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Príncipe de Vergara, 154 – 28002 Madrid – España Telef. : +34 915 903 638 Fax : +34 915 631 263 - e-mail : iooc@internationaloliveoil.org - http ://www.internationaloliveoil.org/

GUIDELINES FOR THE ACCREDITATION OF SENSORY TESTING LABORATORIES WITH PARTICULAR REFERENCE TO VIRGIN OLIVE OIL ACCORDING TO STANDARD ISO/IEC 17025:2005

Introduction

The guidelines are divided into two parts. The first deals with the correct organisational management of the laboratory while the second deals specifically with the application of the sensory assessment of virgin olive oil according to the methodology laid down in COI/T.20/Doc. No 15, as interpreted for the purposes of standard ISO/IEC 17025:2005.

Scope and field of application

The guidelines outline the steps for achieving compliance with the requirements stipulated in ISO/IEC 17025:2005 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 to the panel leader and the laboratories interested in earning accreditation and a source of guidance and uniformity for the inspectors responsible for auditing systems for the sensory analysis of virgin olive oil.

Normative references

ISO/IEC 17025:2005. General requirements for the competence of testing and calibration laboratories.
ISO 9001:2015. Quality management systems - Requirements.
EA-4/09 G:2003. 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 are under control by demonstrating that they obtain the same results within defined limits. In so far as possible, they should also demonstrate that they obtain equivalent results to those obtained by other laboratories.

Accredited sensory testing must be supported by adequate documentation demonstrating the repeatability and reproducibility of testing within the specific laboratory and between a significant 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 parameters of the testing methodology.

Part 1. Management requirements (4)

Organisation (4.1)

4.1.1. The laboratory or its parent organisation should be a **legally responsible** body, i.e. it should enjoy a legal status that is recognised by the Member State: corporate enterprise or partnership, cooperative, consortium, etc.

4.1.2. The laboratory is **responsible** for performing all the **calibration** and **testing** activities (interlaboratory tests) designed to fulfil the sections of the standard and to satisfy the requirements of customers as well as of the authorities or approved organisations in the Member State.

4.1.3. The laboratory management system should make provision for work to be carried out in **fixed** locations of the laboratory outside the permanent installations.

4.1.4. If the laboratory undertaking the sensory analysis of virgin olive oils is part of an organisation involved in other activities (e.g. consortium), the quality system implemented should clearly state the names of the laboratory officers-in-charge in order to highlight possible conflicts of interest.

4.1.5. The laboratory should:

- Have **suitably qualified** managerial and technical **personnel** who are familiar with the tasks assigned to them. This should be demonstrated by using the fact sheets for the management of laboratory personnel to specify the training background of each individual assessor (taster) and of the technical and managerial (panel leader) personnel, which should be in accordance with the national regulations in force;

- Have such arrangements in place as to prove that the personnel involved cannot be subjected to economic, commercial or any other pressure;
- Adopt working policies and procedures to guarantee the **protection** of **confidential information** and the proprietary rights of customers and to enable standard handling of samples and of the resultant data (coding management);
- Define the **tasks** and **responsibilities** for each function concerned, and the horizontal relationships between such functions: role of the panel leader and of the laboratory officer-in-charge vis-à-vis the sensory assessors of virgin olive oils and the technicians involved in sample management;
- Provide technical personnel with suitable supervision;
- Have **technical managers** who will hold overall responsibility for the laboratory and related activities;
- Assign a member of staff who is suitably trained (proven by supporting documentation) as the quality management officer (**QMO)**, who will have access to the entire system and to all data up to the highest level of the organisation;
- Designate the representative of the Management for laboratory management purposes.

The same person may perform several functions or tasks.

Quality system (4.2)

4.2.1 Laboratories undertaking the sensory analysis of virgin olive oils should **draw up**, **implement** and **maintain** a quality system consonant with their activities.

The quality policies (strategy), systems, programmes, procedures (tactics) and working instructions should be documented to the extent necessary to ensure the quality of the tests covered by accreditation, namely the classification and determination of the sensory profile of virgin olive oils. The system should be described in a document in printed or digital format, as appropriate.

The quality policy – strategy – should be defined and announced by the Management. It will be the starting point for the other actions of the laboratories undertaking the sensory analysis of virgin olive oils.

4.2.2 The quality policy should comprise the following at the very least:

- A commitment on the part of the Management to ensure good professional practice;
- A statement by the Management on the standard of services offered;
- The objectives of the quality management system;
- A requirement whereby all personnel involved in sensory assessment activity have to be familiar with the quality documentation and knowledgeable about implementing the quality policy (sharing of objectives);
- A commitment on the part of the facility and of the Management to conform to the normative reference (ISO/IEC 17025:2005).

4.2.3 The quality manual (QM) should include or refer to the technical or managerial support procedures.

4.2.4 The QM should also define the role of the Management and of the QMO.

Document control (4.3)

4.3.1. The laboratory should ensure optimal implementation of the technical and managerial procedures relating to the management of the quality system.

- Managerial procedures: these are very brief, effective procedures for managing specific in-house activities in conformity with the standard (e.g. procedure for document management).
- Technical procedures: these are procedures relating to the working arrangements for performing the specific sensory tests.

