INTERNATIONAL STANDARD

ISO 11035

First edition
1994-12-15

Sensory analysis — Identification and selection of descriptors for establishing a sensory profile by a multidimensional approach

Analyse sensorielle — Recherche et sélection de descripteurs pour l'élaboration d'un profil sensoriel, par approche multidimensionnelle

Reference number
ISO 11035:1994(E)

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 11035 was prepared by Technical Committee ISO/TC 34, *Agricultural food products*, Subcommittee SC 12, *Sensory analysis*.

Annexes A, B and C of this International Standard are for information only.

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Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Introduction

An overall sensory profile describes the sensory attributes of a product.

A "product" is characterized by several parameters. Some of these have a single dimension (e.g. the diameter of a ball, the weight of a sachet, etc.) and others have several dimensions (e.g. the shape of a product, the texture of meat, etc.); a sensory profile requires monodimensional quantities to lead to a measurement of intensity.

Consequently, the evaluation of a complex sensory quantity needs methodology which is founded on identification of appropriate descriptors. This work is given to a trained panel who describe their perceptions both qualitatively (nature of the stimulus) and quantitatively (intensity of each stimulus).

If the aim is to appreciate all the attributes, an "overall sensory profile" is built; if it concerns the evaluation of only flavour, odour, texture or appearance, a "partial sensory profile" is then elaborated.

In both cases, the choice of descriptors is the preliminary phase which determines the quality of the sensory profile.

There are several ways to establish a list of descriptors, for example:

a) leave each assessor to choose and use, for the final profile, his/her own descriptors (free-choice profile);

b) use descriptors common to all the members of the panel, either

   1) by suggesting existing descriptors, on condition that the relevance of the descriptors for the product has been checked and that the assessors have been trained on these descriptors (generally with the help of reference products), or

   2) by the creation of descriptors by all the members of the panel after individual or collective work.

This can be done by a consensus method (see, for example, ISO 6564) or by the method described in this International Standard, which is characterized by the elaboration of a list of descriptors convenient for the product studied and which guarantees, as far as possible, the exhaustivity of this list, and allows verification of the relevance and independence of each descriptor, and if they are monodimensional.

NOTES

1 Drawing up a sensory profile of a product is a complex procedure and the user of this International Standard needs to know that although this method gives satisfactory results, it requires a large investment in preparation time, calculation and number of training sessions.

2 This International Standard requires a basic knowledge of multidimensional analysis [in particular, a minimal knowledge of Principal Components Analysis (PCA) and Hierarchic Ascending Classification (HAC)].

Sensory analysis — Identification and selection of descriptors for establishing a sensory profile by a multidimensional approach

1 Scope

This International Standard describes a method for identifying and selecting descriptors which can then be used for drawing up the sensory profile of a product.

It describes the different stages in the process for setting up tests through which a complete description of the sensory attributes of a product can be obtained:

— from a qualitative point of view, by defining by means of descriptors all the perceptions for distinguishing one product from others of the same type;

— from a quantitative point of view, by evaluating the intensity of each descriptor (stronger or weaker impression analysed by an assessor on one element of the overall perception).

The so-called "sensory profile" method can be used:

— to define a production standard; identification of the nature of the differences makes it easier to grasp the issue;

— to improve or develop products;

— to study the influence of the ageing of products and also of the conditions of storage and preservation; it is thus possible to determine those characteristics which vary and to what extent;

— to compare a product with those of the same type already on the market; it is therefore possible to tell the nature of the differences in terms of sensory perception.

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 4121:1987, *Sensory analysis — Methodology — Evaluation of food products by methods using scales.*

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

ISO 6564:1985, *Sensory analysis — Methodology — Flavour profile methods.*

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.*

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 5492, and the following definitions apply.

3.1 descriptor: A term referring the assessor to an element of the perception of the product. The properties of the descriptor (relevance of the product, monodimensional) shall be such that it can be used to produce an evaluation on a scale of intensity (sweet flavour of sucrose, for example).

3.2 overall sensory profile: The use of descriptive terms in evaluating the sensory attributes of a sample and the intensity of each attribute.

