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Sensory analysis — Methodology — Texture profile

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Analyse sensorielle — Méthodologie — Profil de la texture

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Foreword

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Introduction

Sensory profiling methods are formal procedures used for assessing in a reproducible manner the separate attributes of a sample and then rating their intensity on a suitable scale. The methods can be used for evaluating odour, flavour, appearance and texture, separately or in combination.

As a consequence of the unique nature of texture, methods have been developed specifically for texture profiling.

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Sensory analysis — Methodology — Texture profile

1 Scope

This International Standard describes a method of developing a texture profile of food products (solids, semi-solids, liquids) or non-food products (e.g. cosmetics).

NOTE 1 This International Standard is actually more oriented towards the establishment of texture profiles for solid food products. Further work will be carried out to treat in more detail the texture of drinks and non-food products.

This method is just one approach to sensory texture profile analysis; other methods exist. It describes various steps in the process of establishing a complete description of the textural attributes of a product.

This method may be used for:

— screening and training of assessors;

— orientation of assessors through the development of definitions and evaluation techniques of textural characteristics;

— characterization of the textural attributes of a product to establish a standard profile for the product in order to discern any changes later;

— improving old and developing new products;

— studying various factors which may affect the textural attributes of a product; these factors may be, for example, a change in the process, time, temperature, ingredients, packaging or shelf-life and storage conditions;

— comparing a product with another similar product to determine the nature and intensity of textural differences;

— correlation of sensory and instrumental and/or physical measurements.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 5492:1992, *Sensory analysis — Vocabulary.*

ISO 6658:1985, *Sensory analysis — Methodology — General guidance.*

ISO 8586-1:1993, *Sensory analysis — General guidance for the selection, training and monitoring of assessors — Part 1: Selected assessors.*

ISO 8586-2:1994, *Sensory analysis — General guidance for the selection, training and monitoring of assessors — Part 2: Experts.*

ISO 8589:1988, *Sensory analysis — General guidance for the design of test rooms.*

ISO 11035:1994[1], *Sensory analysis — Identification and selection of descriptors for establishing a sensory profile by a multidimensional approach.*

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 5492 apply. For the con-

1) To be published.

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venience of users of this International Standard, the following definition is repeated.

3.1 texture (noun): All the mechanical, geometrical and surface attributes of a product perceptible by means of mechanical, tactile and, where appropriate, visual and auditory receptors.

The mechanical attributes are those related to the reaction of the product to stress. They are divided in five primary characteristics, i.e. hardness, cohesiveness, viscosity, springiness and adhesiveness.

The geometrical attributes are those related to the size, shape and arrangement of particles within a product.

The surface attributes are those related to the sensations produced by moisture and/or fat content. In the mouth they are also related to the way in which these constituents are released.

4 Principle

Development of a texture profile by systematic classification, describing all of the textural attributes (mechanical, geometrical and surface).

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5 General test requirements

5.1 Test room

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Evaluations shall be carried out in a test room which is in accordance with ISO 8589.

5.2 Materials

Materials shall be selected by the test supervisor, according to the nature of the product, the number of samples, etc., and shall in no way affect the test results.

If standardized apparatus corresponds to the needs of the test, it shall be used.

6 Methodology

6.1 Components of a texture profile

The concept of texture profiling is based on the same elements as in flavour profiling. Therefore, it may include the following, depending on the type of product (food or non-food):

a) perceptible textural attributes, i.e mechanical, geometrical and others;

b) intensity, i.e. the degree to which the attribute is perceptible;

c) order of appearance of the attributes, which can be outlined as follows:

1) **prior to/or without mastication**: all geometrical, moisture and fat attributes perceived visually or by touch (skin/hand, lips);

2) **first bite/sip**: mechanical and geometrical attributes as well as fat and moisture attributes perceived in the mouth;

3) **masticatory phase**: attributes perceived by the tactile receptors in the mouth during mastication and/or absorption;

4) **residual phase**: changes occurring during mastication and/or absorption, such as the rate and type of breakdown;

5) **swallowing**: ease of swallowing and description of any residue remaining in the mouth.