  The reference documents of the International Olive Council (IOC), now listed, comprise the technical procedures for the sensory assessment of virgin olive oil: COI/T.20/Doc. Nos 4, 5 (SO 16657:2006), 6, 14, 15, and 22. These documents provide specific working instructions for the optimal performance of the sensory analysis of virgin olive oils (classification and determination of the sensory profile).

4.3.2. Documents should be:

- Approved before being distributed;
- Released according to the distribution list contained in the document concerned and kept readily available thereafter;
- Checked periodically to ensure that the correct version is always distributed;
- Stored.

Obsolete documents should be taken out of circulation.

Quality system documents should be clearly identified by specifying the date of issue and revision, the total number of pages and the officer responsible for the specific document.

4.3.3 Amendments of documents should be re-examined by the officer who carried out the initial review, if present. Amendments should be identified (by underlining, highlighting, etc.) in the most current text.

Example: Procedure for document management and control

Introduction

The document management procedure is structured in such a way as to describe the arrangements for managing the QM and procedures and any other documents concerning the direct or indirect management of quality system processes.

Field of application

Quality management system of laboratories undertaking the sensory analysis of virgin olive oils, hereafter abbreviated to LANs.

1. Managing the quality manual

Responsibility

The administrative officer (QMO) is responsible for the documentary management of the QM.

Working arrangements

The QM has to be considered a single document; hence, any revisions concern the entire document.

The QM should contain a table at the end (quality manual management table) summarising all the revisions and dates of revision and specifying the officers responsible for drafting, checking and approving them.

The manual should be divided into chapters encompassing the main system processes, which should be cross-linked to the sections of the standard in a conversion table.

The date and version should be indicated at the bottom of the pages; this will help to check from the quality manual management table that the correct version is being used (i.e. the most current one).

Outdated hard-copy versions of the QM should be destroyed when they have been replaced by the new versions; digital forms should be kept in an appropriate directory of old versions.

Any amendments should be temporarily highlighted in the document by underlining, and the page and chapter concerned should be indicated in the quality manual management table.

The distribution of controlled copies of the QM should be recorded in the distribution column of the document list form.

2. Management of QM procedures

Responsibility

The administrative officer (QMO) is responsible for the documentary management of QM procedures.

Characteristics

The control system for procedures is the same as for the QM in that they also comprise a page (the last one) containing the procedure management table. The table specifies all the revision changes and current revision status, which should coincide with the details indicated at the bottom of the pages.

Working documents

The revision status of forms relating to specific procedures is modified at the same time as the procedures themselves.

Record of analyses

It is compulsory to keep a record of all samples.

The Management should periodically check the record to make sure it is being kept properly.

Structure

Fields:

- Name
- Date
- Sample ref.
- Customer ref.
- Confidentiality code ref.
- Type of analysis
- Testing officer
- Result
- Test report ref.
- Issue date of test report
- Final verification

Testing pathway

Document ref. COI/T.20/Doc. No 15 or Doc. No 22

Test report

The test reporting form should contain:

- Name of the organisation
- Name of the customer
- Type of test performed and normative reference
- Description of sample tested and sampling arrangements
- Result
- Verifications and signature
- Most current version of form

NC & Action form

This is the electronic document for recording nonconformities (NCs) and any action taken – corrective, preventive or improvements – at the LAN.

Structure of NC management

N: sequence number

Date: date of detection

Type: type of NC (complaint, internal audit finding, etc.)

Extent of detection: (Mi) minor, (Ma) major, (F) fundamental
Description of NC: description of NC
Disposition of NC: type of disposition to close NC
Cause of NC: cause, when possible
Corrective action (CA) reference: ref N actions
Control: control by officer-in-charge
Time limit: solution time limit
Close: control of close of NC by officer-in-charge

Structure of action management
N: sequence number
Date: date of action
Type: (C) corrective, (P) preventive, (I) improvement
Description of action: description
NC reference: ref.
Solution: verification of solution
Control: control by officer-in-charge
Time limit: solution time limit
Close: control of close by officer-in-charge

LAN spreadsheet
- Excel spreadsheet for classifying virgin olive oils (IOC)
- Spreadsheet for determining the sensory profile of virgin olive oils and for checking for compliance with the reference profile (PDO, PGI).

3. Management of external documents

Field of application
Quality management system for laboratories undertaking the sensory analysis of virgin olive oils, hereafter abbreviated to LANs.

Responsibility
An officer – the quality management officer or the panel leader – should be designated to carry out this task.
Working arrangements
External documents may encompass regulations, directives or other European Union texts, national laws, IOC documents, ISO standards, or other documents.
These documents are managed by registering them in an appropriate record and filing them in an easily located place.

Review of requests, bids and contracts (4.4)

The laboratory should draw up and keep procedures for the review (control and verification) of requests for testing, bids submitted to potential customers and contracts (accepted bids).

4.4.1 Contracts should ensure that:

- Requirements are carefully specified and care is taken to cite the methods used and any bibliographical or normative references;
- The laboratory has the capabilities and resources to fulfil requirements.

4.4.2 Contracts should be recorded or kept for the requisite length of time (usually two years). Meetings with customers to establish requirements should also be documented and recorded.