3.3 partial sensory profile: The use of descriptive terms in evaluating the sensory attributes of a sample and the intensity of each attribute by one or by several sensory inputs.

Examples: flavour profile, texture profile, appearance profile and odour profile.

4 Principle

Identification and selection of a set of relevant descriptors giving maximum information on the sensory attributes of the product under analysis, in order to establish a sensory profile.

The various stages in the methodology are given below (see figure 1):

— training of the panel,

— preparation of a list of descriptive terms,

— reduction of the list of terms,

— choice of reference products,

— training,

— use of the profile.

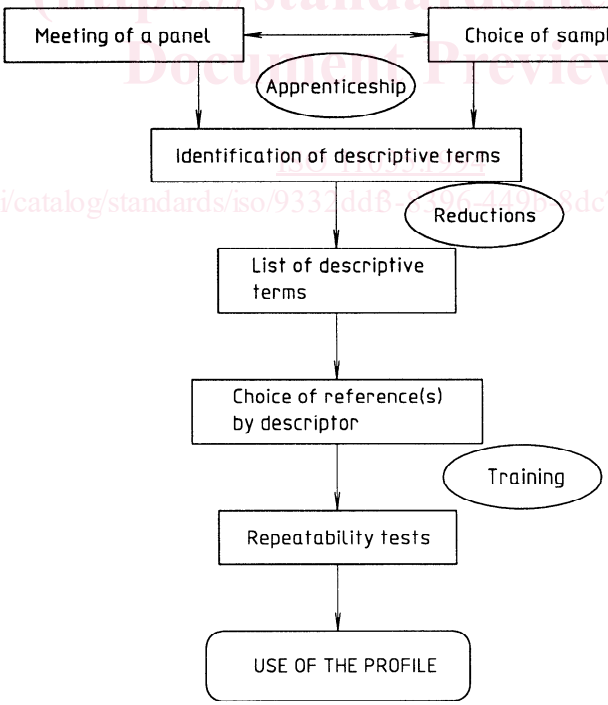

Figure 1 — Stages in the identification and selection of descriptors for establishing a sensory profile

5 General test requirements

The general directives concerning the methodology of sensory analysis described in ISO 6658 shall be followed.

5.1 Test room

See ISO 8589 for the characteristics of the room in which the tests are to be performed.

5.2 Apparatus

The apparatus should be selected by the panel leader according to the nature of the product or products to be analysed, the number of samples, etc., and shall have no influence on the results.

If standard apparatus meets the requirements of the test, it shall be used.

6 Methodoloy

6.1 Number of assessors

A minimum number of six assessors is required in order to allow for individual differences.

In order to have a group of six to ten assessors permanently available, it is recommended that two or three times this number be trained and coached.

6.2 Training of the panel

The quality of the sensory profile depends on the quality of the panel. It is important that the assessors be correctly trained and coached before selection according to their ability to recognize and evaluate the stimuli pertaining to the types of products for which a sensory profile is to be established.

When selecting the assessors, their creativity and their ability to express themselves are the first criteria to be taken into account. In fact, it is important for the assessors to have an extensive vocabulary and to be at ease in the use of this vocabulary in order to produce a simple and easily understood description of the product to facilitate communication between the various parties concerned.

Training is carried out on the types of products for which the profile is to be established or on their component parts (identification of the components and evaluation of the perceived intensities). All these preliminary sessions contribute to the training of the assessors. When this training period is over, the capacity of each assessor to repeat the evaluation shall be verified.

For conventional methods of selection, training and testing, consult ISO 8586-1 for assessors and ISO 8586-2 for experts. However, these methods shall be adapted to the profile concerned (overall profile, flavour profile, texture profile, etc.).

It is important that the assessors regularly attend sensory analysis training sessions. Regular attendance at the classes also gives an indication of the motivation of the assessors.

6.3 Role of panel leader

The role of the panel leader is of utmost importance in the selection of the panel, its training and maintaining the motivation of the assessors.

The panel leader should also be able to conduct and coordinate a work group, taking into account the opinions of each participant and harmonizing them.