6.2 Classification of textural attributes

Texture is composed of different properties since the sensory evaluation of texture is a dynamic process. Textural attributes can be grouped into three main classes (see 6.2.1 to 6.2.3) according to the degree to which each is present, and the order in which they appear.

Textural attributes are manifested by the reaction of a food to constraint. They are measured either

a) by kinaesthesis, which includes the sensations of position, movement, and tension of parts of the body, perceived through nerves and muscles, tendons and joints; or

b) by somaesthesis, which includes the sensations of pressure (touch) and pain perceived by receptors located in the skin and lips, including oral mucosa, tongue and periodontal membrane.

6.2.1 Mechanical attributes

Mechanical attributes for semi-solid and solid food products can be divided into five primary parameters and four secondary parameters (see table 1).

NOTE 2 Definitions of popular nomenclature are given in ISO 5492.

Table 1 — Definitions and methods of evaluation for mechanical textural attributes

Characteristic	Sensory definition	Technique
Primary parameters		
Hardness	Mechanical textural attribute relating to the force required to achieve a given deformation or penetration of a product. In the mouth, it is perceived by compressing the product between the teeth (solids) or between the tongue and palate (semi-solids).	Place the sample between the molar teeth or between the tongue and palate and chew evenly, evaluating the force required to compress the food.
Cohesiveness	Mechanical textural attribute relating to the degree to which a substance can be deformed before it breaks.	Place the sample between the molar teeth, compress it and evaluate the amount of deformation before rupture.
Viscosity	Mechanical textural attribute relating to resistance to flow. It corresponds to the force required to draw a liquid from a spoon over the tongue, or to spread it over a substrate.	Place a spoon containing the sample directly in front of the mouth and draw the liquid from the spoon over the tongue by slurping, evaluating the force required to draw the liquid over the tongue at a steady rate.
Springiness	Mechanical textural attribute relating to the rapidity of recovery from a deforming force, and the degree to which a deformed material returns to its undeformed condition after the deforming force is removed.	Place the sample either between the tongue and palate (if it is a semi-solid) or molar teeth (if it is a solid) and compress it partially; remove the force and evaluate the degree and rapidity of recovery.
Adhesiveness	Mechanical textural attribute relating to the force required to remove material that adheres to the mouth or to a substrate.	Place the sample on the tongue, press it against the palate, and evaluate the force required to remove it with the tongue.
Secondary parameters		
Fracturability (brittleness)	Mechanical textural attribute related to cohesiveness and to the force necessary to break a product into crumbs or pieces.	Place sample between molar teeth and bite down evenly until the sample crumbles, cracks or shatters, evaluating the force with which the food moves away from the teeth.
Chewiness	Mechanical textural attribute related to cohesiveness and to the length of time or the number of chews required to masticate a solid product into a state ready for swallowing.	Place sample in the mouth and manipulate at one chew per second at a force equal to that required to penetrate a gum drop in 1/2 second, and evaluate the energy or the number of chews required to reduce the sample to a state ready for swallowing.
Gumminess	Mechanical textural attribute related to the cohesiveness of a tender product. In the mouth, it is related to the effort required to disintegrate the product to a state ready for swallowing.	Place sample in the mouth and manipulate with the tongue against the palate, evaluating the amount of manipulation necessary before the food disintegrates.

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a) **Primary parameters**

— hardness: main adjectives used include soft, firm and hard;

— cohesiveness: main adjectives used include fracturability (crumbly, crunchy, brittle; crispy, crusty); chewiness (tender, chewy, tough); and gumminess (short, mealy, pasty, gummy);

— viscosity: main adjectives used include fluid, thin, viscous;

— springiness: main adjectives used include plastic, malleable, elastic, springy;

— adhesiveness: main adjectives used include sticky, tacky, gooey, gluey.