4.4.3. Any subcontracting of services should also be covered by this review process.

4.4.4. Customers should be advised of any deviation from the contract.

4.4.5. If the contract has to be amended to incorporate non-scheduled activities, the review process should be repeated from the very beginning.

Subcontracting (4.5)

If a laboratory has to subcontract tests for the sensory assessment of virgin olive oils, the customer should be advised accordingly and subcontracting management should be placed under full control through the appropriate management procedure and control forms (internal audit).

Procurement of services and supplies (4.6)

4.6.1. Laboratories undertaking the sensory analysis of virgin olive oils should draw up, implement and maintain procedures for the selection, assessment and management of suppliers of services or products relating to laboratory activity, such as the suppliers of glasses for the sensory assessment of olive oils or the suppliers of stationery.

4.6.2. Supplies inherent to the quality of service provided should only be used after undergoing prior inspection for conformity with specifications.

4.6.3. Procurement documents (bids, orders, invoices, packing lists, etc.) should be checked and approved from the technical standpoint prior to release.

4.6.4. Laboratories should apply a procedural methodology to assess the efficiency of suppliers who provide products critical to the quality of the system.

Example: procedure for assessment of suppliers

Introduction

This procedure should establish the criteria for the selection, assessment and re-assessment of service or product providers.

Assessment of suppliers

Field of application

LAN quality management system

Responsibility

The LAN is responsible for the supplier assessment process.

Stages

Supplier selection

The General Management and the procurement officer jointly draw up the list of suppliers required for the day-to-day management of the LAN.

Supplier qualification

Suppliers of services are divided into two categories:

1. Long-standing suppliers linked with the LAN for at least two years;
2. Newly hired suppliers.

The suppliers in the first category are qualified for the activity they perform; however, their annual activity is controlled.

Supplier control

General suppliers should be assessed in terms of the quality of their supplies, which may vary greatly.

Hence, the administrative officer is entrusted with carrying out an overall quality assessment by inspecting incoming supplies according to the quality rating scale listed below:

1. Bad
2. Inadequate
3. Adequate
4. Good
5. Optimal

All suppliers belonging to the first category should be included in a list of qualified suppliers that specifies the rating awarded to each one and the frequency of rating.

Customer services (4.7)

Customer management is intended to collect useful information to achieve full customer satisfaction and to ensure LAN transparency.

Cooperation with customers may encompass:

- Providing partial access to testing areas;
- Continuing communication;
- Sharing methods;
- Other.

Handling of complaints (4.8)

Example of handling complaints and customer communication
Communication with external customers varies depending on the stage concerned. When requesting the LAN for information, users/customers should be provided with all the important details to enable them to evaluate the chosen test; most of such details are set out in the LAN quality policy. Complaints are handled through a permanent desk where customers can outline their concerns and grievances orally or via post, e-mail or fax. Complaints are entered in the NC & ACTION form and may be extracted for the purpose of reviewing management and introducing improvements. Communication with internal customers is conducted orally through the panel leader, who is the most appropriate channel for this purpose.

Control of non-conforming testing and/or calibration (4.9)

The laboratory should have a clear procedure for managing any nonconformities that occur during the performance of tests or the handling of samples.

This procedure should enable the laboratory to:

- assign the responsibilities and authority for dealing with each nonconforming action;
- assess the danger and extent of the NC;
- take corrective action (CA) straight away;
- inform the customer;
- specify the responsibilities and authority for the continuation of NC activities.

The classification of the nonconformities is:

- Minor nonconformity – Any nonconformity which does not adversely affect the performance, durability, interchangeability, reliability, maintainability, effective use or operation, weight or appearance (where a factor), health or safety of a product. Multiple minor nonconformities when considered collectively may raise the category to a major or critical nonconformity.
- Major nonconformity – Any nonconformity other than critical, which may result in failure or materially reduce the usability of the product for the intended purpose (i.e. effective use or operation, weight or appearance (where a factor), health or safety) and which can not be completely eliminated by rework or reduced to a minor nonconformity by an approved repair.

- Critical nonconformity – Any nonconformity which may result in hazardous or unsafe conditions for individuals using, maintaining or depending upon the product or prevent performance of a vital agency mission.

When critical NCs are observed, it is necessary to review the entire system.

Example: NC management

Types of nonconformity

The following types of nonconformity are identified according to their nature:

- Nonconformity of testing services:
    * Failure of a test report to provide the requested service (classification instead of profile);
    * Failure to comply with the maximum permitted variability (CVr% defect most prominently perceived > 20%);
    * Failure to present the test report in the required manner
- Nonconformity of processes: failure of a process to comply with the relevant specifications;
- Nonconformity with the quality management system requirements for all the system processes: such cases are detected in internal audits (IAs);
- Customer complaints;
- Complaints (nonconformity) by in-house customers (assessors, panel leader, technical departments, etc.).

Cases of NC may be:

- Major; or
- Minor;
- Critical.

depending on the extent of the problem that arises.

Detecting and documenting nonconformity

Any service, activity or other instance that does not conform to plan generates the following actions:

1. Detection
2. Reporting
3. Recording
4. Solution
5. Close

Nonconformities are detected by the personnel who carry out the scheduled controls, i.e. the administrative officer and the quality system management officer.