6.4 Identification of the largest possible number of descriptive terms

The aim of this stage in the identification of descriptors is not to neglect any aspect of the product and to avoid bias due to the influence of an individual on the group. It also serves as an apprenticeship for identifying and evaluating the nature of the differences.

6.4.1 Selection of products

A series of similar products should be selected (three or four per session) which, when tasted, will enable the assessors to distinguish all the possible qualitative differences which can be detected in the product for which the profile is to be drawn up.

To obtain these differences between products, factors such as ageing, proportions of ingredients during manufacture, or the duration of certain stages in manufacture can be varied. Another possibility would be to examine similar rival products.

6.4.2 Generation of descriptors in tasting booths

In order for the assessors to achieve the necessary concentration for individual identification of the descriptive terms, without trying to make do with the terms given by others, the assessors should each be in tasting booths (see ISO 8589) under the usual conditions for sensory evaluation of products.

In the initial sessions (at least four), the assessors are presented with the product for which the profile is to be made as well as the series of selected samples. The assessors are asked to generate the maximum number of terms (descriptors) to describe all the sensations produced by these products, whether visual, tactile, olfactory or gustatory (in the case of an overall profile) and to note down on the form provided all the terms which occur to them. (See annex A for a specimen form.)

6.4.3 Group discussion

The assessors then discuss in a group and compare their perceptions under the guidance of the panel leader who should encourage each of them to analyse the different components of the perception of the products.

These components shall be expressed by an appropriate descriptor (e.g. bitterness, acidity, smoky flavour, etc.).

The identification of terms ceases once the assessors have exhausted their vocabulary on the product. The group usually manages, in several sessions, to generate without difficulty more than a hundred different descriptive terms.

All the descriptive terms are then collected together at this stage, including synonyms.

See an example of an application to sandwich bread in annex B.

6.5 Preliminary sorting of descriptors

This sorting is performed during the initial sessions by the panel leader during group discussions and in the presence of the samples.

The following are gradually eliminated from the discussion:

— hedonistic terms, such as pleasant, fine, appetizing, good, etc.;

— quantitative terms, such as too much, too little, strong, weak, etc.;

— terms describing the product in its own terms, such as "bready taste" for bread (except for certain cases of prepared or converted products where the odour or the aroma of a constituent remains, for example the aroma of vanillin or vanilla in vanilla ice cream);

— irrelevant terms such as "acid" when describing an odour.

The panel leader explains to the assessors why these terms are considered to be unsuitable for the intended purpose, which is to identify and describe the nature of the perception and the combinations of differences between products.

6.6 First reduction of the number of descriptors

The descriptors resulting from the preliminary sorting are generally too great in number; in further tasting sessions, terms are eliminated which do not appear suitable for describing or differentiating products from a sensory point of view.

In order to make this reduction, it is necessary to make sure that the assessors have well understood the meaning of each descriptor.

The assessors are presented with different variants of the product and are asked, for each of the descriptors used, to judge the perceived intensity by allocating it a mark on a scale from 0 to 5, specifying that zero (0) is equivalent to an absence of perception for the property considered.

NOTE 3 It is possible to check if there are differences or not in the perception of the products by using triangular tests.

Figure 2 presents the type of scale which is usable for each descriptor in the first reduction.

Consult ISO 4121 for methods using scales and categories.

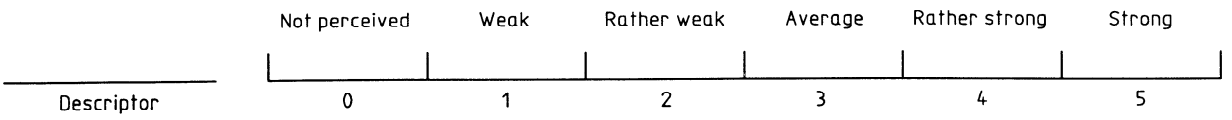

Figure 2 — Scale of intensity for the first reduction of descriptors

In order to reduce at this stage the number of descriptors, they are initially classified by the geometric mean M, which is the square root of the product of the frequency, F, and the relative intensity, I, of each descriptor:

$$M = \sqrt{F \cdot I}$$

where

F is the number of times the descriptor is mentioned over the total number of times it is possible to mention that descriptor, expressed as a percentage; and

I is the sum of the intensities given by the whole panel for a descriptor over the maximum possible intensity for this descriptor, expressed as a percentage.