NOTE 3 The first four parameters are related to forces of attraction acting between particles of food and opposing disintegration, whereas adhesiveness is related more to surface properties. Three additional secondary parameters have been identified in order to make characterization as meaningful as possible to individuals accustomed to popular

terminology, whilst at the same time keeping it in agreement with basis rheological principles. It sometimes is more useful to rate any sensory characteristic in the simplest form, for example, to rate the firmness, cohesiveness and springiness as separate attributes. Sometimes, with some products, it is helpful for assessors to rate or judge a concept or phase like "overall chewy impression" and then directly under it rate the components.

b) **Secondary parameters**

— fracturability (brittleness): related to the primary parameters of hardness and cohesiveness; in brittle products cohesiveness is low and hardness can vary from low to high;

— chewiness: related to the primary parameters of hardness, cohesiveness and springiness;

— chew count;

— gumminess: related to the primary parameters of hardness and cohesiveness in semi-solid foods where hardness is low.

NOTES

4 Not all scales are equally appropriate for describing foods. For fluid foods such as beverages, a deeper analysis is required than that which is obtained by the single parameter of viscosity that appears in the standard texture profile analysis.

5 Annex B proposes a classification of terms relative to the sensory analysis of drinks. A study of the texture of liquids will be carried out in the future.

To obtain the maximum benefit from the use of scales in a training programme, each attribute shall be defined, the technique for evaluating the particular parameter shall be carefully explained and standardized among assessors, and three or four samples varying in intensity from each scale shall be presented to each assessor. A sensory technique should always accompany the definition of a textural attribute.

Table 1 summarizes the sensory definitions and techniques for evaluating mechanical textural attributes.

6.2.2 Geometrical attributes

Geometrical attributes are perceived by tactile receptors located in the skin (mainly in the tongue), mouth and throat. These attributes are also discernable through the appearance of the products, whether food or not.

6.2.2.1 Granularity

Granularity is a geometrical textural attribute relating to the perception of the size and shape of particles in a product.

Attributes relating to particle size and shape can be demonstrated by reference products in the same manner as the mechanical attributes. For example, terms such as smooth, chalky, grainy, gritty and coarse comprise a scale of increasing particle size.

6.2.2.2 Conformation

Conformation is a geometrical textural attribute relating to the perception of the shape and the orientation of particles in a product. Attributes relating to the orientation of particles represent highly organized structures.

Different terms correspond to a certain number of conformations. For example:

— "fibrous" refers to long particles oriented in the same direction (e.g. celery sticks);

— "cellular" refers to a highly organized structure composed of spherical ovoid particles, or composed of cell walls filled with a gas (e.g. egg white foam);

— "crystalline" refers to angular particles (e.g. granulated sugar);

— "puffy" refers to hard or firm outershells filled with large, often uneven, air pockets (e.g. cream puffs, puffed rice);

— "aerated" refers to relatively small, even cells filled with air and surrounded (usually but not always) by soft cell walls (e.g. marshmallows, meringues, polyurethane foam).

NOTE 6 Geometrical attributes do not lend themselves to clear-cut scaling and, although scales and references have been developed, no intensity reference scales have been published. Evaluation is qualitative and quantitative as to the type and amount present.

Examples of the different geometrical attributes will be presented and the amount of each characteristic present described. When greater discrimination is required, a scale can be established for a specific characteristic. See table 2.

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Table 2 — Examples of reference products for geometrical attributes

Attributes relating to particle size and shape	Reference product	Attributes relating to orientation	Reference product
Powdery	Confectioner's sugar	Flaky	Boiled haddock
Chalky	Dry meringue, toothpaste	Fibrous	Asparagus, chicken breast, celery sticks
Grainy	Semolina	Pulpy	Peach pulp
Gritty, sandy	Pear core, sand	Cellular	Orange
Coarse	Cooked oatmeal	Aerated	Sandwich loaf, milk shake
Lumpy	Cottage cheese	Puffy	Puffed rice, cream puffs
Beady	Tapioca pudding, caviar	Crystalline	Granulated sugar

6.2.3 Other attributes (moisture and fat contents)

These attributes refer to mouthfeel qualities related to the perception of moisture and fat contents of a product by the tactile receptors in the mouth cavity or on the skin, and may also be concerned with the lubricating properties of the product.