Nonconformities are recorded in the relevant action management form:

Form structure

N: sequence number

Date: date of detection

Type: type of NC

Detection: reporting arrangements

Description of NC: description
Disposition of NC: disposition to resolve simple NCs
Cause of NC: determination of any causes of NC
CA reference: start of CA
Control: record control
Time limit: time limit for disposition or CA
Close: control of close of NC

Any NCS can be recorded and handled through the form.
The Management or the quality system management officer decides how to resolve the NC and records the solution in the same form.

Documents
Action management form

Corrective action (4.11)

4.11.1. The laboratory should implement the corrective action procedure when an NC is detected.

4.11.2. A precise analysis should be carried out of the causes of the NC.

4.11.3. The corrective action should be chosen and implemented.

4.11.4. The corrective action should be monitored and recorded, to assure that the NC will not be reapeated.

Example: procedure for ACTION management

Responsibility
The administrative officer (QMO) is responsible for the documentary management of the QM.

Working arrangements
Action may be corrective or preventive or may entail improvements.
The LAN may implement the following action on the basis of NC detection and management:
- Corrective: to correct any NCs;
- Preventive: to prevent any unforeseen NCs;
- Improvements: to improve process management.

Corrective action (CA) is initiated straight away when major NCs are detected; minor NCs can be resolved without such action by direct disposition of the NC.
The NC & ACTION form is used for this purpose:

Form structure
N: sequence number

Date: date of action
Type: type of action (corrective, preventive, improvement)
Description of action
NC reference: NC reference number
Solution: description of solution
Control: record control
Time limit: solution time limit
Close: control of close of NC

Documents
Form specially designed for NC & Action management.

Preventive and improvement action (4.10 and 4.12)

Necessary improvements should be identified to prevent the occurrence of sources of nonconformity and to better the effectiveness of the system.

Control of records (4.13)

4.13.1. Records should be controlled, updated and monitored. They should be filed on a specific form, specifying the type of document and the time and place of filing.

4.13.2. Technical Records

The records of each test should contain all the necessary information to be able to repeat it in conditions as similar 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 subsamples;
(e) method of sample preparation and equipment used;
(f) identity of the personnel who prepare the samples;
(g) 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;
(i) identity of the panel leader;
(j) method of data collection;
(k) method of statistical analysis.

Internal audits (4.14)

Internal audits are the tool for the internal control of the quality management system.

They are carried out on the basis of the following principles:

- Regular control of all processes;
- Use of third parties not directly involved in the process being audited;
- Use of a suitable checklist for control and verification purposes;
- Recording of every audit;
- Reporting of findings to the General Management.

Example: procedure for management of internal audits (IAs)

Introduction

The procedure for managing IAs describes the arrangements for managing in-house audits.

Field of application

LAN quality management system.

Responsibility

The quality system management officer is responsible for IAs.

IA planning

After review, the quality system management officer draws up the IA plan for the next year, taking into account the criticality of the different areas, and submits it to the Management for approval. The plan should be entered in the IA form.

Criticality is assessed on the basis of:

- earlier IA findings;
- assessments by the Management;
- requests;
- findings of external audits.

All processes should undergo assessment at least once during the course of the year.

Preparing internal audits

Near the deadline specified in the plan the quality management system officer notifies the date of the IA to the audit team leader.

The audit team leader must be qualified for this purpose, i.e. he or she must have received training and conducted an audit under supervision. The other members of the team become qualified by conducting at least one audit under the supervision of a qualified person.

Outside audit personnel must also be properly qualified.

Audit personnel may not audit their own area of responsibility.

Auditing is facilitated by using the internal audit form containing the main points for inspection, divided by process.

Implementing internal audits

The audit team carry out their tasks as follows:

- They hold an initial meeting with the Management and personnel involved in the audit in order to confirm the proposed plan;

- They perform the audit by checking those facts providing “objective evidence” of nonconformity with the requirements laid down in the audit reference documents.

Closing internal audits

At the end of the IA, the audit team leader has to analyse the findings against the scope of the audit, on the basis of the cases of nonconformity detected and noted down in the check-list, and to issue a summary document, namely the final internal audit report.

Documents

Internal audit form

Final internal audit report

Review by the Management (4.15)

Management reviews are the tool employed for the joint management of long-term (strategic) and short-term (tactical) objectives. Hence, the frequency with which they take place depends on:

- LAN activity;
- political–administrative events;
- achievement of previously set objectives;
- generic and specific requirements.

General requirements

The Management review of the quality management system entails checking the suitability, adequacy and effectiveness of the system and assessing the room for improvement and any modifications required to fine-tune processes.

Review input

- Internal audit results;
- Customer satisfaction feedback, including complaints;
- Process performance;
- Corrective and preventive action taken;
- Any action prompted by earlier reviews;
- Proposed necessary modifications of the system;
- Recommendations and proposals for improvements made by task officers.

Review output

- Review of quality policy in the light of the new instructions issued by the Management and of the new objectives;
- Instructions on modifications/improvements to be made to the system;
- Planning of internal audits;
- Planning of training by instructors, when possible;
- Requirements for the procurement of new resources.

