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Sensory analysis — General guidance for the application of sensory analysis in quality control

Analyse sensorielle — Lignes directrices générales pour l'application de l'analyse sensorielle en contrôle qualité

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Foreword

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This document was prepared by Technical Committee ISO/TC 34, *Food products*, Subcommittee SC 12, *Sensory analysis*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Sensory analysis — General guidance for the application of sensory analysis in quality control

1 Scope

This document gives guidelines for the implementation of a sensory analysis programme in quality control (QC), including general elements and procedures.

It is applicable to food and non-food industries.

It is limited to in-plant sensory analysis in QC.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5492, *Sensory analysis — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5492 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
quality
degree to which a set of inherent characteristics of an object fulfils requirements

Note 1 to entry: The definition of quality in this context includes consumer input.

Note 2 to entry: Quality has a multidimensional nature. The critical quality dimensions or inherent quality characteristics of the product should be determined.

Note 3 to entry: Satisfaction in this context includes consistent conformance to stated or implied needs. The product's degree of conformance and its reliability should be taken into consideration.

[SOURCE: ISO 9000:2015, 3.6.2, modified — The notes to entry have been replaced.]

3.2
quality control
QC
part of *quality* (3.1) management focused on fulfilling quality requirements

Note 1 to entry: QC is a procedure or set of procedures intended to ensure that a manufactured product adheres to a defined set of quality criteria or meets the requirements of the customer.

[SOURCE: ISO 9000:2015, 3.3.7, modified — Note 1 to entry has been added.]

3.3
quality assurance
QA
part of *quality* (3.1) management focused on providing confidence that quality requirements will be fulfilled

Note 1 to entry: In developing products, QA is any systematic process of checking to see whether a product being developed is meeting specified requirements.

[SOURCE: ISO 9000:2015, 3.3.6, modified — Note 1 to entry has been added.]

3.4
specification
document stating requirements

Note 1 to entry: A specification can be related to activities (e.g. procedure document, process specification and test specification), or products (e.g. product specification, performance specification and drawing).

Note 2 to entry: A specification is an exact statement of the particular needs to be satisfied, or essential characteristics that a customer requires and which a vendor must deliver. Specifications are written usually in a manner that enables both parties (and/or an independent certifier) to measure the degree of conformance.

[SOURCE: ISO 9000:2015, 3.8.7, modified — The example has been deleted and Note 2 to entry has been replaced.]

3.5
sensory specification/standard
document or product that defines the required sensory characteristics of an ingredient (raw material), a packaging material, an in-process or finished product (including its packaging) and their acceptable ranges of variation

Note 1 to entry: It may also be called "control standard".

Note 2 to entry: It may be a paper standard (paper or electronic document with written and/or pictorial descriptions) or reference samples (product standard), which is or are selected to represent the *quality* (3.1) of the product.

3.6
calibration reference
material that represents the possible range of deviations from the *specification* (3.4)

Note 1 to entry: For a finished product, calibration references can be created through formula modification or by aging or abusing the product to demonstrate minor, moderate and major variations from the control.

Note 2 to entry: Reference products with unacceptable deviations can be helpful in demonstrating issues arising from raw materials, processing and packaging.

Note 3 to entry: It is recommended to determine calibration references by experts from the R&D department and/or sensory group, but references should be checked against consumer's opinions.

3.7
in-out test
test to determine whether a test sample is within or outside a relevant sensory *specification* (3.4)

Note 1 to entry: It is also called "pass/fail method" or "accept/reject method".

[SOURCE: ISO 5492:2008/Amd.1:2016, 4.60, modified — Note 1 to entry has been added.]

3.8
difference-from-control test
test to indicate the degree of difference between a test sample and a control standard

Note 1 to entry: It is a comparison test. It is essential to establish and maintain a constant control standard.

Note 2 to entry: The range of difference from control standard and its meaning for disposition in *quality control* (3.2) should be established.