The dynamic attribute of melting in the presence of heat should be noted (contact with the skin or in the mouth) where the idea of time/intensity is related to the time necessary for a change in state and to the perception in the mouth of different textures (e.g. a piece of cold butter or an ice-cube put into the mouth and simply allowed to melt without chewing).

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6.2.3.1 Moisture content

Moisture is a surface textural attribute which describes the perception of water absorbed by or released from a product.

The popular terms used to describe the moisture content of a product reflect not only the total amount of moisture perceived but also the type, rate and manner of release or absorption. Popular terms include: dry (e.g. dry biscuit); moist (e.g apple); wet (e.g. water chestnut, mussels; juicy (e.g. orange).

6.2.3.2 Fat content

Fatness is a surface textural attribute relating to the perception of the quantity or the quality of fat in a product. With fat content, the total amount of fat and its melting point, as related to mouth-coating attributes and geometrical attributes, are also important.

Secondary parameters, i.e. oily, greasy and fatty, have been established to distinguish between these attributes:

— oily reflects the perception of soaking and runny fat (e.g. salad with French dressing);

— greasy reflects the perception of exuding fat (e.g. bacon, chips);

— fatty reflects the perception of high fat proportion in a product, without exudation (e.g. lard, tallow).

6.3 Development of terminology

See ISO 11035.

Terms must be established to describe the texture of any product. Traditionally, this is done by having the panel evaluate several samples representing the full range of textural variations for the particular product type of interest. It is helpful to give assessors a broad range of terms with clear concise definitions at the beginning of the session to ensure that as many one-dimensional attributes as possible are utilized.

The assessors then list all the terms which are applicable to one or all of the samples.

These are then discussed under the direction of a panel leader and a mutually acceptable list of terms and definitions is compiled. The following points should be considered:

— whether the terms include all the characteristics of the basic method relevant to the product;

— whether any of the terms have the same meaning and can be combined or deleted;

— whether each panel member agrees to the use of each term and its definition.

6.4 Reference products

6.4.1 Scales of reference products

Based on the classification of textural attributes, standard rating scales have been developed in order to provide a defined quantitative method of evaluation of the mechanical attributes of texture. These scales are only illustrative of the basic concept of using familiar reference products to quantify the intensity of each sensory texture attribute. These scales reflect the range of intensities of the mechanical attributes normally encountered in foodstuffs intended to be profiled. They may be adopted without modification, or other reference products may be selected to allow for local availability, food habits, etc.

These scales, as given, are suitable for training. However, they cannot be used to evaluate profiles of all products without some adaptation. For example, when evaluating products which are all soft (e.g. varying formulations of cream cheese), then the lower end of the hardness scale will have to be expanded and other portions deleted. Therefore, any portion of the scales could be expanded to allow for more precise ratings of similar products.

The described scales offer a basis for quantitative texture evaluation and the resulting values gives a "texture profile". The scales are given in annex A. The scales for cohesiveness and springiness are those suggested by Munoz [9] and are not part of the originally developed scales by Szczesniak and Brands [11] (see annex C). The reason for this is that no suitable set of reference products has been developed to represent varying intensities of cohesiveness.

6.4.2 Criteria for selection of reference products

NOTE 7 The intent in establishing reference products scales is to point out that it is feasible to construct intensity scales for sensory textural attributes and that it is possible to select well-known foods as examples of specific intensities of these attributes. It is a method used to train assessors to use the same scale and evaluate the same sensory concept and also to speak the same language.

It should be realized that:

a) some foods may not be available in certain parts of the world;

b) even within a country, some of the foods may become unavailable with time;

c) the intensity of the textural attributes of some foods may change due to the use of different raw materials, or to changes in manufacturing practices.

Under these conditions, other products should be selected to fill out the scales.

Each scale shall encompass the full intensity range of the textural attribute encountered in the food products.