Quality objectives

LAN objectives can be divided into two categories:

- Strategic or long-term objectives;
- Tactical objectives regarding the improvement of process effectiveness and efficiency.

Each objective is planned to ensure it can be measured and managed with the utmost ease and speed.

Achievement of the objectives laid down by the General Management depends on correct planning of the procedural steps, which help to attain the proposed goals by making use of personnel and financial resources.

Planning

To ensure optimal planning of the activities for attaining short-term and long-term objectives the LAN should adopt a planning facilitation system based on the following principles:

- Clear identification of long-term objectives;
- Identification of the short-term sub-objectives for attaining the long-term objectives;
- Identification of the steps for achieving the short-term and long-term objectives;
- Allocation of general and specific responsibilities;
- Allocation of the human and financial resources for each plan;
- Setting of the start and end of each plan;
- Identification of the step-by-step controls for checking that the approach taken is correct;
- Recording of each basic activity.

Part 2. Technical requirements (5)

General (5.1)

5.1.1 The factors determining whether tests and/or calibrations are performed correctly and reliably by a laboratory are:

- Human factors;
- Environmental and workstation conditions;
- Testing, calibration and validation methods;
- Equipment;
- Traceability of measurements;
- Sampling;
- Handling of devices.

5.1.2 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.

Personnel (5.2)

The laboratory Management should **ensure** that all the persons involved in testing are competent and **aware** of their roles.

In the case of 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**.

The standard referenced **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 mean perception threshold of the panel and **a technique for monitoring panel proficiency**.

A) Panel leader

Sensory analysis must be carried out under the supervision of a qualified and experienced panel leader possessing relevant qualifications. The Management should assign the panel leader a post in the organisation chart of the Organisation. It should provide all the pertinent, 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.

The document COI/T.20/Doc.15 “method for the organoleptic assessment of virgin olive oil” describes in details the duties of panel leaders.

Normally, a person should possess at least 2 years relevant sensory analysis work experience (e.g. taster of a panel) before being considered as panel leader. In addition, he or she should have knowledges of:

- The kinds of oils which he or she will come across in the course of their work.
- Statistical analysis.
- Office software.
- Special training is needed for panel leaders (except of the training for tasters), which should include at least:
    a) Selection of test procedures, experimental design and analysis;
    b) Reception and storage of the samples before and after being tested;
    c) Preparation, coding and presentation the samples to the tasters;
    d) Organisation and performance of the tests;
    e) Data input and processing;
    f) Preparation of reports;
    g) Maintenance of records;
    h) Maintenance of all necessary supplies and services;

i) Sensory assessor screening, selection, training and monitoring procedures;
j) Importance of the assessor's health and safety;
k) Statistical analysis;
l) Human resources management (useful for the motivation of the panel members);
m) Training in quality management system and ISO-17025.

Moreover, the panel leaders should participate in calibration sessions for the panel leaders organized by the IOC or in national or international competitions of extra virgin olive oil, in order to gain experience of the organoleptic characteristics of olive oils worldwide.

B) <u>Assessors (tasters)</u>

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 instrument in sensory analysis, strict requirements of qualification are demanded in order a taster to be member of a panel and to produce reliable results.

The recommended procedures include:

(a) Requirements for the incorporation of a new sensory assessor to a panel

Taking into account all the before mentioned, a taster can become member of a panel if he fulfils the below requirements of qualification.

- He has been interviewed by the panel leader and has completed the relative questionnaire.
- Its threshold in the characteristic attributes has been determined.
- He has successfully passed the tests “Selection of tasters by the intensity rating method”
- He has attended training courses and has been judged competent for the application of sensory method.

(b) Requirements of tasters’ qualification.

It is obvious that a new taster that fulfils all the requirements to become a panel member, does not maintain its competence, if he is not participating in the panel and is not controlled on a continuous basis in accordance with the provisions of chapter 5.9.1.

Consequently, a person is considered full qualified taster, if he fulfils the below requirements:

- He meets all the requirements for its incorporation to a panel .
- He is participating in the sessions of panel on ongoing basis.
- His performance is controlled and his competence is demonstrated on a regular basis, according to the panel procedures in which he is member.

The laboratory should document the screening and training programme to make sure that all the sensory assessors are properly trained for the tasks they are entrusted.

(c) Additional training, when necessary

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.

Workstation and environmental conditions (5.3)

5.3.1 The laboratory should have all the equipment for 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 the glasses to optimal temperatures are the chief specific items of ware 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 environmental conditions should ensure that the results are not rendered invalid or lowered in quality.

5.3.2. The laboratory manager should **monitor, control and record** the environmental conditions (temperature, relative humidity, light), which should comply with the specified conditions. The recommended temperature levels are specified in the reference standard for the installation of a laboratory undertaking the sensory analysis of virgin olive oils, ref. COI/T.20/Doc. no.6. These conditions are recommendations aimed at ensuring 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.

5.3.3. 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 controlled lighting, individual booths to reduce visual contact to a minimum, odour-free surfaces and adequate ventilation; the walls should be neutral in colour. A separate area should be set aside for preparing the samples.