4 Elements for implementing and maintaining a sensory quality control programme

4.1 Assessment from various perspectives

During its set up and implementation, a sensory QC programme should be assessed from various perspectives, such as

— existing quality assurance (QA)/QC practices,

— product quality records and factors influencing the required sensory quality of finished products,

— possible sensory test capability,

— technical level of the production manufacturer,

— cost and economic benefit,

— consumer acceptance, and

— market feedback.

4.2 Sensory analysis in all phases of production process

A sensory QC programme should cover all phases of the production process. Sensory analysis of raw ingredients as well as in-process and finished products should be taken into account. Evaluation procedures should follow the rules of good sensory practices, such as capable assessors and proper sensory methods, when possible with same conditions of preparation and evaluation for each sample, proper environment, controlled procedures and balanced designs.

4.3 Consumer-derived sensory specifications

Input from target consumers should contribute to establishing sensory specifications of products. Key sensory attributes and their acceptable limits should be established on the recognition and acceptance of targeted consumers to ensure that the sensory QC programme can meet the needs of consumers and allow monitoring of the current quality of products (including competitive products in the market). Examples of defective products should be maintained to assist in resolving production problems or consumer complaints.

4.4 Sensory and instrumental data

Sensory analysis and instrumental analysis are both powerful tools that can be used in QC. The relationship between sensory and instrumental data is needed to explore and validate the instrumental techniques to measure or provide information on the key sensory attributes of product. Sensory analysis is the only way to obtain direct measurement of perceived attributes. It assists in better understanding and satisfying the needs of consumers. All instrumental devices or analytical measures used to estimate sensory quality should be tested with the company's products and production variability ranges, and validated with the sensory responses collected by sensory analysis.

4.5 Detailed quality records

The monitoring requirements for sensory QC and their inspection should be fully documented and recorded. Records should be completed and detailed in such a way that they are easy to understand conveniently and effectively. They should clearly explain the state of product quality and give reliable

reasons for the rejection of products that do not meet the specified quality. They can provide guidance on the specific actions to be taken.

5 Procedures to implement a sensory quality control programme

5.1 General

To carry out a sensory QC programme, it is important to

— first, establish the sensory specification in paper and/or physical standards,

— second, to collect quality data, including the establishment of a sensory panel, the facilities with appropriate equipment, the selection of sensory analysis methods, and statistical analysis and interpretation of results, and

— finally, to take decisions through statistical analysis of the data.

Figure 1 shows a design for a complete programme.