The reference products selected ideally should

— include specific examples for each point on the scale;

— possess the desired intensity of the textural attribute and this attribute shall not be overshadowed by other textural attributes;

— be readily available;

— have a constant quality;

— be generally familiar products or well-known brands;

— require minimum handling to prepare the product for evaluation; and

— undergo minimum change in textural attributes on small temperature variations or on short-term storage.

NOTE 8 Speciality items and laboratory preparations should be avoided as much as possible. Attempts should be made to select well-known commercial products of known low variability. Commercial products should be selected solely on the basis of the desired intensity, the particular intensity of the attribute and the reproducibility from batch to batch. Fresh fruits and vegetables should be avoided, where possible, because the texture varies greatly with the variety, degree of maturity and other factors. Items that require cooking should also be avoided.

Reference products shall be standardized as to size, shape, temperature and form (i.e. peeled, sliced, ground).

The textural attributes of many foods are dependent on the humidity of the environment in which they are stored (e.g. biscuits, potato chips). In these cases it may be necessary to control the humidity of the atmosphere under which such foods are tested and to condition the samples prior to testing so that they are in equilibrium with the test atmosphere. The implements or containers used by assessors shall also be standardized.

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6.4.3 Modifications of reference scales

Once familiar with the basic method and reference scales, the panel shall establish a frame of reference by using several samples of the same product type in order to develop the evaluation technique, terminology and specific order of appearance in which the textural attributes are to be evaluated. As the panel evaluates each set of reference products they shall decide where they fall on the scale being used. This allows the panel to express the perception of variations in the attribute.

NOTE 9 Since the samples are well controlled with respect to size and temperature, panel members usually agree very well on any variations. This gives the panel confidence in their ability to judge.

Several reference materials for those texture scales provided may be substituted by other materials and/or serving conditions in order to:

— facilitate a more accurate illustration of a given texture attribute and/or intensity;

— expand the range of intensities in a reference scale;

— reduce the scale intervals between two reference materials;

— provide more convenient serving conditions (size and temperature) in order to facilitate manipulation of the material and the perception of the particular texture attribute; and

— account for the unavailability of products.

Standard scales for hardness, adhesiveness, springiness, cohesiveness of mass, moisture absorption, adhesiveness to teeth and touch have been proposed (see ref. [9], annex C), but these are only examples which must be adapted as a function of needs.

6.5 Order of appearance

Texture attributes follow a definite pattern of perception as described in 6.1 c). The panel shall evaluate the same characteristics in the same order. Usually each attribute shall be evaluated at the time at which it is most obvious and, therefore, most easily discerned.

After the panel has developed a method and a list of appropriate descriptors in the proper sequence, an answer form shall be drawn up. This form is a guide for each panel member for reporting the data. It shall describe the procedure to be followed at each stage of the evaluation, the descriptors to be evaluated and their proper sequence and the corresponding intensity scales.

6.6 Evaluation technique

When establishing a standard technique for evaluation, the manner in which the product is normally consumed is considered, including:

a) the way the food is introduced into the mouth (e.g. bitten with front teeth, removed from spoon by lips, or placed whole in the mouth);

b) the way in which the food is broken down (e.g. it is chewed with the teeth only; it is manipulated between the tongue and palate; or it is partially broken down by the teeth and then manipulated by the tongue to complete the breakdown);

c) the condition of the food prior to swallowing (e.g. is the food usually swallowed as a liquid, semi-solid, or as particles suspended in saliva?).

The adopted technique should duplicate as closely as possible the eating conditions to which the food is normally subjected.

(See for example figure 1.)

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6.7 Use of intensity scales

Category, line and ratio scales are the types commonly used for texture profiling (see ISO 4121).

7 Preparation and presentation of samples for training and for tests

Procedures for sample preparation shall be standardized. Particular attention shall be paid to:

a) standardizing the preparation of samples so that the resulting textures are representative of the products to be tested and reproducible from day to day and batch to batch;

b) standardizing the sample size and shape so that the object to be masticated or manipulated is consistent as well as representative of the product as it is usually introduced into the mouth;

c) defining and controlling, whenever appropriate, sample temperature, moisture content, time elapsed after preparation, etc.