5.3.4. If the sample preparation area is not near the test area, care should be taken over transporting the samples and keeping them at the right temperature for presenting them for analysis. **Access of sensory assessors to the sample preparation area should be controlled to prevent visual cues from influencing the analysis.** This is particularly important when the samples are being prepared prior to analysis.

5.3.5. The laboratory should be aware of the importance of keeping the test and sample preparation areas clean and tidy.

Testing methods (5.4)

The procedures complementing the sensory assessment method should be short, clear, simple and effective.

The laboratory **should document the method** in the necessary detail to ensure its correct application and repeatability.

The procedure for sensory analysis should include:

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

The testing method used entails robust techniques, also called *distribution-free* techniques, which are not sensitive to outliers. The underlying statistical system of the method helps to overcome two fundamental constraints, namely that:

- the oils have to be **classified** in a finite series of legally defined categories;
- as a result, there cannot be mobile or variable limits according to the random error, i.e. there cannot be categories in between those legally defined.

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

The pertinent methodology is based on the ISO standard for the determination of the sensory profile (ISO 13299:2016).

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.

5.4.5. Validation 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 (documents available at IOC, Madrid).

5.4.6. Estimation of uncertainty. Sensory analyses are a category of test which do 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.

5.4.7. Control of data. Data are controlled using a spreadsheet or other statistical method constructed specifically for determining and checking robust statistics (COI/T.20/Doc. No 15). The data are monitored by the panel leader who is trained as necessary for this purpose. The panel leader may decide to repeat the test or to approve and sign it, so authorising and releasing the test report.

Equipment (5.5)

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

The laboratory should carry out regular maintenance and checks to ensure that equipment complies with the required 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 analyses 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.

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 NCs.

NC apparatus should be taken out of use.

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

- Glass for tasting virgin olive oils (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 to give clear instructions on how to use the devices on the basis of the profiles.

It is strongly recommended not to use yoghurt makers, which are used by many laboratories as a cheaper alternative to the heating device. The reason is that they do not have a temperature control mechanism and the temperature is not uniform across the whole of the surface. Hence, it is very difficult to control and check the temperature of the oil during the test and so prove that all the assessors have tasted the oil at the same temperature.

Traceability of measurements (5.6)

5.6.3. Reference materials and chemical standards

5.6.3.1 When appropriate reference materials are available **(including certified reference material)**, the laboratory should use them to train the sensory assessors, to supervise the laboratory results and to validate and compare methods.

These materials will be Certified Reference Materials, if they exist; if it is not possible, the only ones that can be obtained are samples from interlaboratory tests conducted by the IOC and other accredited suppliers (according to ISO 17043). Using such samples, the quality control can be performed according to the rules of the next section. When this procedure 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 assignment of the reference values of defect and/or fruity flavour should be previously defined.

The range of the samples will be varied in order to cover different classes of virgin olive oil, intensities and attributes, along a year/campaign.

The laboratory will take into account the shelf life of the reference material.

5.6.3.2 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. All the containers should be properly labelled and should state the identity, concentration, date of preparation and/or date of expiry. Reference materials and standards should be handled in such a way as to keep them away from all contamination. The records should permit identification of the personnel responsible for their preparation and handling.

Sampling and handling (5.7 and 5.8)

The laboratory should have suitable procedures to ensure that samples do not undergo spoilage or damage and its traceability into the laboratory is guaranteed.

The sampler is responsible for transporting the sample to the laboratory, which should be carried out in appropriate conditions (ISO 5555:2001).

The laboratory is responsible for handling the sample inside the laboratory and should follow the rules laid down in the above-mentioned standard.

The store where products are kept prior to analysis should be kept at specific controlled temperatures (recorded daily). 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 the analysis of samples which are not 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.

Quality assurance of test and calibration results (5.9)

A) Internal quality control

Although each sensory test is controlled statistically (CVr≤20% for predominant defect and fruity attribute), a sensory laboratory should have adequate quality control procedures in place to check the validity of the results obtained every time the sensory method is used. The quality control systems adopted by the laboratory will depend on the type of sample, the methods of analysis and the frequency of the determinations. Nevertheless, the level of quality control should be sufficient to prove the validity of the results.

Irrespective of the method employed for the purposes of quality control, the same one 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 level of quality control may be at least 9% of all the samples analysed.

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

The laboratory should clearly define all the quality control measures in the quality system documentation.

The techniques for internal quality control guide for sensory laboratories of virgin olive oil are included in the **Annex I.** It includes a broad variety of procedures, which are time consuming. The application of all the procedures is not compulsory. It depends on the panel leader to select those procedures that ensure the competence of tasters and the panel and prove that the obtained results are reliable.

B) External quality control (proficiency tests)

Laboratories should participate in proficiency tests periodically (recommended, once a year, at least). In some specific cases, like 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, and issue the corresponding report, as well as the evaluation performed by the organizer of the proficiency test.

At least, three simultaneous criteria will be defined for such evaluation:
- Laboratories should classify correctly each sample, except in samples among categories, in which the uncertainty must be taken into account..
- Laboratories should obtain a satisfactory Z-score ($-2 \leq Z \leq 2$)
- The intensity of the classifying attributes should keep within the specified limits reported. This assessment is performed by means of the normalized error E_n as follows:

$$E_n = \frac{|V_{lab} - V_{pt}|}{\sqrt{u_{lab}^2 + u_{pt}^2}} \leq 2$$

Where:

V_{lab} is the value of the median of the attribute (positive or negative).

