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GUIDELINES FOR THE ACCOMPLISHMENT OF REQUIREMENTS OF STANDARD ISO 17025 OF SENSORY TESTING LABORATORIES WITH PARTICULAR REFERENCE TO VIRGIN OLIVE OIL

Introduction

For the accreditation of sensory testing laboratories, all the requirements of ISO/IEC 17025:2017 must be met and verified by the competent Accreditation Body. However, because implementing the standard in sensory laboratories presents certain difficulties, the IOC has issued this additional guide, which is divided into two parts. The first deals with the correct organisational management of a sensory testing laboratory, while the second deals specifically with the recommended procedures of internal quality control for a laboratory for the sensory assessment of virgin olive oil (according to the methodology outlined in COI/T.20/Doc. No 15), as interpreted for the purposes of standard ISO/IEC 17025:2017.

Scope and field of application

The guidelines outline the steps for achieving compliance with the requirements stipulated in ISO/IEC 17025:2017 for the accreditation of sensory testing laboratories, with particular reference to virgin olive oil, under the international testing laboratory accreditation scheme.

The scope of this guide is to provide a source of recommendations, guidance and suggestions for panel leaders and laboratories interested in obtaining accreditation and a source of guidance and uniformity for inspectors responsible for auditing systems for the sensory analysis of virgin olive oil.

Normative references

ISO/IEC 17025:2017. General requirements for the competence of testing and calibration laboratories.
ISO 9001:2015. Quality management systems - Requirements.
ISO 13299:2016: General guidance for establishing a sensory profile
EA-4/09 G:2017. Accreditation for Sensory Testing Laboratories. COI/T.20/Doc. No 4. General basic vocabulary.
ISO 16657:2006. Sensory analysis Apparatus Olive oil tasting glass (COI/T.20/Doc. No 5). COI/T.20/Doc. No 6. Guide for the installation of a test room.
COI/T.20/Doc. No 14. Guide for the selection, training and monitoring of skilled virgin olive oil tasters.
COI/T.20/Doc. No 15. Method for the organoleptic assessment of virgin olive oil. COI/T.20/Doc. No 22. Method for the organoleptic assessment of extra virgin olive oil applying to use a designation of origin.
ISO 5555:2001. Animal and vegetable fats and oils – Sampling.

Scope of accreditation

Approved accreditation bodies only accredit objective sensory tests which are suitably documented and validated. Laboratories should prove that tests have been performed under control by demonstrating that they obtain results within defined limits. In so far as possible, they should also demonstrate that they obtain equivalent results to those obtained by other accredited laboratories.

Accredited sensory testing laboratories must be supported by adequate documentation demonstrating the repeatability and reproducibility of testing within the specific laboratory and between a considerable number of laboratories (interlaboratory test).

Laboratories undertaking the sensory analysis of virgin olive oils should prove to the accreditation inspectors that when performing such analysis, they comply with the IOC reference standards for the testing methodology.

Review of requirements

General

The main factors determining whether the activities of a sensory testing laboratory are performed correctly and reliably are:

- Human factors;
- Environmental and workstation conditions;
- Equipment;
- Traceability of measurements;
- Testing, calibration and validation methods;
- Handling of test items;
- Control of technical records;
- Ensuring the validity of results.

The laboratory should take the above factors into consideration when developing testing methods and related procedures and when training or qualifying technical personnel and sensory analysis assessors of virgin olive oils.

Structural requirements (5 ISO//IEC 17025:2017)

The sensory testing laboratory shall be a legal entity, or be defined as part of a legal entity; define its organization and management system structure; and have its procedures documented to the extent necessary to assure the consistent application of its activities and thus validity of its results.

The implemented management system must guarantee the identification of deviations and the application of actions to prevent or minimize such deviations, ensuring the required validity of the laboratory’s activities.

Personnel (6.2 ISO/IEC 17025:2017)

The laboratory manager should ensure that every individual involved in testing is competent and aware of their roles.

For laboratories undertaking the sensory analysis of virgin olive oils, personnel may be divided into two groups: technical personnel, who ensure the method can be applied and who prepare the necessary apparatus for this purpose; and sensory analysis assessors of virgin olive

oils, who are the specific analytical tools for performing the test. The technical personnel include the panel leader and the deputy panel leader.

The referenced standard COI/T.20/Doc. No 14 specifies the training required of the panel leader and of the sensory assessors of virgin olive oil. It also lays down the methodology for determining the detection threshold for characteristic attributes of the panel, for the selection of tasters by the intensity rating method and techniques for monitoring panel proficiency.

A) Panel leader

Sensory analysis must be carried out under the supervision of a qualified and experienced panel leader possessing the relevant qualifications. Management should assign the panel leader a post on the organisation chart. They should provide the necessary means and sufficient time for the panel leader to carry out his or her tasks and should give adequate recognition of the work carried out.

Paragraph 8.1 of document COI/T.20/Doc. No 15 “method for the organoleptic assessment of virgin olive oil” describes the duties of panel leaders in detail, and paragraph 7.2 of document COI/T20/Doc. No 14 points out the knowledge and experience required for panel leaders.

B) Assessors (tasters)

A sensory analysis panel is a measurement tool and the results of all the analyses performed depend on the members of the panel. Since the tasters of a panel are the measuring instruments in sensory analysis, strict requirements in terms of qualification are demanded for the taster to be a member of a panel and give reliable results. These requirements are specified in paragraph 7.1 of document COI/T20/Doc. No 14.

The laboratory should document the screening and training programme to make sure that all of the sensory assessors are properly trained for their role.

C) Additional training

The laboratory should have procedures and criteria in place for additional training of sensory assessors who have not performed a test for some time or whose results do not lie inside acceptable limits. Paragraph 6 of document COI/T20/Doc. No 14 points out the cases in which retraining of a taster is required.

Facilities and environmental conditions (6.3 ISO/IEC 17025:2017)

6.3.1. The laboratory should have all the necessary equipment to ensure the optimal performance of the sensory tests. Laboratory ware should be such as to facilitate the performance of the tests.

Tasting glasses and the device for heating glasses to the optimal temperature are the chief specific items for tasting virgin olive oils. The technical details of the tasting glass and heating device are given in standard COI/T.20/Doc. No 5 (ISO16657:2006).

The panel leader should ensure that the environmental conditions are adequate so that results are not rendered invalid or lower in quality.

6.3.2. The panel leader should monitor, control and record the environmental conditions, which should comply with the specified conditions. The recommended room temperature is specified in the reference standard for the installation of a laboratory undertaking the sensory analysis of

virgin olive oils (COI/T.20/Doc. No 6), to ensure the *comfort* of tasters when performing the analyses.

Special attention should be paid when sampling virgin olive oil. Suitable facilities should be in place for storing the product in temperature-controlled conditions by means of systems which can be checked and recorded.

6.3.3. The tests should be carried out in an area dedicated specifically for this purpose. In general, the premises used for carrying out sensory tests should be quiet and free from distractions. They should have individual booths to keep visual contact to a minimum, odour-free surfaces and adequate ventilation and lighting; the walls should be neutral in colour. A separate area should be set aside for preparing the samples (COI/T.20/Doc. No 6).

6.3.4. If the sample preparation area is not near the testing area, care should be taken when transporting samples. Access to the sample preparation area by the panellists should be controlled to prevent visual cues from influencing the analysis.

6.3.5. Laboratory manager and technicians should be aware of the importance of keeping the test and sample preparation areas clean and tidy.

Equipment (6.4 ISO/IEC 17025:2017)

The laboratory should have all the equipment required for sampling, storing and performing the sensory assessment of olive oils.

The laboratory should carry out regular maintenance and checks to ensure the equipment complies with the technical specifications. Calibrations and checks are necessary when the equipment may have a significant influence on the result of the test.

Equipment not used directly in the analysis or tests, such as washers or water purifiers, should undergo a suitable maintenance and cleaning programme. The laboratory should keep a record of maintenance work.

Equipment should be labelled. Each piece of equipment should be identified, except for tasting glasses and lids.
Regular calibrations and any maintenance should be recorded for each piece of identified equipment. Recording should include:

- Identification;
- Name of manufacturer;
- Conformity checks;
- Location in laboratory;
- Manufacturer’s instructions;
- Calibration dates and certificates;
- Maintenance plan;
- Evident nonconformities (non-compliant equipment should be taken out of use).

The equipment required for the sensory assessment of virgin olive oils comprises:

- Glass for virgin olive oils tasting (COI/T.20/Doc. No 5 – ISO 16657:2006);
- Thermostat-controlled heating device (COI/T.20/Doc. No 5);
- Sensory testing laboratory (COI/T.20/Doc. No 6).

The performance of the heating devices will depend on a series of variables. If they are critical, it may be necessary to establish heating profiles and give clear instructions on how to use the devices on the basis of the profiles.

The temperature of the oil during the test should be checked and so prove that all the assessors have tasted the oil at the same temperature (28 ± 2 ºC).

Metrological traceability (6.5 ISO/IEC 17025:2017)

The laboratory should use appropriate reference materials to train sensory assessors, to supervise the laboratory results and to validate and compare methods.