This method of calculation makes it possible to take into account, in the same way, descriptors which are rarely mentioned but which are very important in terms of the perceived intensity and descriptors with a low perceived intensity but which are mentioned often (see ref.[1] in annex C).

The classification of descriptors according to the size of this mean makes it possible to eliminate a number of descriptors whose geometrical means are relatively low.

EXAMPLE

Tables 1 and 2 give the sequence of calculations in the case of 5 products tested with 9 descriptors by 18 assessors.

The total number of times each descriptor is mentioned is, in this case, 90 (5 products by 18 assessors).

The total possible intensity per descriptor is 450 (maximum of 5 on the scale of intensity for 5 products with 18 assessors = 5 × 5 × 18).

In this example, the calculations (table 3) show that the descriptors classed in the lowest two positions (D3 and D8) could be eliminated.

Table 1 — Calculation of the frequency, F, of mentioning each descriptor

Product	Descriptors								
	D1	D2	D3	D4	D5	D6	D7	D8	D9
P1	12	8	0	9	8	17	17	1	12
P2	17	17	0	15	16	9	4	1	16
P3	2	12	0	4	8	0	1	1	3
P4	7	1	3	5	8	14	14	1	4
P5	1	9	0	6	14	2	3	2	3
Number of mentions	39	47	3	39	54	42	39	6	38
F = Number/total number (%)	43,3	52,2	3,3	43,3	60,0	46,7	43,3	6,7	42,2

Table 2 — Calculation of the relative intensity, I, of each descriptor

Product	Descriptors								
	D1	D2	D3	D4	D5	D6	D7	D8	D9
P1	69	43	0	16	27	64	31	5	19
P2	43	33	0	30	52	44	9	3	33
P3	3	25	0	13	42	2	2	1	11
P4	36	8	10	6	8	37	50	5	5
P5	4	19	0	30	78	5	11	11	7
Perceived intensity per descriptor	155	128	10	95	207	152	103	25	75
I = intensity/total intensity (%)	34,4	28,4	2,2	21,1	46,0	33,8	22,9	5,6	16,7

Table 3 — Classification of descriptors by importance (by geometric mean)

Parameter	Descriptors								
	D1	D2	D3	D4	D5	D6	D7	D8	D9
I	0,344	0,284	0,022	0,211	0,460	0,338	0,229	0,056	0,167
F	0,433	0,522	0,033	0,433	0,600	0,467	0,433	0,067	0,422
M	0,386	0,385	0,027	0,302	0,525	0,397	0,315	0,061	0,265
As a percentage	38,6	38,5	2,7	30,2	52,5	39,7	31,5	6,1	26,5
Classification of descriptors	3	4	9	6	1	2	5	8	7

See also an example of the application to sandwich bread in annex B (tables B.2 to B.4).

6.7 Second reduction in the number of descriptors by multidimensional analysis and variance analysis

The second reduction makes it possible to group together synonyms (correlated positively) or antonyms (correlated negatively) and eliminate descriptors which make very little contribution to showing differences between the products tested in a sensory profile.

6.7.1 General principles

Multidimensional analysis allows evaluation of the relative importance and the contribution of descriptors in differentiating products since it allows all the products to be visualized at the same time as well as the correlations between the descriptors. By identifying the closeness of the descriptors and the weight attached to each descriptor for distinguishing between products, it is possible to eliminate some of them or to group them together.

The interpretation of a Principal Components Analysis (PCA) thus permits the following to be noted:

a) the relative importance of each axis (linear combination of the descriptors) in relation to the total cloud (% inertia):

b) the contribution of each descriptor in relation to the main axes (relative contribution);

c) the "quality" of the representation of each element on the chosen plane (cosine square), which indicates whether or not the element is close to the plane of projection of the product/descriptor space.