V_{pt} is the value of the assigned median in the exercise for the same attribute.

u_{lab} is the experimental s* obtained by the lab.

u_{pt} is the objective s* of the exercise.

In this case, the normalized error must be equal or lower than 2,0.

If the uncertainty is expressed as “expanded uncertainty”, then c = 1.96; hence, the normalized error should be equal or lower than 1,0:

$$E_n = \frac{|V_{lab} - V_{pt}|}{\sqrt{U_{lab}^2 + U_{pt}^2}} \leq 1$$

Where U_{lab} and U_{pt} are the expanded uncertainties, calculated as c x u_{lab} or c x u_{pt}.

The E_n value of the fruity will be calculated for extra virgin olive oil, and for the rest of the categories, the E_n calculation will be performed for the defect and the fruity, if it exists.

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. Corresponding records of such activities should be kept.

Reporting of results (5.10)

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 identification of the test report on each page;
- Name and address of the customer;
- Clear specification of the method used;
- Description, status and identification of the test samples;
- Date of receipt of the samples;
- Reference to sampling plans actually implemented;
- Test results – Precise classification of the sample or identification of the sensory profile determined;
- Name, post and signature of the person authorising the report.

When necessary for the interpretation of the results, the following should also be included in the test report:

- Uncertainty of measurement;
- Additional information on methods;
- Useful information on sampling.

Check list

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ANNEX I

INTERNAL QUALITY CONTROL GUIDE FOR SENSORY LABORATORIES

1. METHODS OF INTERNAL QUALITY CONTROL IN SENSORY ANALYSIS

1.1. Replicate analysis

1.2. Analysis of reference materials and characterised materials

2. CONTROL OF THE PERFORMANCE OF EACH TASTER

2.1. Control of the taster's precision

2.2. Control of the taster's trueness

2.3. Control of taster's competence (correct both classification and intensity's recognition of samples)

3. CONTROL OF THE PERFORMANCE OF PANEL

3.1. Control of the panel's precision

3.2. Control of the panel's trueness

4. QUALITY CONTROLS CHARTS IN SENSORY ANALYSIS

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

4.2. Quality control charts for indexes based on analysis of reference materials

4.3. Quality control charts of quality control samples

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This text is a complete internal quality control guide for sensory laboratories. It includes a broad variety of procedures, which are time consuming. The application of all the procedures is not compulsory. It depends on the panel leader to select those procedures that ensure the competence of tasters and the panel and prove that the obtained results are reliable.

1. METHODS OF INTERNAL QUALITY CONTROL IN SENSORY ANALYSIS

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

Some of the procedures employed for the purposes of quality control are:

(a) replicate analysis of samples in a specific percentage of all the samples analysed or in the sample testing system at adequate intervals.

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

For a guide, the level of quality control may be at least 9% of all the samples analyzed.

1.1. Replicate analysis

One sample to be replicated will be selected between the samples that are going to be analysed, or one sample analyzed in a previous day can be reanalyzed.

The maximum frequency of use of these samples for internal quality control should be every 11 tests (percentage 9% of all the samples analysed); however, the recommended frequency of use is every tasting day.

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

Number of samples per day	Level of control (*)
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%

(*) % duplicate samples, respect the total number of analyzed samples.

If at any period the sensory analysis is not performed, then the internal quality control is performed immediately prior to the analysis of samples. Throughout time, the replicate samples will cover the widest possible range of fruity, defects and intensities, and their position in the sessions will be randomly changed.

Although the method of replicate analysis 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 control 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 (Note: except for the months when no sample is analysed).

These materials will be Certified Reference Materials, if they exist; if it is not possible, remaining samples from proficiency tests should be used; in the absence of the mentioned samples, the laboratory will prepare a sufficient amount of samples for quality control, which will be characterized by comparison with, at least, three accredited panels. The criteria for assignement of the reference values of defect and/or fruity flavour should be previously defined.

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

The laboratory will take into account 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 the control of the trueness of both 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 an organoleptic test and the changes that occurs in the organoleptic characteristics of a sample during storage.

2. CONTROL OF THE PERFORMANCE OF EACH TASTER

Some minimal levels of precision and trueness are required for the tasters, in order to keep their qualification; moreover, additional requirements may be defined, as a minimal level of attendance to the sessions of the panel.

2.1. Control of the taster's precision

Precision is the closeness of agreement between independent test values. The precision assessment involves estimation of repeatability (r) and within-laboratory reproducibility / intermediate precision (R / Ip).

In the sensory method, the precision (repeatability and within laboratory intermediate precision) of tasters is determined by using the replicate analysis.

The repeatability of each taster is controlled by comparing the pair of the intensities given by the taster to a sample in duplicate.

It is recommended that the precision is controlled along time, in order to evaluate the different stages that the performance of the taster may undergo throughout time.

The precision may be controlled throughout time by means of the cumulative index of intermediate precision, which takes into account the intensities given by the taster to number of duplicated samples, between 6 and 10, (12-20 analysed samples, in total), as described in 1.1.