These materials will be Certified Reference Materials (CRM), if they are available to the laboratory. If not, samples from interlaboratory tests conducted by the IOC and other accredited suppliers (according to ISO 17043) can be used. With these samples, quality control can be performed according to the rules found in **Annex 1**. When this is not possible, the laboratory should prepare sufficient quantities of internal material and should assign the reference value by analysis of at least three accredited panels. The criteria for assigning reference values of main defect and/or fruity attribute should be defined beforehand.

The range of the samples shall be varied in order to cover different classes, intensities and attributes of virgin olive oil, throughout a crop year.

The laboratory has to define the “use by” date of the reference material if the supplier has not done so (i.e. samples used for proficiency testing).

Reference materials and chemical standards should be clearly labelled so that they can be readily identified. Information should be available on the period of validity, the storage conditions, the applicability and the restrictions on their use. Reference materials and standards should be handled in such a way as to keep them from all contamination.

Selection, verification and validation of methods (7.2 ISO/IEC 17025:2017)

The procedures complementing the sensory assessment method should be short, concise and effective. The laboratory should document the method in the required amount of detail to ensure its correct application.

The procedure for sensory analysis should include:

(a) panel composition;
(b) training requirements of sensory assessors;
(c) environmental conditions and special facilities;
(d) sample preparation and presentation;
(e) procedure for the execution of the test;
(f) assessor supervision and monitoring;
(g) methods for statistical analysis of the results.

The sensory testing method used entails robust techniques, also called distribution-free techniques, which are not sensitive to outliers.

Calculation of the median and control based on the CVr% (non-linear value inversely proportional to the intensity of the attribute) make it possible to overcome these constraints.

The standard referenced COI/T.20/Doc. No 15 sets out the general methodology for the sensory assessment procedure and specifies the statistical methodology; and standard COI/T.20/Doc. No 14 covers the selection, training and monitoring of panel assessors undertaking the sensory analysis of virgin olive oil.

Data are recorded and checked using a spreadsheet so that statistical methods can be applied for the robustness of the results. The data are monitored by the panel leader; he or she may decide to repeat the test or to approve and sign it, thereby authorising and releasing the test report to the Laboratory Management.

Validation of methods: The method for the determination of the commercial category of virgin olive oils according to their sensory profile has been validated by a two-year IOC proficiency test entailing the participation of an international group of official, highly qualified panels in the sensory assessment of virgin olive oils and an accompanying in-depth statistical validation.

Verification of methods: Each lab should verify the method by determining repeatability and reproducibility at least. The verification should be reviewed periodically.

Handling of test items (7.4 ISO /IEC 17025:2017)

The laboratory should have suitable procedures to ensure that samples do not get spoilage or damaged and to guarantee their traceability to the laboratory.

The sampler is responsible for transporting the sample to the laboratory, which should be carried out under the appropriate conditions (ISO 5555:2001). The laboratory is responsible for handling the sample inside the laboratory and should follow the rules outlined in the above-mentioned standard.

The storage room where products are kept prior to analysis should be kept at controlled temperatures, and these records must be available. The product should be traceable throughout the test, i.e. permanent records should be kept of the movement of the sample inside the laboratory.

In the case of samples which are not kept at ambient temperature, the laboratory should have facilities for bringing the sample to the correct, homogeneous temperature and for keeping that temperature for as long as required. The laboratory should keep records proving that this requirement is met.

When it is necessary to mark sample containers, the use of strong-smelling felt-tip pens should be avoided.

Technical Records (7.5 ISO /IEC 17025:2017)

Records should be regularly checked, updated and monitored. The records of each test should contain all the necessary information to be able to repeat it in conditions as close as possible to the original conditions. The following information is of particular importance in sensory analysis:

(a) instructions and questionnaires issued to sensory assessors;
(b) test results sheets or references to computer files;
(d) identification codes of samples and (sub)samples;
(e) method of sample preparation and the equipment used;
(f) identity of the personnel who prepare the samples;
(g) the order in which the samples are presented to each assessor and details of the presentation;
(h) identity of the sensory assessors and suitable level of qualification for the method used;
(d) identity of the panel leader;
(e) definition of the method of data collection;
(k) definition of the method applied for statistical analysis.

Evaluation of measurement uncertainty (7.6 ISO /IEC 17025:2017)

Sensory analysis is a scientific discipline that applies statistical analysis, however it does not permit strict, metrological, statistically valid calculation of the uncertainty of measurement.

In some cases, when a numerical result is expressed, the estimation of the uncertainty can be based on repeatability and reproducibility data exclusively.

Ensuring the validity of results (7.7 ISO/IEC 17025:2017)

A) Internal quality control

Although the results of a sensory test are checked statistically (CVr ≤20% for the median of predominant defect and fruity attribute), a sensory laboratory should have adequate quality control procedures in place to check the validity of their results.

Irrespective of the method employed for the purposes of quality control, the same method should be used at each tasting session. It should be documented, complete with clearly defined acceptance and rejection criteria. The corresponding evidence should exist and should concur with the documented information.

The level and type of quality control will depend on the nature and frequency of the analysis, and the difficulty and reliability of the tests. For a guide, the frequency of sample checks should be at least 9% of all the samples analysed.

The internal quality control procedures should be applied to both the panel and each individual taster.

The laboratory should define quality control measures in its quality system documents.

The techniques used for internal quality control in sensory laboratories of virgin olive oil are explained in Annex I. It includes a broad variety of procedures, but the application of all the procedures is not compulsory. It is up to the panel leader to select procedures that ensure the competence of tasters and the panel and prove that the results are reliable.

B) Proficiency testing (7.7.2. ISO/IEC 17025:2017)

It is required by ISO /IEC 17025:2017 to participate in proficiency tests periodically (recommended at least once a year). In some cases, such as for official control laboratories, participation may be compulsory.

Laboratories should apply external quality control not only to detect possible systematic errors but also to check the validity of the entire quality system.

They should evaluate the quality of the results obtained in these tests and issue the corresponding report according to their own criteria, as well as the evaluation performed by the organizer of the proficiency test.

At least three simultaneous criteria are used for this kind of evaluation:

- *Laboratories should correctly classify the sample, taking into account the uncertainty when the samples are on the limits between two categories.*
- *Laboratories should obtain a satisfactory z-score (± 2.0) for the classifying attributes. The action limits for the z-score is ± 3.0.*
- *The intensity of the classifying attributes should keep within previously defined limits. This assessment is performed using the normalised error (En), defined as follows:*

$$En = \frac{|Me_{lab} - Me_{pt}|}{\sqrt{U_{lab}{}^2 + U_{pt}{}^2}} \leq 1.0$$

where:

- Me_{lab} is the value of the median of the attribute (positive or negative) obtained by the laboratory.
- Me_{pt} is the value of the median assigned to the proficiency test for the same attribute.
- U_{lab} is ($c * u_{lab}$), with c (coverage factor)=1.96 for a 95% confidence interval, and u_{lab} is the experimental s* value obtained by the laboratory.

• U_{pt} is (c * u_{pt}), with c=1.96 for a 95% confidence interval, and u_{pt} being the target s* value of the proficiency testing.

The normalised error must be equal to or lower than 1.0.

For extra virgin olive oil, the z-score and the En value of the fruity attribute must be calculated. For the other categories, the calculation will be performed for the median of the predominant defect and fruitiness, if the latter is present.

The causes of any nonconforming results should be investigated and corrective measures should be established and evaluated after implementation in order to demonstrate that the causes of the poor results have been remedied. Records of such activities should be kept.

Reporting of results (7.8 ISO/IEC 17025:2017)

Results should be presented in a test report comprising the following sections:

- Title (test report);
- Name and address of the laboratory and place where the tests were carried out;
- Clear and unequivocal identification of the test report on each page;
- Name and address of the customer;
- Clear identification of the data provided by the client; the laboratory is not responsible for that information;
- Clear specification of the method used;
- Description, status and identification of the test samples;
- Date of receipt of the samples;
- Date of the analysis;
- Date of emission of the report;
- Reference to sampling plans, if relevant;
- Test results – Precise classification of the sample or identification of the sensory profile determined;
- Name, post and signature of the person authorising the report.

If opinions or interpretations are given in the report, they should be clearly identified as such, and based on the results of the test. The laboratory shall document the process for issuing opinions and interpretations in the appropriate procedure, and those performing this activity must be identified and authorized by management based on their training and experience.

When it is necessary to change or correct a published report, the changes shall be clearly identified and the reason for such changes must be justified. An amendment can only be given by issuing another document that clearly states that it is a correction of a previous analysis report, which must be referenced.

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ANNEX I

INTERNAL QUALITY CONTROL GUIDE FOR SENSORY LABORATORIES

This document is a complete quality control guide for sensory laboratories undertaking the analysis of virgin olive oils. It includes a broad range of procedures. As some of them are time-consuming, it is not compulsory to apply all of them; the panel leader can select the most appropriate procedures that will ensure the competence of tasters and the panel and will prove that results are reliable.