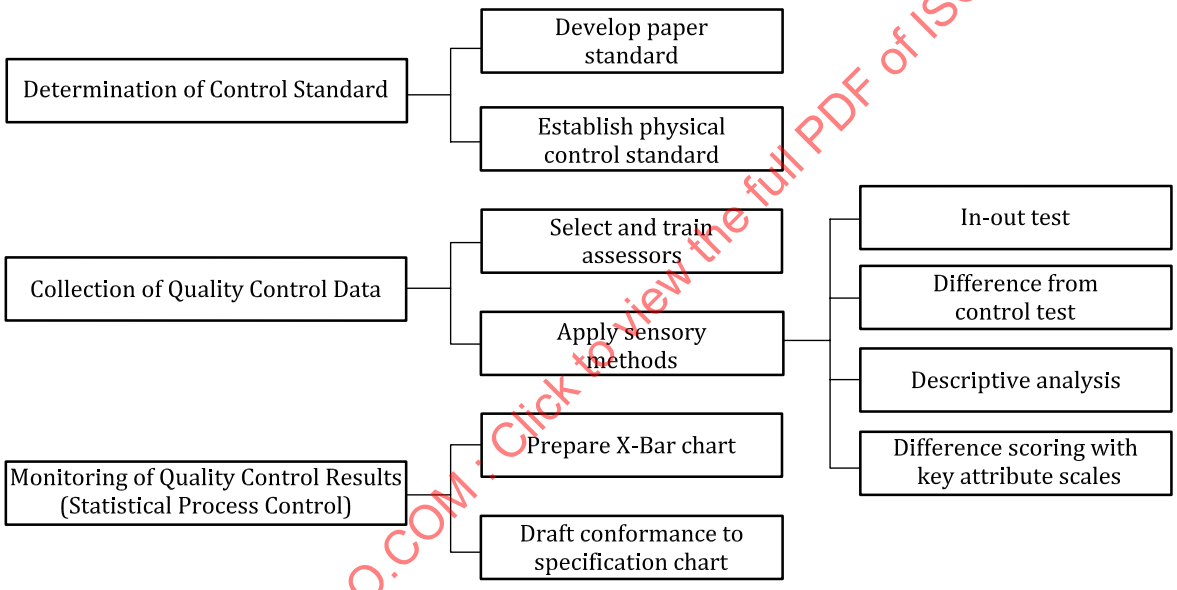

Figure 1 — Design for implementing a sensory QC programme

5.2 Establishing sensory specifications/standards

5.2.1 General

When defining the sensory specifications/standards, several factors should be considered, such as marketing objectives, production variability, attributes that drive consumer acceptance, the nature of the product, manufacturing conditions and available resources. The specific objectives of the QC programme should also be taken into account. When the objective is to design a sensory QC programme to avoid sensory defects, the sensory quality standards will include a description of the most common defects in the product, including those defects resulting from inadequate characteristics of the raw materials used or from process conditions. Defects can also result from incorrect or prolonged storage or from accidental causes. When the objective of the QC programme is to control the featured sensory quality in a specific designation of origin or to compare the quality of an industrial product with competitors in the market, the sensory quality standards should include, not only the attributes defining their sensory profiles, but also those affecting acceptability.

5.2.2 Paper standard

The elaboration of a paper standard should include definitions for all the key attributes, especially those driving consumer acceptance and perceptible variations with acceptable limits depending on the raw materials and/or manufacturing process. Key attributes refer to those attributes that vary in production and that are likely to cause consumer rejection. Sensory professionals and/or management staff should determine them based on descriptive analysis and consumer testing. Photographs can also be used as supplements of paper standards, especially for the appearance requirements of raw materials in process and finished products.

5.2.3 Physical control standard

The physical control standard or target-finished product can be prepared according to the formula and process determined by product development and can be stored in the required conditions. It can also be prepared by selecting products of required quality from practical production under normal conditions. Physical control standards of raw materials should be determined jointly by the manufacturer and supplier and contracted by a preliminary protocol.

The validity of physical control standards can vary with time and should be periodically renewed to be sensorially identical to the previous ones and/or updated and adapted to market variations as per consumer-derived sensory specifications.

5.2.4 Preservation and renewal of physical control standards

Once a physical standard has been identified, optimal storage conditions and an adequate supply of the standard in storage should be determined and documented for future reference. An appropriate quantity of the control standard in suitable packaging and storage conditions should be preserved to guarantee that the change of its sensory quality is minimal. It should be replaced when it is depleted or when the sensory properties have changed. A clear methodology to substitute the standard product when necessary should be established. The new standard product should have identical sensory characteristics to the previous one. This similarity should be ascertained by means of a sensory discrimination test, such as the triangle test defined in ISO 4120.

5.3 Selection, training and qualification of assessors in quality control

5.3.1 General

The assessors involved in sensory QC are selected within the enterprise and/or external experienced panellists. Selection, training and monitoring are carried out in accordance with ISO 8586. Calibration references and sensory specifications of finished products, in-process products and incoming ingredients should be used in training sessions.

Appropriate assessors, either initiated, selected or expert, are recruited following ISO 8586 and ISO 13300 (all parts) according to the assessor's requirements for the sensory analysis methods.

5.3.2 Assessors for finished product evaluation

Assessors for finished product evaluation can be selected from large number of sources (e.g. external panels or company employee panels with selected assessors or expert assessors), depending on the requirements for the method selected. Their main task is to carry out the sensory tests for the QC (except in-process evaluation and consumer testing) of the finished product. In addition, they may provide guidance or assist in adjusting the sensory programme. They should be trained to

— be familiar with sensory relevant standard products and the limits of acceptable variations,

— give diagnostic information on defects, if references are available typifying these problems, and

— provide reproducible, repeatable and valid sensory results.

