vinegar	1 1/2	Salty	1
Eggs, hard-cooked	1	Spice bite and burn	1
Spice complex(onion,	1	Garlic	1 1/2
garlic,mustard)		Astringent	1 1/2
Black Pepper	1/2		
Oily mouthfeel	1 1/2		
Other: Bite and burn		Other: Eggy	
AFTERTASTE		AFTERTASTE	
Salty		Sour	
Oily plus mouthfeel		Spice burn	
COLOR		COLOR	
Slight eggy yellow		Pale creamy white	
TEXTURE		TEXTURE	
Smooth, gelatinous		Lumpy, slightly grainy	

FIG. 2—*Examples of flavor profiles of mayonaise.*

MEMO TO: Project Manager - Canned Soups

FROM: Flavor Profile Panel Leader

SUBJECT: Flavor Profile Report of Tomato Soups

INTRODUCTION:

Samples of canned condensed Alpha Tomato Soup and Beta Tomato Soup were profiled during five panel sessions. The objective was to characterize the two market leaders in order to provide sensory data for management to select a flavor target for a new store brand soup line. For the study, a sufficient number of identically coded samples of each brand were purchased locally. Expiration dates for the two brands were similar. Samples were evaluated for aroma, flavor and aftertaste. Differences in appearance and texture were also noted. Tabular profiles are attached.

SUMMARY OF CONCLUSIONS:

• In aroma and flavor both tomato soup brands exhibited early tomato identity with the Alpha brand having a more intense fresh tomato identity and the Beta brand described as burnt or scorched tomato.

• The development of the tomato identity in Alpha's product was supported by other vegetable and spice notes to produce a moderately full and blended soup. Beta brand was more disjointed in the flavor with the tomato aromatic suppressed by the starchy character of the soup.

• In Alpha brand the salivating mouthfeel with a slight MSG character contributed to a quick washout of flavor and a shorter aftertaste. In Beta the pepper burn lingered into the aftertaste along with a drying mouthfeel.

• Both soups had very slight off-characteristics; metallic in Alpha soup and bitter and musty in the Beta product.

• The appearance and texture of the two soups were different. Alpha soup was dark red in color with dispersed oil and slightly pulpy. The Beta brand was thick and particulate with a burnt red-orange color. The Beta brand was also difficult to heat as it had a tendency to burn.

FLAVOR PROFILES OF CONDENSED TOMATO SOUPS
RECONSTITUTED WITH SPRING WATER

ALPHA CODE:23567APR92		BETA CODE:54K8JUN92	
AROMA (160°F - 150°F)			
Amplitude 2		Amplitude 1 1/2	
Tomato,cooked fresh	2	Tomato puree,scorched	1 1/2
Cooked vegetables	1 1/2	Starchy,cooked pasta	1 1/2
Sour,citrus-like	1	Briny	1
Briny	1	Sour,fatty acid,cheesy	1/2
Spice Complex, Black pepper	1	Cooked vegetables	1/2
Other:Starchy, Non-fat dry milk		Other: Spice complex,musty	
FLAVOR (150°F - 140°F)			
Amplitude 2		Amplitude 1	
Tomato,cooked fresh, slight green	2	Starchy,cooked pasta	2
Sweet	1/2	Tomato, stewed, burnt paste	1
Cooked vegetables	1 1/2	Starchy mouthfeel	1
Sour	1 1/2	Sweet	1/2
Salty	1 1/2	Salty	1 1/2
Spice Complex, Black pepper	1	Cheesy, fatty acid sour	1 1/2
Salivating	1	Sour	1/2
Metallic	1/2	Bitter	1/2
Pepper bite	1/2	Pepper bite and burn	1 1/2
MSG	1	Musty	1/2
Other:Starchy, oily plus mouthfeel		Other: Spice complex, oily plus mouthfeel	
AFTERTASTE			
Tomato,sour		Sour,pepper burn,drying, starchy,tomato	
COLOR			
Dark red,oily sheen some pulp and skin pieces		Burnt red-orange	
TEXTURE			
Thin, smooth, slight pulpy		Thick,particulate, slight tacky	