1. METHODS OF INTERNAL QUALITY CONTROL IN SENSORY ANALYSIS

Since the measuring instrument in sensory analysis is the group of tasters and the results depend on its members, the performance of each individual taster and the whole panel should be monitored on a regular basis. As such, internal quality control in a sensory laboratory must ensure that the panel and each sensory assessor are checked. The effectiveness of monitoring the performance of panel and each taster depends on the method used for internal quality control and the appropriate processing of the results.

Some of the procedures applied for quality control purposes are:

(a) replicate analysis in a specific percentage of the total number of samples at adequate intervals.

(b) analysis of reference materials and characterised materials as part of the quality control system.

For a guide, the frequency of quality check may be at least 9% of all samples analysed.

1.1. Replicate analysis

Sample to be replicated will be selected among those that are going to be analysed or selected from the ones analysed in previous days.

According to IOC/T.20/Doc. No 15, twelve is the maximum samples per day. The minimum frequency for internal quality control should therefore be every 11 samples (9% of the samples analysed); however, the recommended frequency is to check the samples every tasting day.

If the replicate is performed every tasting day, the monitoring frequency is shown in the table below; in this case, it varies depending on the number of samples analysed per day (≥9% of all the samples analysed).

Number of samples per day	Frequency of check (*)
4 (= 3+1)	1/3 = 33 %
5 (= 4+1)	1/ 4 = 25 %
6 (= 5+1)	1/6 = 20%
7 (= 6+1)	1/5 = 17%
8 (= 7+1)	1/7 = 14 %
9 (= 8+1)	1/8 = 13 %
10 (= 9+1)	1/9 = 11%
11 (= 10+1)	1/10 = 10%
12 (= 11+1)	1/11 = 9%

(*) % of duplicate samples, in relation to the total number of samples.

If the sensory panel has not been active for some time (for example, holidays or long breaks), the internal quality checks have to be performed immediately before analysing samples. The replicate samples must cover the widest possible range of intensities of fruitiness and defects. Their position in the sessions should be random.

Although the method of using replicate samples has the advantage that it does not require the provision of special samples, its main disadvantages are that it only gives information on the random errors (it evaluates the precision of both panel and tasters) and it does not check the correct classification of a sample.

1.2. Analysis of reference materials and characterised materials

At least one reference material will be analysed each month (except for the months when no sample is analysed). These materials will be CRM, if they exist. If they are not available, the remaining samples from proficiency tests should be used. In the absence of the mentioned samples, the laboratory will prepare a sufficient number of samples for quality checks, which will be characterised by comparison with at least three accredited panels. The criteria for assigning reference values of defect and/or fruity attribute should be defined and documented

by the panel leader and reported in the standard operating procedure (SOP).

The range of the samples used as reference materials will be varied in order to cover different classes of virgin olive oil, intensities and attributes, over the course of a year. The laboratory should define the shelf-life of the reference material.

The main advantage of this method is that the results obtained by carrying out the analysis of reference materials or characterised materials could be used for monitoring the trueness of the panel and each individual taster. On the other hand, the use of certified or of secondary reference materials in the sensory tests is difficult, due to the large quantity required for carrying out organoleptic assessment and the changes that occur in the organoleptic characteristics of a sample during storage.

2. CHECKING THE PERFORMANCE OF EACH TASTER

The minimum levels of precision and trueness shall be set by the panel leader in relation to the tasters, in order to keep their qualification; moreover, additional requirements may be defined, such as the minimum attendance to panel sessions.

The taster's performance must be checked over time using different types of samples and product categories, as well as the psychophysiological stages that the taster may undergo.

The technique for checking taster performance is based on the use of a set of samples analysed double-blind. From the results of these analyses, the Precision Number (PN) and Deviation Number (DN) are calculated. These indicators are needed because the taster's performance consists of two different factors, namely:

- Deviation from itself when analysing the same sample in two different moments;
- Deviation from the group (the panel) during the same session.

To measure these differences, the PN and DN can be used. They must be analysed together, and they are defined as follows:

$$Precision\ Number\ (PN) = \frac{\sum_{i=1}^{n}(x_{i,1} - x_{i,2})^2}{n} \leq 2.0$$

where $x_{i,1}$ and $x_{i,2}$ are the values given by the taster to the first and second assessment of a duplicated sample, and *n* is the number of differences ($x_{i,1}$-$x_{i,2}$) which corresponds to the number of duplicated samples analysed.

$$Deviation\ Number\ (DN) = \frac{\sum_{i=1}^{n}(x_{i,1} - \bar{x}_{i,1})^2}{n} \leq 2.0$$

where $x_{i,1}$ is the value of the first replicate given by the taster, $\bar{x}_{i,1}$ is the value of the median of the replicate considered, and n is the number of differences ($x_{i,1}$ - $\bar{x}_{i,1}$), i.e. the number of duplicated samples analysed.

For the Deviation Number, only the value from one of the two replicates shall be used, in order to avoid the bias that could be added in the calculation. Therefore, the panel leader must indicate in the SOP which of the two replicates will be used.

The number of samples analysed in duplicate should be between 6 and 10, depending on the frequency of analysis of the panel.

In order to know the direction of the differences of the Deviation Number, control charts shall be used.

The Deviation Number can also be used for other performance check purposes (for example, to check the deviation of the taster, or the panel, to the reference value of characterised sample/reference material).

As the limit value for these numbers is 2.0, the maximum allowed deviation for the taster is 1.4 (=2*0.7), on average. For example:

$$\text{PR or DN} = \frac{1.4^2 + 1.4^2 + 1.4^2 + 1.4^2 + 1.4^2 + 1.4^2}{6} = 1.96$$

2.1. Checking the taster's precision

Precision is the closeness of agreement between independent test values. The precision assessment involves estimating repeatability and in-laboratory reproducibility/intermediate precision. In the sensory method, the precision (repeatability and in-laboratory intermediate precision) of tasters is determined by using the replicate analysis. The repeatability of each taster is checked by comparing the score of the intensities given by the taster when analysing a sample in duplicate.

The intermediate precision may be checked over time by means of the so called "Precision Number", which takes into account the intensities given by the taster to a set of duplicate samples, between 6 and 10 (12-20 analysed samples in total) as described in section

1.1. Alternatively, the intermediate precision of each taster can be measured over time using the same index, but analysing the same sample on different days. To do so, samples (if possible, these should be representative of the categories tested most often by the laboratory) are prepared for tasting as double-blind samples by the tasters within a maximum of 6 months, depending on the attributes. In this case, samples must be properly stored in order to guarantee that their characteristics remain unchanged.

Table 1. Indicator of taster precision, when several numbers of replicated samples have been analysed.

Field of application: taster	
Frequency: when the number of duplicate samples is between 6 and 10.	
Estimation of Precision	Precision Number (PN_t) of the taster $PN_t = \frac{\sum(x_{a1} - x_{a2})^2}{n}$ where: ❖ PN_t is the precision number of one taster, for a specific attribute (a defect, the fruity attribute or the classified attribute). ❖ x_{a1}, x_{a2} are the intensities given by the taster to a specific attribute in the first and second assessment of the replicated sample (for a defect, the fruity attribute or the classified attribute) ❖ n is the number of duplicate samples tested (example: one duplicate sample, n=1 / six samples tested in duplicate, *n*=6). Criteria of acceptance: $PN_t \leq 2.0$ **If the PN_t value is above 2.0, training should be arranged for the taster.**

Notes:

1. The sensory laboratory can use either:
   - one Precision Number for each taster for the classified attribute identified by the panel (fruity for EVOO and predominant defect for other categories), or
   - one for the defects and another for the fruity attribute, separately. In any case, the laboratory should keep fully documented records.
2. Since the Precision Numbers are used to check how the taster repeats their own assessments, it is possible to calculate these numbers with the attribute score with greater intensity, according to the taster (classified or higher defect/fruity found by the taster), and not to the panel. It is mandatory that the selected option is previously defined in the operative protocol.
3. When the taster evaluation is performed with duplicate samples, the PN must be calculated with the DN, at the same time and with the same samples, since both give an indication of the analytical behaviour of the taster. They are strictly linked and should not be studied separately or at different times. These two indicators must agree, as if one of them is outside acceptable limits, it indicates poor performance.
4. Warning limit = optionally, a warning limit may be defined, so, when indices are between 1 and 2, the panel leader should study the possible causes and, if necessary, perform the preventive actions to improve the taster's performance. It will not be necessary to exclude the taster from the panel since the indices are lower than 2.
5. The tables below include the necessary calculations for the estimation of the cumulative PN, in order to facilitate the work of sensory laboratories (optionally, these results can be expressed to two decimal digits).

Table 2.a. Example of calculations for Precision Number of the taster for predominant defect and fruity.