5.3.3 Assessors for in-process evaluation

Assessors from the production facilities are usually recruited for in-process evaluations and their task is to carry out sensory checking throughout the production. In their recruitment, their interest, willingness and availability to participate can be as important as, or sometimes should have more priority than, sensory acuity. They should receive necessary sensory training that covers

— basic knowledge of sensory evaluation methods,

— the sensory specification and use of standard products, intermediates or incoming ingredients,

— the appropriate range of variation in key sensory attributes,

— common sensory defects in the product,

— sensory changes that could arise from accidental variation in product formula and/or processing, and

— the steps to be taken based on the results of their sensory tests.

5.3.4 Assessors for raw materials evaluation

Assessors from the production facilities are usually recruited for evaluation of raw materials when they are safe and can be evaluated by human senses. In their recruitment, their interest, willingness and availability to participate can be as important as, or sometimes should have more priority than, sensory acuity. They should receive necessary sensory training that covers

— the sensory specification and use of standard raw materials,

— the appropriate range of variation in key sensory attributes,

— common sensory defects and changes in raw materials, and

— the steps to be taken based on the results of their sensory test.

5.4 Appropriate facilities

There should be a distraction-free environment for sensory evaluation in each manufacturing location. Minimal distractions from noise and extraneous odours are required to ensure that assessors are not biased. A separate room or an area with an open table top should be used.

The lighting in the environment should be uniform, free from strong shadows and controllable (see ISO 6658 and ISO 8589). If colour is the key attribute of the product to be evaluated, there should be strictly controlled conditions of lighting (e.g. type, level, direction) and of the surroundings of the viewing area (see ISO 11037 for details). The temperature and humidity of the testing place should be appropriately controlled to make assessors feel comfortable. Appropriate space and an easy access location should also be taken into consideration when selecting and designing the place for sensory analysis.

The facility should include specific equipment depending on the nature of the product (e.g. kitchen, booths, mirrors, sinks) and the office equipment necessary to prepare and store samples for evaluation.

5.5 Sensory method applications

5.5.1 General

Many sensory methods have been introduced for application in QC. This document provides a description of the four most common methods: the in-out test (see 5.5.2), the difference-from-control test (see 5.5.3), the descriptive sensory analysis method (see 5.5.4) and the difference scoring with key attribute scales test (see 5.5.5). Other sensory methods include (but may not be limited to) overall discrimination tests, overall quality rating, attribute scaling, and quality grading or rating with diagnostics.

5.5.2 In-out test

NOTE See DIN 10973:2006-04.

An in-out test is used to determine whether the tested sample is within its sensory specification or not. It is especially suited for raw materials, relatively simple products or more complex finished products with very few variable sensory dimensions. It is recommended for the following conditions:

— when product deviations cannot be easily described by independent attributes;

— when no single control standard can represent the entire group of products that are "in";

— when all types of defects and deviations likely to occur from raw materials, processing or packaging are represented by calibration references.

The organization should set the criteria (e.g. 70 % "in") to determine the acceptance or rejection.

5.5.3 Difference-from-control test

NOTE See DIN 10976:2016.

A difference-from-control test is used to indicate the magnitude of differences between a tested sample and a control standard. The feasibility to maintain a constant control standard product for comparison is essential in this method. It is also suitable for comparing products where there is a single sensory attribute or only a few sensory attributes that vary.

There are several ways to perform the test: one is to evaluate the overall degree of difference using a single intensity category scale; another is to evaluate the differences of key attributes from those of the control standard with a bipolar scale and a central point corresponding to the control standard. The latter allows for the assessment of both the magnitude and direction of differences in sensory attributes.

The level of unacceptable quality or rejection should be agreed upon in advance based on consumer testing and/or management input and this should be documented in the sensory specifications. Assessors should have knowledge of an acceptable, unacceptable and rejectable range of products.

EXAMPLE 1 Quality criterion for 10-point category scaling[14][15].