Certain products can make too great a contribution to the inertia by overpowering the others in the chosen representation space and by masking the differences. These should be eliminated from the search for descriptors.

Care should be taken that there is a good distribution of the products in the four quadrants of the projection planes.

6.7.2 Rules for reducing the number of descriptors

Three rules have to be applied in order to reduce the number of terms.

a) Delete terms which do not best characterize the product space and/or the differences between products. If a descriptor maintains a constant value for all of the products evaluated, it may be kept provided that it is always desirable to find again that characteristic at a given intensity (e.g. in quality control).

In a multidimensional analysis, a weak contribution of the descriptors in relation to the relevant axes is interpreted as a term which is only slightly appropriate or a descriptor which maintains a constant value.

It is best to examine the contribution of each descriptor on all the axes so as not to eliminate a descriptor which is independent of the others and which would constitute by itself an axis which is relevant but of weak inertia.

b) Delete synonymous terms, since they will appear close together in the PCA and in the associated Ascending Hierarchical Classification (AHC) (see refs. [2]-[6]).

c) Replace by a single descriptor, to be defined with the assessors, two terms which are sensory opposites (correlation close to −1 and descriptors opposite in relation to the centre of gravity of the descriptor space).

Before eliminating a strongly correlated term or a term anti-correlated to another, it is necessary to ensure that it really does belong to the same sensory continuum. For example, "sweet" and "acid" in the case of ripening of a fruit do not belong to the same sensory continuum, even if a diminution of acidity may be related to an increase in sweetness.

In practice, the corresponding scores of synonymous descriptors are added up if a second processing of the data table is desired. Consequently, a single term will be kept which has to be redefined with all the assessors. The advantage of the second processing is that it can check that no information has been lost. A "product" space or a "descriptor" space largely identical to that resulting from the first processing should be obtained.

The final number of descriptors shall be at most 15 in order to obtain an operational profile, i.e. one enabling an assessor to evaluate several samples of products in less than one hour. If the number of descriptors is too high, what one hopes to gain in finesse is lost in the accuracy of the measurement.

EXAMPLE

A simplified example given in table 4 [1] helps to illustrate two important points in the reduction of terms from the data table by grouping the intensities given by the panel for each product and each descriptor.

In this example it can be seen that descriptor D1 does not discriminate between products since the mean of the perceived intensities is similar (assuming that all the scales are identical).

NOTE 4 The power of discrimination of each descriptor should be verified for the different products by a ranking test and/or a variance analysis. The ranking test permits verification of the discrimination of the products no matter how the assessors use the scale. The variance analysis ensures the similarity of the mean of the values of each product for one descriptor. The equality of the means given by assessor and by product can be tested by applying a two-factor variance analysis ("product" factor and "assessor" factor).

If only differences between products are of interest, descriptor D1 can be eliminated (provided that samples have been taken of all the products within the range in order to make sure that this descriptor will not play any part in the differences).

In the case of quality control, for example, it would be important to keep D1 in order to be sure of finding again this characteristic with the same intensity in all of the products.

Descriptors D2 and D3 are always in the same ratio of intensity; they are therefore closely correlated.

6.8 Choice of reference products or substances

If the number of descriptors is reduced, a definition of each descriptor shall be given, understood by all the assessors, which shall be kept for easy reference. A suitable stable reference product shall also be assigned to each of these descriptors.

A pure chemical is not necessarily a relevant reference substance for defining a descriptor. For example, the assessor must be able to extract from a complex sensation the stimulus which echoes the descriptor (e.g. bitterness of a coffee, astringency of a fruit, etc.).

It is important to use reference products which are stable or reproducible in time. The choice of these reference products can be difficult, as it is a question of reconciling appropriateness and ease of use.

Table 4 — Example of a table of results for the whole panel

Product	Descriptors					
	D1	D2	D3	D_i	...	D_n
P1	11	60	20	...	...	...
P2	13	45	15	...	...	...
P3	12	75	25	...	...	...
P4	12	30	10	...	...	...
P5	11	6	2	...	...	...
P6	13	15	5	...	...	...

1) This example is not connected to tables 1 to 3.