Intensity given by the taster				(Difference)^2	
Predominant Defect		Fruity		Predominant Defect	Fruity
1st test	2nd test	1st test	2nd test		
X_{D11}	X_{D12}	X_{F11}	X_{F12}	$(X_{D11}- X_{D12})^2$	$(X_{F11}- X_{F12})^2$
X_{D21}	X_{D22}	X_{F21}	X_{F22}	$(X_{D21}- X_{D22})^2$	$(X_{F21}- X_{F22})^2$
X_{D31}	X_{D32}	X_{F31}	X_{F32}	$(X_{D31}- X_{D32})^2$	$(X_{F31}- X_{F32})^2$
X_{D41}	X_{D42}	X_{F41}	X_{F42}	$(X_{D41}- X_{D42})^2$	$(X_{F41}- X_{F42})^2$
……	……	……	……	…….	…….
X_{Dn1}	X_{Dn2}	X_{Fn1}	X_{Fn2}	$(X_{Dn1}- X_{Dn2})^2$	$(X_{Fn1}- X_{Fn2})^2$
				SUM D	SUM F
				PN_{dt} = SUM D / n	PN_{ft} = SUM F / n

Table 2.b. Example of calculation of Precision Number with six duplicate samples (n=6), for a given attribute, in "batch mode".

Intensity given by the taster		(Difference)^2	Calculations
1st test	2nd test		
X_{11}	X_{12}	$(X_{11}- X_{12})^2$	PN_t = SUM(1-6) / 6
X_{21}	X_{22}	$(X_{21}- X_{22})^2$	
X_{31}	X_{32}	$(X_{31}- X_{32})^2$	
X_{41}	X_{42}	$(X_{41}- X_{42})^2$	
X_{51}	X_{52}	$(X_{51}- X_{52})^2$	
X_{61}	X_{62}	$(X_{61}- X_{62})^2$	
X_{71}	X_{72}	$(X_{71}- X_{72})^2$	PN_t = SUM(7-12) / 6
X_{81}	X_{82}	$(X_{81}- X_{82})^2$	
X_{91}	X_{92}	$(X_{91}- X_{92})^2$	
X_{101}	X_{102}	$(X_{101}- X_{102})^2$	
X_{111}	X_{112}	$(X_{111}- X_{112})^2$	
X_{121}	X_{122}	$(X_{121}- X_{122})^2$	

X_{131}	X_{132}	$(X_{131}- X_{132})^2$	PN_t = SUM(13-18) / 6
X_{141}	X_{142}	$(X_{141}- X_{142})^2$	
X_{151}	X_{152}	$(X_{151}- X_{152})^2$	
X_{161}	X_{162}	$(X_{161}- X_{162})^2$	
X_{171}	X_{172}	$(X_{171}- X_{172})^2$	
X_{181}	X_{182}	$(X_{181}- X_{182})^2$	

Table 2.c. Example of calculation of Precision Number with six duplicate samples (n=6), for a given attribute, in "continuous mode".

Intensity given by the taster		(Difference)^2	Calculations	(Difference)^2	Calculations	(Difference)^2	Calculations
1st test	nd test						
X_{11}	X_{12}	$(X_{11}- X_{12})^2$	PN_t =SUM(1-6)/6				
X_{21}	X_{22}	$(X_{21}- X_{22})^2$		$(X_{21}- X_{22})^2$	PN_t=SUM(2-7)/6		
X_{31}	X_{32}	$(X_{31}- X_{32})^2$		$(X_{31}- X_{32})^2$		$(X_{31}- X_{32})^2$	PNt=SUM(3- 8)/6
X_{41}	X_{42}	$(X_{41}- X_{42})^2$		$(X_{41}- X_{42})^2$		$(X_{41}- X_{42})^2$	
X_{51}	X_{52}	$(X_{51}- X_{52})^2$		$(X_{51}- X_{52})^2$		$(X_{51}- X_{52})^2$	
X_{61}	X_{62}	$(X_{61}- X_{62})^2$		$(X_{61}- X_{62})^2$		$(X_{61}- X_{62})^2$	
X_{71}	X_{72}			$(X_{71}- X_{72})^2$		$(X_{71}- X_{72})^2$	
X_{8-1}	X_{8-2}					$(X_{81}- X_{82})^2$	

Table 2.d. Example of calculation of Precision Number with 6 duplicate samples (n=6), in "batch mode".

Sample			**Median of the panel for one attribute**	
	1st test	**2nd test**	**1st test**	**2nd test**
M1	2.6	2.9	3.1	3.4
M2	4.3	3.9	4.5	4.1
M3	1.8	2.2	2.5	2.7
M4	6.2	5.7	6.0	6.3
M5	3.5	3.1	3.8	3.4
M6	0.9	1.6	1.4	1.7

$$PN_t = \frac{(2.6-2.9)^2 + (4.3-3.9)^2 + (1.8-2.2)^2 + (6.2-5.7)^2 + (3.5-3.1)^2 + (0.9-1.6)^2}{6} = 0.22$$

2.2. Checking the taster's trueness

In addition to evaluating the precision of each taster, it is also necessary to evaluate their trueness. Trueness is the closeness of agreement between the average value of a large series of measurements and the accepted reference value "true value." Systematic error (bias) is a measure of accuracy.

The *trueness of taster*s is determined by using the analysis of *reference materials* or *characterised materials* (as long as the sample to be used is clearly defined). Since the reference materials are not included in each session of the panel, this estimation does not assure a *continuous control of the performance of the taster*, and therefore, this calculation is just a complement of the previous one (2.1. Checking the taster's precision). In the same manner, the performance of the tasters with respect to the panel over time could be included as well, by using the replicate analysis.

Table 3.a. Estimator of single taster "trueness" (deviation from the panel median) using Deviation Number.

Field of application: taster
Frequency: 9% of analysed samples in case of replicate analysis. The frequency should be once per month when analysing reference material, depending on its availability.

Deviation Number (DN_t)

Calculation with replicate samples

$$DN_t = \frac{\sum(x_i - Me_i)^2}{n}$$

Calculation with reference materials

$$DN_t = \frac{\sum(x_i - TMe_i)^2}{n}$$

where:

- DNt is the deviation number of a taster "t", for a specific attribute (predominant defect, fruity attribute or classified attribute), in the first (1) or second (2) replicate of the duplicate sample "i".
- xi is the intensity score given by the taster for the predominant defect, fruity attribute or classified attribute in the first (1) or second assessment (2) of the duplicate sample "i",
- Mei is the value of the panel median for the predominant defect, fruity attribute or classified attribute in the first or second assessment of the duplicate sample.
- TMei is the reference value (assigned value) of the reference material.
- The selected duplicate for the calculation (first or second) must be previously defined in the operative protocol.
- *n* is the number of differences taken into account for the calculation (example: for 6 duplicate samples or 6 reference materials n=6)

Criteria of acceptance: $DN_t \leq 2.0$

If the DN_t value is above 2.0, training should be arranged for the taster.

Table 3.b. Estimator of single taster "trueness" in terms of deviation from all panels participating in the reference material certification.

Field of application: taster
Frequency: once per month depending on the availability of reference materials.

Taster's z-score

$$\text{z-score}_t = \frac{(x - TMe)}{SD}$$

where:

- x is the intensity given by a taster "t", for a specific attribute (predominant defect, fruity attribute or classified attribute), in the assessment of sample,
- TMe is the value of reference sample (assigned value) for the attribute (either the predominant defect, the fruity attribute or the classified attribute)
- SD is the standard deviation of all values of the laboratories participating in the certification process of the material, for the predominant defect, the fruity attribute or the classified attribute, or the standard deviation of the method (±0.7).

Criteria of acceptance:
Warning limits: $\text{z-score}_t = \pm 2.0$, and action limits: $\text{z-score}_t = \pm 3.0$.

If the z-score_t is out of action limits, training should be arranged for the taster.

Notes:

6. As for the estimators for precision, the sensory laboratory can calculate either:

   - one index for classified attribute determined by the panel (fruity for EVOO and defect of a higher intensity - predominant defect - for other categories), or
   - one for the defects and another one for the fruity attribute separately.

In any case, the laboratory should keep the corresponding fully documented records.

7. Unlike the PN, the attribute chosen for the calculation of the DN, with replicate samples, should be the attribute which has been used to classify the sample by the panel, and not the taster (classified or higher defect/fruity found by the panel), because this index measures how the taster deviates from the panel.

8. When the evaluation of the taster is performed with duplicate samples, the DN shall be calculated together with the PN and they must agree at the same time (see note 3).

9. Additionally, the DN can also be calculated with any sample of the tasting day, not duplicated. If this criterion is applied, two conditions shall be considered: (i) the level of control must not be lower than 9% of analysed samples and (ii) the selected sample for DN calculation must be clearly pre-defined in the operative protocol. For example, if a reference material is included in the tasting session, the calculation of the DN can be performed with the score of the taster and the median of the panel, given for that reference material; therefore, the analysis of the duplicate sample can be avoided that day.

10. The calculation can be performed in batch mode or in continuous mode, and two decimal digits can be used for calculations.

11. A useful system to check taster's performance is to include, from time to time, one or more reference samples (clearly defined, pre-tested oils), as explained in ISO 13299:2016. The study of the individual variance of the scores obtained by each taster for these check samples allows checking whether the tasters' performance is consistent over time, by checking the correspondent F value. Likewise, the use of the variance of the mean values obtained by the panel is a useful indicator to understand whether the panel has consistent results over time.