— A score of 9 to 10 is equal to match. The sample has similar sensory characteristics to the control. It is only with careful comparison to the control that a very fine distinction can be detected. The sample can be released.

— A score of 6 to 8 is equal to acceptable. The sample basically meets the definition for the product, but is somewhat different from the control in a way that can be relatively easily spotted. The sample is still acceptable.

— A score of 3 to 5 is equal to unacceptable. The sample does not meet the definition of the product and is very different from the control. The sample could be retested or all of the products could be reworked.

— A score of 1 to 2 is equal to reject. The sample has discernible defects and is completely different from the control. The product is therefore discarded.

EXAMPLE 2 Quality criterion for 5-point category scaling.

— A score of 5 is equal to a match. The sample is without difference or without just noticeable difference to the control. The product can be accepted.

— A score of 4 is equal to acceptable. The sample has a slight difference to the control. The product can be accepted.

— A score of 3 is equal to unacceptable. The sample has a medium difference to the control. The sample could be retested or all of the products could be reworked.

— A score of 2 is equal to reject. The sample has a large difference to the control. The product is therefore discarded.

— A score of 1 is equal to reject. The sample has an extremely large difference to the control. The product is therefore discarded.

5.5.4 Descriptive sensory analysis method

The descriptive sensory analysis method can be applied in QC to provide intensity ratings of key attributes of products. This approach is the most comprehensive in-plant sensory programme. It can provide quantitative data, which can be used for correlation analysis of the sensory data with either instrumental and/or consumer data. The correlation coefficient resulting from correlation analysis can then be used to understand the relationship between sensory data and instrumental data or consumer data. Descriptive sensory analysis is mainly geared to the evaluation and QC of finished products and needs many methodology requirements, mainly in assessors' training and descriptors' intensity measurement.

Specifications for a descriptive profile consist of a range of allowable intensity scores for the key attributes, which should be set via consumer testing and/or a management input by considering realistic production and cost limitations. Usually, the key attributes are a small set of the product's sensory attributes (approximately 5 to 15). Standard procedures for carrying out descriptive analysis methods can be found in ISO 13299.

The aim of descriptive analysis is to highlight differences, find their causes and make corrective actions easier to infer. Specific panel training is required in this method. If intensity on any given attribute for a sample falls outside the sensory specifications, the product is considered not compliant or out of specification. Products that fall within the intensity limit set by the sensory specifications are considered compliant or in specification.

5.5.5 Difference scoring with key attribute scales test

Difference scoring with key attribute scales testing is used to provide overall difference ratings and key attributes diagnostics. The feasibility to maintain a constant control standard product for comparison is essential in this method. It is a combination of overall difference ratings and key attributes diagnostics. It detects not only the magnitude of the overall difference from control, but also the direction and magnitude of the difference in key attributes. This procedure is useful when the objective is to evaluate the effect of a change in the product formulation on its sensory quality and when the direction of the possible changes in any quality attribute is not predictable. Intensity scales can be used for defects that could cause a higher unacceptable assessor response. For others, such as off-flavours or defects that could result in product rejection at any level, a list of descriptors and/or comments to check them should be provided. A descriptive analysis panel should be involved and its members should be well-trained to meet the requirements of ISO 13299. A mean score or frequency count of the number of assessors can be used to make action criteria. A small number of responses that give high differences can be considered to make decisions, rather than being considered outliers. If consistent patterns of disagreement between assessors occur, there should be retraining of the assessors involved.

For attributes that are bi-directional, a bipolar scale with a central point corresponding to the control standard can enable the assessment of the magnitude and direction of differences in sensory attributes.

5.6 Data presentation and integration of control charts

5.6.1 General

Quantitative sensory data can be reported as means with ranges of the observed data, standard deviations or standard errors. These data can be plotted as points on a line graph across time or batches, or as bar graphs.

They can also be presented in control charts, usually $\bar{X}$ chart. Control charts are a statistical process control tool used to determine if a manufacturing or business process is in a state of control. Statistical