12. Analysis of variance (ANOVA) can easily be carried out with some software packages available commercially or as freeware.

Table 4. Example of calculation of the Deviation Number with six duplicate samples, in batch mode, selecting the second assessment (*), *n*=6.

Sample	**Score for one attribute, given by the taster**		**Median of the panel for one attribute**	
	1st test	**2nd test**	**1st test**	**2nd test**
M1	2.6	2.9	3.1	3.4
M2	4.3	3.9	4.5	4.1
M3	1.8	2.2	2.5	2.7
M4	6.2	5.7	6.0	6.3
M5	3.5	3.1	3.8	3.4
M6	0.9	1.6	1.4	1.7

(*) The same calculation may be performed with the *first* assessment of the duplicate sample.

$$DN_t = \frac{(2.9-3.4)^2+(3.9-4.1)^2+(2.2-2.7)^2+(5.7-6.3)^2+(3.1-3.4)^2+(1.6-1.7)^2}{6} = 0.17$$

2.3. Checking the taster's competence (sample classification and intensity evaluation)

The above estimation of trueness only considers the values given by the tasters in the assessment of a reference material. However, the organoleptic method is simultaneously qualitative and quantitative, since its application results in the classification of samples, based on the median of the predominant defect and the presence or not of the fruity attribute. Consequently, tasters can be checked with a similar procedure to that applied by the IOC for the evaluation of the results of panel proficiency tests.

This check evaluates the performance of the tasters in one day only, not considering possible changes over time. The recommended procedure is presented below.

The competence of a taster could be checked by using the results of each taster in the most recent interlaboratory proficiency testing. If this is not possible (for example in the case of a new taster), then the taster's competence is checked through organoleptic analysing of samples with known and reliable data (CRM, samples from proficiency tests or characterised samples).

The samples selected for the competence check should belong to different categories and have defined reliable data (category statistically significant at 95% confidence level, median of predominant defect and/or fruity, standard deviation - not robust standard deviation

- or upper and lower confidence limit for the predominant defect and fruity). The taster's score will be set to 1 if he/she has correctly classified the sample and the intensity of the predominant defect for the virgin and lampante categories and of fruitiness for the extra virgin category. The taster will give a score for each sample, which should fall between the upper and lower confidence limit or according to the acceptance criteria of the taster's z-score. If any of the preceding cases do not apply, the taster's score will be set to 0.

The taster's score is evaluated by considering (a) or (b):

(a) The z-score limit of 2*SD (where SD is the standard deviation and not the robust standard deviation of all values of the laboratories participating in the certification process of the material, or the standard deviation of the method (±0.7));
(b) The upper and lower confidence limits of the material. This criterion is stricter than using the z-score.

The panel leader can choose the most appropriate criterion for the laboratory. For each taster, the median taster score is calculated. If it is 1, the taster is considered competent for carrying out organoleptic tests. If the score is 0, when this is not the case for other tasters, then training is required for this taster.

An example of the evaluation of taster's competence is reported as follows.

Frequency: the taster's competence should be evaluated whenever the taster participates in inter-laboratory testing and at least once a year.

Table 5. Example of calculation of taster's competence based on the intensities of the perceived attributes and the classification of a sample.

		sample 1	sample 2	sample 3
Taster's results				
Classification		extra	virgin	lampante
Taster's score		fruity 3.9	defect 2.0	defect 8.0
Reliability data of the samples				
Classification		extra	virgin	lampante
median		fruity 4.3	defect 1.0	defect 6.1
Upper limit		5.2	1.3	7.2
Lower limit		3.4	0.6	4.9
2*SD		2.4	1.0	2.5
Evaluation of the taster				
Option a (z-score)	**z-score**	-0.33	+2.00	+1.52
	taster's score	1	1	1
	Median of scores=1 ⇨ **THE TASTER IS COMPETENT**			
Option b	**taster's score**	1	0	0
	Median of scores=0 ⇨ **THE TASTER IS NOT COMPETENT**			

3. CHECKING THE PANEL'S PERFORMANCE

During the procedures for checking the performance of each taster, the precision and trueness of the values obtained from the whole panel can be performed as well.

3.1. Checking the panel's precision

The panel's precision can be estimated during the procedure of replicate analysis for the assessment of a single tasters' precision.

The performance of the panel may be checked every tasting day by means of replicate analysis, calculating the normalised error "En" as reported in COI/T.20/Doc. No 15 (section 10.5) and Table 7.a below. "En" determines whether the two results of a duplicate analysis are homogeneous or statistically acceptable. The tasting day is considered "valid" if the "En" value

of the replicate sample is correct. This is known as "validation of the tasting day".

The repeatability of the panel is evaluated by comparing the pair of medians obtained by analysing a sample in duplicate.

The precision of the panel is checked by comparing the pairs of medians obtained by analysing a number of duplicate samples between 6 and 10 (in total 12-20 samples analysed).

The panel leader should keep a record of the historical performance of the panel in an appropriate database as well as in tabulated form.

The formulae used for the assessment of repeatability and intermediate precision of the panel are reported as follows.

Table 6.a. Estimation of panel precision by Normalised Error.

Field of application: panel	
Frequency: every 11 tests (9% of all the samples analysed) or every tasting day (≥9% of all the samples analysed).	
Estimation of Repeatability	Normalised Error (En) $En = \frac{\lvert Me_1 - Me_2 \rvert}{\sqrt{U_1^{\,2} + U_2^{\,2}}}$ where: ❖ En is the normalised error of the panel for a specific attribute (predominant defect, fruity attribute or classified attribute). ❖ Me_1 and Me_2 are the medians obtained by the panel for a specific attribute (predominant defect, fruity ❖ attribute or classified attribute) in the first and second assessment of a sample, respectively. ❖ U_1 and U_2, are the respective expanded uncertainties calculated as $c*s_1$ and $c*s_2$, with c=1.96 for a 95% probability, being s_1 and s_2 the experimental robust standard deviation values of the medians Me_1 and Me2, respectively, for the predominant defect, fruity attribute or classified attribute. Occasionally, it could be considered as the maximum error allowed by the method or the standard deviation of the method (±0.7). Criterion of acceptance: En ≤ 1.0

Table 6.b. Estimation of panel precision when several duplicated samples are available.

Field of application: panel	
Frequency: when a number of replicate samples between 6 and 10 have been analysed.	
Estimation of Panel Intermediate Precision	Precision Number for the panel (PN_p) $PN_P = \frac{\sum (Me_1 - Me_2)^2}{n}$ where ❖ PN_p is the indicator of the consistency of a panel "p", for a specific attribute (predominant defect, fruity attribute or classified attribute), in evaluating a sample in duplicate. ❖ Me_1, Me_2 are the medians of the panel for a specific attribute (predominant defect, fruity attribute, or classified attribute) in the first and second assessment of the duplicated sample, respectively. ❖ n is the number of duplicated samples taken into account (example: one duplicate sample, n=1 / six duplicate samples, n=6). Criteria of acceptance: $PN_p \leq 2.0$ **If PN_p is above 2.0, training should be arranged for the whole panel.**

Note: the notes describing the control of each taster's precision should also be applied for the control of the panel's precision. In the current section, the word "taster" is substituted by the word "panel".

3.2. Checking the panel's "trueness"

Checking the panel's "trueness" is the object of the laboratory's external quality control. Nevertheless, estimating the trueness of the panel can also be performed during the analysis of reference materials or characterised materials for the assessment of taster trueness. The formulae used to estimate the panel's "trueness" are reported as follows.

Table 7.a. Estimators of panel's trueness by using Deviation Number on data obtained from reference material (or characterised samples).

Field of application: panel
Frequency: once per month depending on the availability of reference materials

Deviation Number of a panel (DN_p)

$$DN_p = \frac{\sum(Me_i - TMe_i)^2}{n}$$

where:

- DN_p is the deviation number of a panel "p", for a specific attribute (predominant defect, fruity attribute or classified attribute).
- Me_i is the median value of the panel for the attribute (predominant defect, fruity attribute or classified attribute) in the assessment of sample i.
- TMe_i is the value of the reference sample i (training sample), for the attribute (predominant defect, fruity attribute or classified attribute).
- n is the number of reference samples analysed (example: for six reference materials, n=6).

Criterion of acceptance: $DN_p \leq 2.0$

If DNp is above 2.0, training should be arranged for the whole panel.

Table 7.b. Estimators of panel's trueness by using z-score on data obtained from reference material.

Field of application: panel
Frequency: once per month depending on the availability of reference material.

z-score for a panel

$$z\text{-score}_p = \frac{(Me_p - TMe)}{SD}$$

where:

- Me_p is the median obtained by a panel "p", for a specific attribute (predominant defect, fruity attribute or classified attribute), in the assessment of the reference sample.
- TMe is the value of the reference sample (assigned value), for a specific attribute (predominant defect, fruity attribute or classified attribute).
- SD is the standard deviation of all values of the laboratories participating in the certification process of the material, for the predominant defect and for the fruity attribute, or in general, the standard deviation corresponding to the TMe. Occasionally, the maximum error allowed by the method or the standard deviation of the method (±0.7) could be considered.

Criterion of acceptance:

Warning limits: z-score$_p$ = ± 2.0, and action limits: z-score$_p$ = ± 3.0.

If z-score$_p$ is out of action limits, training should be arranged for the panel.

Note: the notes describing the control of each taster's "trueness" should also be applied for the control of the panel's "trueness". In the current section, the word "taster" is substituted by the word "panel".

4. QUALITY CONTROL CHARTS IN SENSORY ANALYSIS

The quality control charts used in analytical laboratories play the role of a control mechanism to determine whether the analytical procedure to be followed is "in statistical control", i.e. if the results produced are continuously within control limits.

In sensory analysis, the changes in performance of each taster and the whole panel shall be checked over time. To do so, the values obtained during the procedures for the performance check of each taster and the panel should be placed in quality control charts, as part of the internal quality control. *The quality charts facilitate the monitoring of the performance of each taster and panel over time.*

The laboratory should define corrective actions to perform when a result is outside the limits, or several consecutive results are obtained at the same side (positive or negative) of the central value, but within the limits, since in this case, the laboratory may present systematic error (bias).

4.1. Quality control charts for indices based on replicate analysis.

As described above in paragraphs 2.1, 2.2 and 3.1, the indices based on replicate analysis are precision and deviation numbers of tasters and normalised error and precision numbers of the panel.

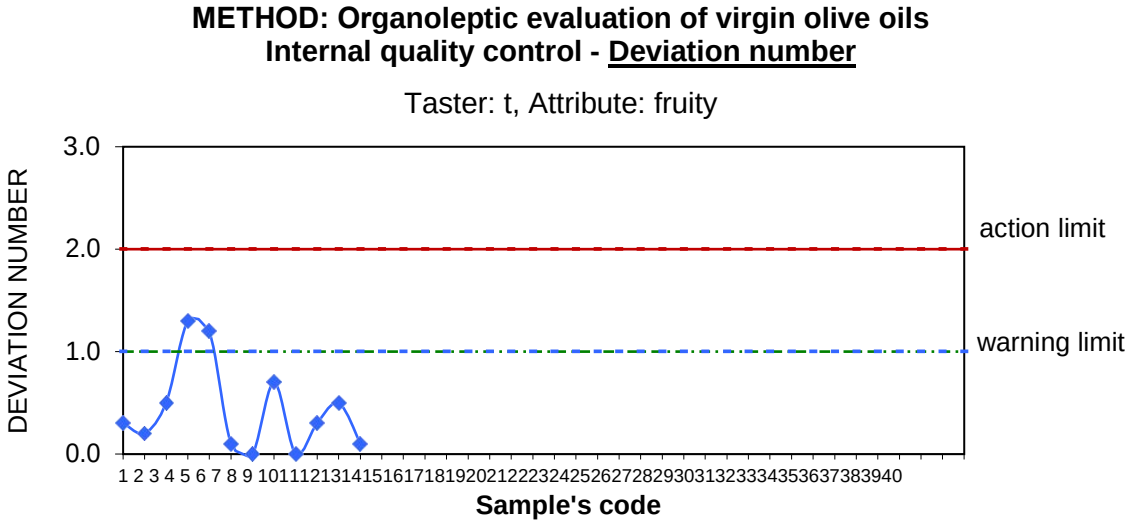
Taking into account that they are always positive numbers, their control chart could be a “trend chart”. In this group, the deviation numbers of panel and tasters based on the analysis of reference materials should be included, since they are also always positive.

The "trend charts" can be used to illustrate experimental results when quality control is based on the assessment of conformity by performing duplicate measurements of a sample. The minimum value of these indices is zero (0) and the maximum value is two (2) except of the normalized error where the maximum value is 1. Consequently, in both cases the “x” axis intersects the “y” axis at 0.

The value of the index is indicated on the vertical axis and the code of the sample is indicated on the horizontal axis (or date of the analysis), to ensure traceability.

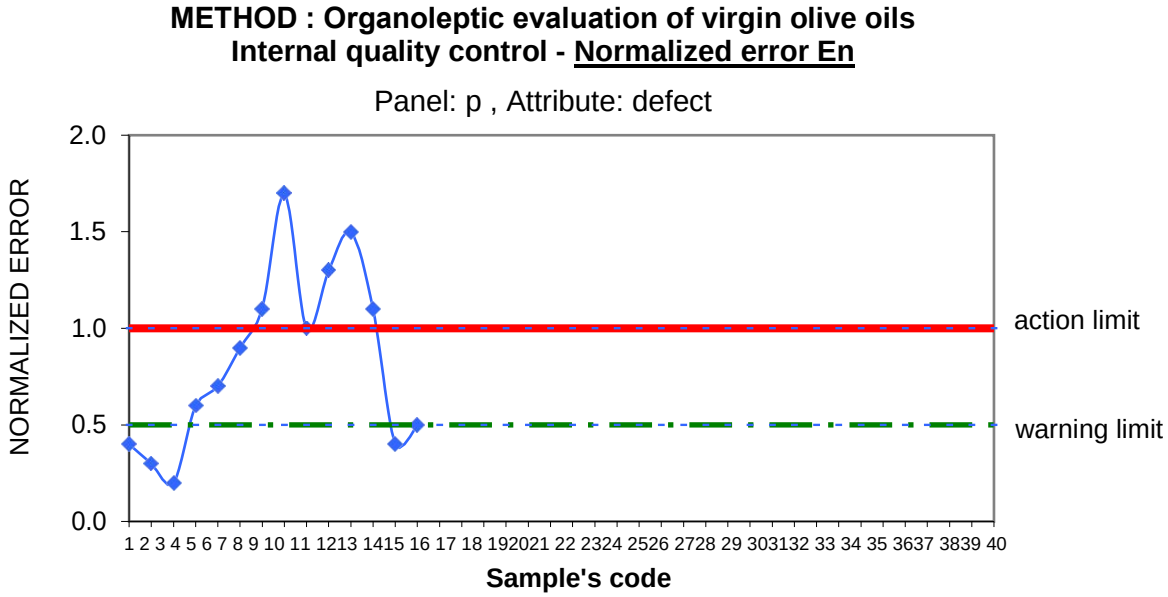
Some models are illustrated as follows, also including the criteria for chart interpretation. Each laboratory should define the criteria for implementing the preventive and corrective actions.

Figure 1. Quality control chart for single taster DN for the fruity attribute.



Criteria
1. One (at least) from 5 consecutive blue points must lie under the dotted line.
2. If a blue point is above the red line, the taster is out of control.
3. If 5 or more consecutive blue points lie between the red and dotted lines, there is a trend for the taster to be out of control.

Figure 2. Quality control chart for the Normalised Error of the panel, for defects.



Criteria
1. One (at least) from 5 consecutive blue points must lie under the dotted line.
2. If a blue point is above the red line, the analytical procedure is out of control.
3. If 5 or more consecutive blue points lie between the red and dotted lines, there is a trend for the analytical procedure to be out of control.

4.2. Quality control charts for indices based on analysis of reference material.

As mentioned above in paragraphs 2.2. and 3.2., the main indices based on the analysis of reference materials are the z-score and the DN of the taster and the panel.

- Deviation Number

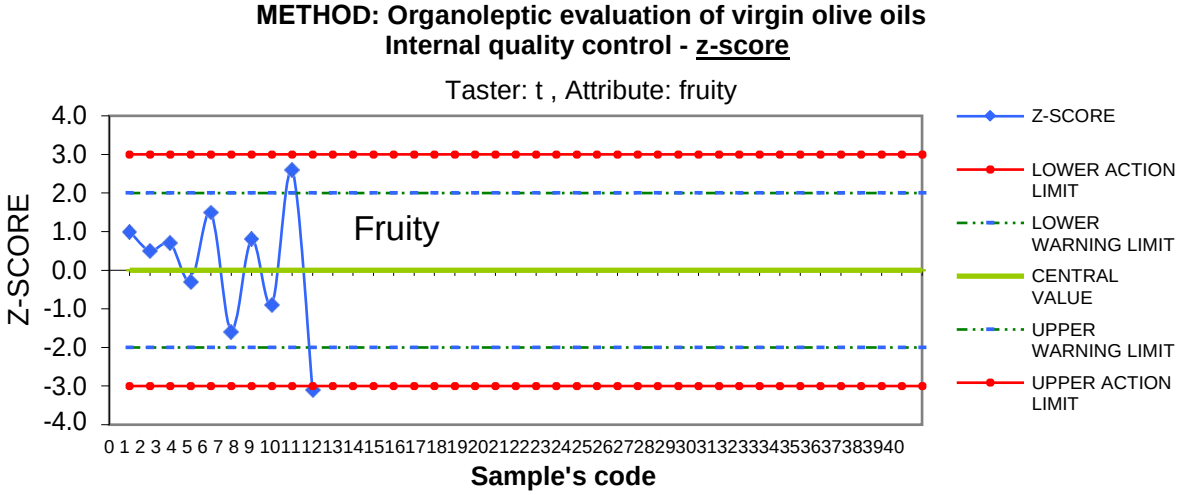
The graphs are designed as explained in section 4.1.

- z-score graphs

This index can have positive or negative values, the central value being zero, the warning limits for the index ±2, and the action limits ±3. The laboratory should define the corrective and preventive actions which will be performed whether a result is outside the limits, or several consecutive results are obtained at the same side (positive or negative) of the central value (bias). The same chart can be used by the sensory laboratory for the graphic representation of its z-score from its participation in the interlaboratory proficiency tests (external quality control). They are very useful to evaluate the "trueness" of the panel over time.

An example of the graph and some criteria for its interpretation are presented below.

Figure 3. Quality control chart for z-score of a single taster, for the fruity attribute.



Criteria
1. If a blue point (z-score) is under or above the red lines, the taster is out of control.
2. If 2 consecutive blue points lie between red and dotted lines, the taster is out of control.
3. If 10 consecutive blue points lie in the same side between the green and dotted lines, the taster is out of control.
4. If 7 consecutive blue points lie in the same side between the green and dotted lines, there is a trend for the taster to be out of control.
5. if one from 20 consecutive blue points lie between the dotted and red lines, the taster is within control.

4.3. Quality control charts of quality control samples

Control samples should be treated exactly as any other sample. Quality control charts are used to graphically represent the results of analysing control samples over time; they are known as $\bar{x}$ chart.

As mentioned in paragraph 1.2, it is difficult to use certified or secondary reference materials in sensory analysis. However, these samples can be prepared and refrigerated in bottles of 150 mL for one year. The frequency of the use of these samples could be the same as the use of reference materials (once per month) or every 20 unknown samples. The results of the analysis of these quality control samples should be recorded in a $\bar{x}$ chart, in which the vertical axis represents the median of fruitiness or the defect, and the horizontal axis identifies the date of the analysis or the sample code. These charts could be double, to illustrate both fruity and negative sensory attributes (fruity to the positive axis, defect to the negative axis).

Moreover, in organoleptic assessment the correct intensity score and the correct classification of a sample should be checked. It is also appropriate to adopt the following restrictions:

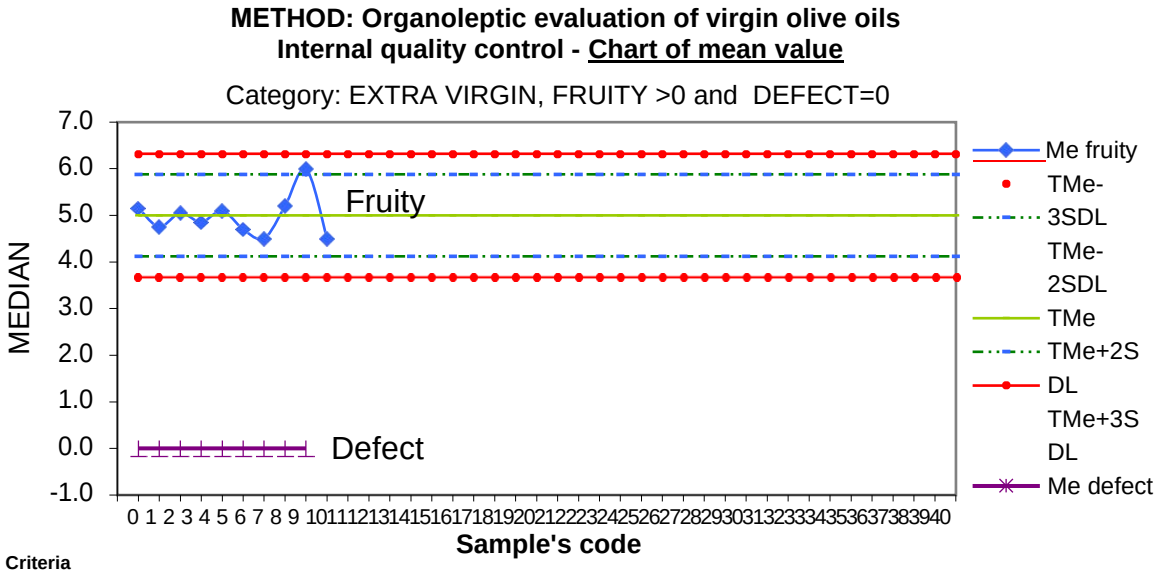
- Category extra virgin: If defect >0, the analytical procedure is out of control.
- Category virgin: If defect=0, the analytical procedure is out of control.
- Category ordinary: If fruity>0 and defect≤3.5 or defect>6, the analytical procedure is out of control.

- Category lampante: If defect≤6, the analytical procedure is out of control. In case that the category ordinary does not exist,
- Category lampante: If fruity>0 and defect ≤3.5, the analytical procedure is out of control.

Some examples of quality control charts for each category are presented below, including examples of the criteria for interpreting the chart. In these charts:

- TMe is the "assigned value" of the quality control sample.
- SD_L is the standard deviation (not the robust standard deviation) determined during the preparation of the quality control sample or during the procedure of the verification of the method in the lab. The standard deviation of the method (± 0.7) could also be used.

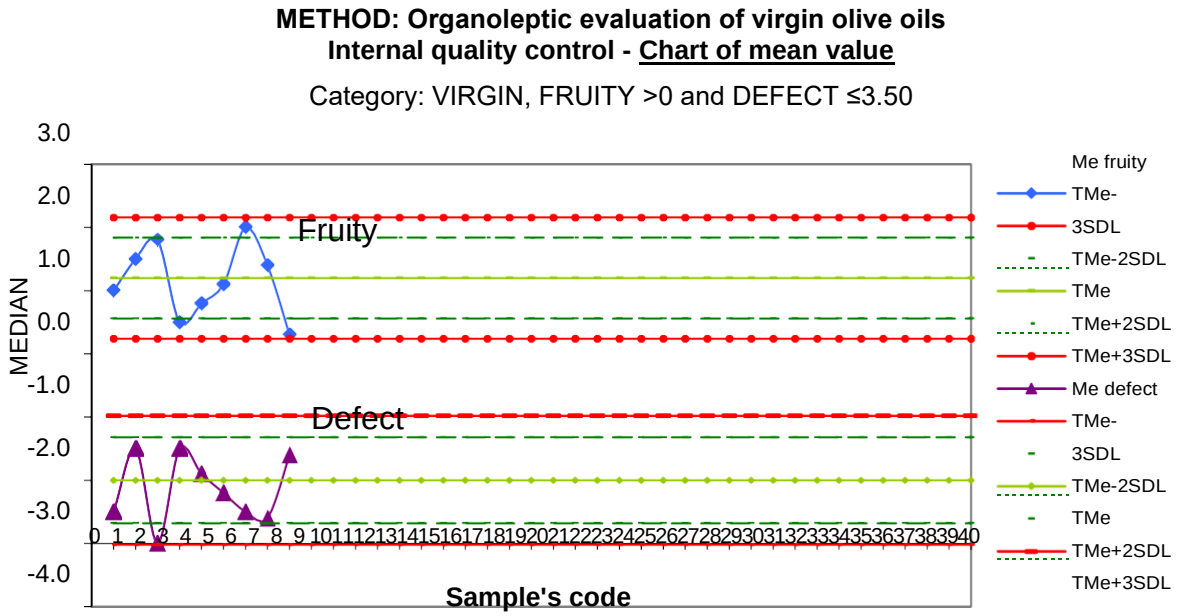
Figure 4. Example of quality control chart for the category extra virgin.



Criteria

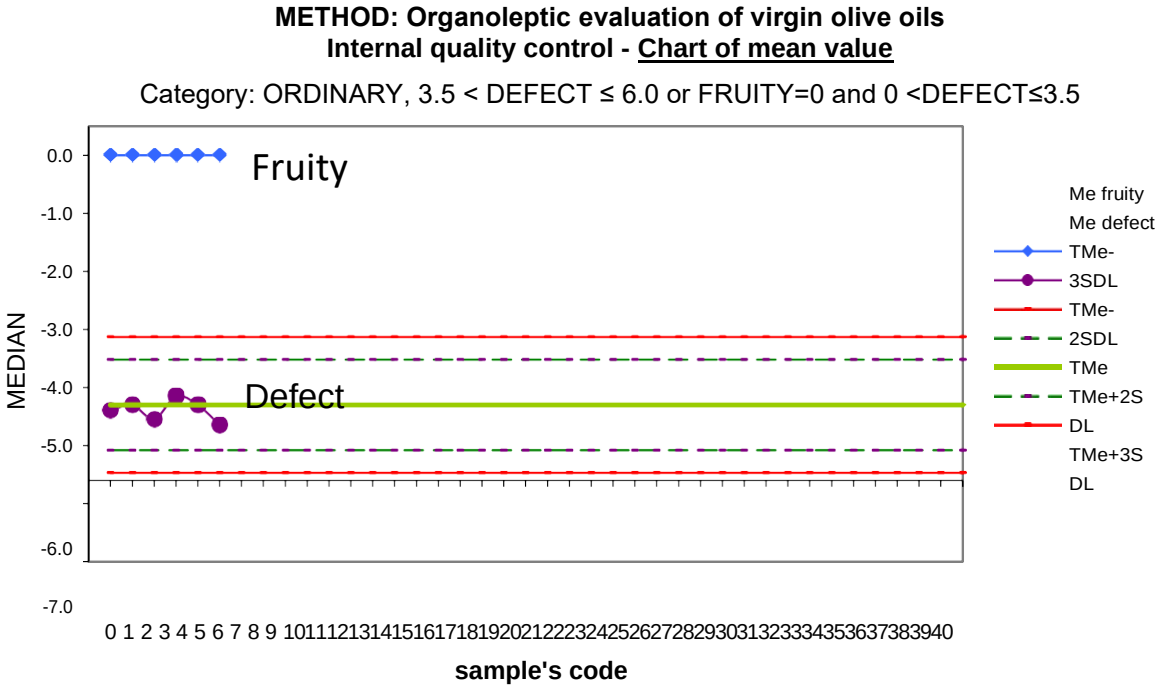
1. If a violet point (defect) is >0, the analytical procedure is out of control.
2. If a blue point (fruity) is under or above the red line, the analytical procedure is out of control.
3. If 2 consecutive blue points (fruity) lie between red and dotted lines, the analytical procedure is out of control.
4. If 10 concetutive blue points (fruity) lie in the same side between the green and dotted lines, the analytical procedure is out of control.
5. If 7 consecutive blue points (fruity) lie in the same side between the green and dotted lines, there is a trend for the analytical procedure to be out of control.
6. if one from 20 consecutive blue points lie between the dotted and red lines, the analytical procedure is within control.

Figure 5. Example of quality control chart for the category virgin.



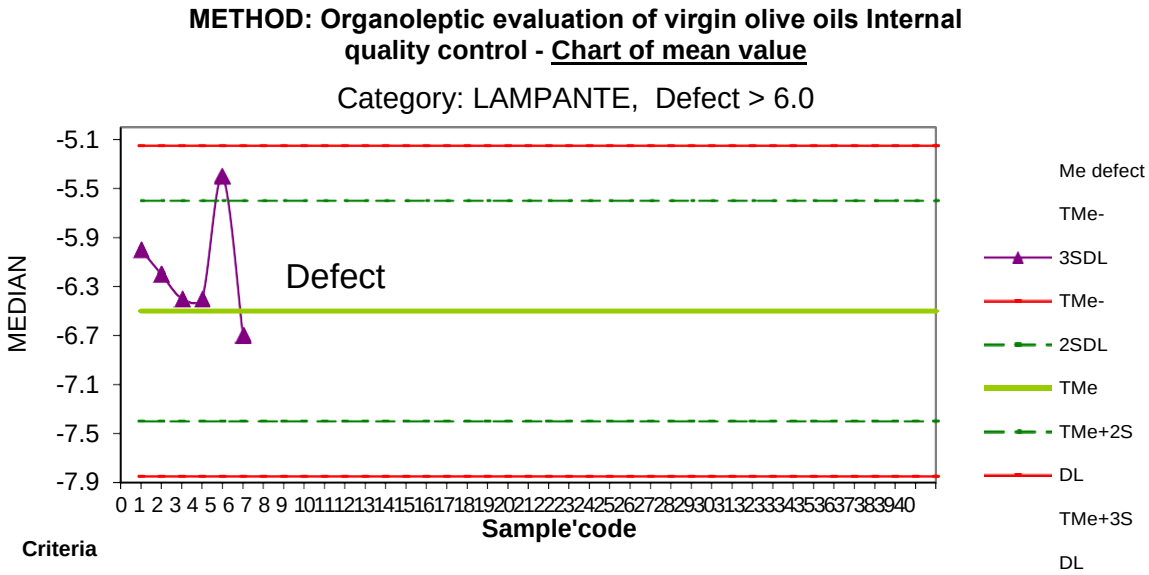
Criteria
1. If a violet point (defect) is equal to zero, the analytical procedure is out of contol.
2. If a blue (fruity) or a violet point (defect) is under or above the red line, the analytical procedure is out of control.
3. If 2 consecutive blue points (fruity) or violet points (defect) lie between red and dotted lines, the analytical procedure is out of control.
4. If 10 concetutive blue or violet points lie in the same side between the green and dotted lines, the analytical procedure is out of control.
5. If 7 consecutive blue points (fruity) lie in the same side between the green and dotted lines, there is a trend for the analytical procedure to be out of control.
6. if one from 20 consecutive blue or violet points lie between the dotted and red lines, the analytical procedure is within control.

Figure 6. Example of quality control chart for the category ordinary.



Criteria
1. If a violet point (defect) is > -3.5 and a blue point (fruity) is > 0, the analytical procedure is out of control.
2. If a violet point is < -6, the analytical procedure is out of control.
3. If a violet point is above or under the red line, the analytical procedure is out of control.
4.If 2 consecutive violet points (defect) lie between red and dotted lines, the analytical procedure is out of control.
5. If 10 successive violet points (defect) lie in the same side between the green and dotted lines, the analytical procedure is out of control.
6. If 7 consecutive violet points (defect) lie in the same side between the green and dotted lines, there is a trend for the analytical procedure to be out of control.
7. if one from 20 consecutive violet points lie between the dotted and red lines, the analytical procedure is within control.

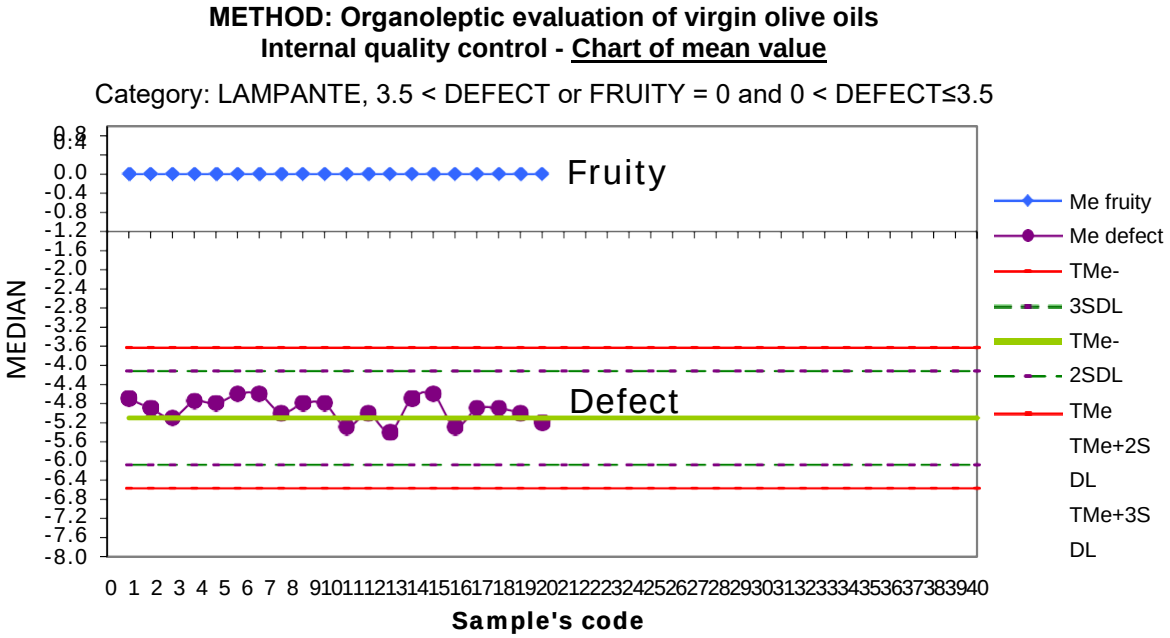
Figure 7. Example of quality control chart for the category lampante.



Criteria

1. If a violet point (defect) is > -6, the analytical procedure is out of control.
2. If a violet point is above or under the red line, the analytical procedure is out of control.
3. If 2 consecutive violet points (defect) lie between red and dotted lines, the analytical procedure is out ofcontrol.
4. If 10 consecutive violet points (defect) lie in the same side between the green and dotted lines, the analytical procedure is out of control.
5. If 7 consecutive violet points (defect) lie in the same side between the green and dotted lines, there is a trend for the analytical procedure to be out of control
6. if one from 20 consecutiveviolet points lie between the dotted and red lines, the analytical procedure is within control.

Figure 8. Example **of** quality control chart for the category lampante (in case that the category ordinary does not exist).



Criteria:

1. If a violet point (defect) is > -3.5 and a blue point (fruity) is > 0, the analytical procedure is out of control.
2. If a violet point is above or under the red line, the analytical procedure is out of control.
3. If 2 consecutive violet points (defect) lie between red and dotted lines, the analytical procedure is out of control.
4. If 10 consecutive violet points (defect) lie in the same side between the green and dotted lines, the analytical procedure is out of control.
5. If 7 consecutive violet points (defect) lie in the same side between the green and dotted lines, there is a trend for the analytical procedure to be out of control.
6. if one from 20 consecutive violet points lie between the dotted and red lines, the analytical procedure is within control.