Alternatively, the intermediate precision of each taster can be measured throughout time, using the same index, but analyzing the same sample in 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 period of time of 6 months, depending on the attributes. In this case, conservation of the samples must guarantee that their characteristics remain unchanged.

The intensities taken into account are those used for the classification of the sample, that is the intensity of the predominant defect or/and of the fruity attribute.

Following are the formulas of estimators used for the assessment of repeatability and intermediate precision.

Tables 1.a and 1.b. Estimators of each taster precision

Field of application: taster	
Frequency : every 11 tests (percentage 9% of all the samples analysed) or every tasting day (percentage ≥9% of all the samples analysed)	
Estimation of Repeatability	**Repeatability Index (rI_t)** $rI_{dt} = \left(1 + \frac{\left(x_{d1} - x_{d2}\right)^2}{2}\right)$ for predominant defect $rI_{ft} = \left(1 + \frac{\left(x_{f1} - x_{f2}\right)^2}{2}\right)$ for fruity attribute or $rI_{ct} = \left(1 + \frac{\left(x_{c1} - x_{c2}\right)^2}{2}\right)$ for classified attribute Where: 1. rI_{dt} and rI_{ft} are the repeatability indexes of the taster t, for the predominant defect (d) and fruity attribute (f) respectively. 2. rI_{ct} is the repeatability index of the taster t, for the classified attribute (c). 3. x_{d1}, x_{d2} are the intensities given by the taster t to the predominant defect (d) in the first and second assessment of sample. 4. x_{f1}, x_{f2} are the intensities given by the taster t to the fruity attribute (f) in the first and second assessment of sample. 5. Xc1, xc2 are the intensities given by the taster t to the classified attribute (c) in the first and second assessment of sample. **n = number of analysed samples = 2.** Criteria of acceptance : rIct ≤3,0 or, rIdt and/or rIft≤3,0 **If this index is more than 3, refresher training should be arranged for the taster**

Field of application: taster	
Frequency : when the number of duplicate samples is between 6 and 10.	
Estimation of Intermediate Precision	**Intermediate Precision Index (IpI)** $IpI_{dt} = 1 + \frac{\Sigma (x_{di1} - x_{di2})^2}{n}$ for defects $IpI_{ft} = 1 + \frac{\Sigma (x_{fi1} - x_{fi2})^2}{n}$ for fruity attribute or $IpI_{t} = 1 + \frac{\Sigma (x_{ci1} - x_{ci2})^2}{n}$ for classified attribute Where: ❖ IpI_{dt} and IpI_{ft} are the indexes of the taster t, for defects (d) and fruity attribute (f), respectively. ❖ IpI_t is the index of the taster t, for the classified attribute (c). ❖ x_{di1}, x_{di2} are the intensities given by the taster t to the predominant defect (d) in the first and second assessment of sample i ❖ x_{fi1}, x_{fi2} are the intensities given by the taster t to the fruity attribute (f) in the first and second assessment of sample i. ❖ x_{ci1}, x_{ci2} are the intensities given by the taster t to the classified attribute (c) in the first and second assessment of sample i. ❖ n is the number of analysed samples . Criteria of acceptance : $IpI_t \leq 3{,}0$ or, IpI_{dt} and $RI_{ft} \leq 3{,}0$ If this index is more than 3, refresher training should be arranged for the taster.

Notes:

1. The sensory lab can calculate either one repeatability or intermediate precision index for each taster for **classified attribute (fruity for EVOO and defect of a higher intensity - predominant defect - for VOO, OVOO (if necessary) and LVOO, <u>determined by the panel</u>)** or one for the defects and another for the fruity attribute separately. In any case, the lab should keep the corresponding fully documented records.
2. The cumulative indexes may be calculated in batch or in continuous way
3. <u>Warning limit</u> = optionally, a warning limit may be defined, so, when indexes are between 2 and 3, the panel leader should study the possible causes, and if necessary, will perform the preventive actions to straighten

out the taster performance to the lower values of the indexes. It will not be necessary to apart the taster from panel since the indexes are lower than 3.

4. The below tables 2 include the necessary calculations for the estimation of cumulative index IpI_t, in order to facilitate the work of sensory lab. The continuous mode allows a more complete control of the taster.

Table 2.a. General calculations of intermediate precision indexes 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_{11}	X_{12}	X_{11}	X_{12}	$(X_{11}- X_{12})^2$	$(X_{11}- X_{12})^2$
X_{21}	X_{22}	X_{21}	X_{22}	$(X_{21}- X_{22})^2$	$(X_{21}- X_{22})^2$
X_{31}	X_{32}	X_{31}	X_{32}	$(X_{31}- X_{32})^2$	$(X_{31}- X_{32})^2$
X_{41}	X_{42}	X_{41}	X_{42}	$(X_{41}- X_{42})^2$	$(X_{41}- X_{42})^2$
……	……	……	……	…….	…….
X_{n1}	X_{n2}	X_{n1}	X_{n2}	$(X_{n1}- X_{n2})^2$	$(X_{n1}- X_{n2})^2$
				SUM1	SUM2
				A=SUM1/n	B=SUM2/n
				IpI_{dt}=(1+A)	IpI_{ft}=(1+B)

Table 2.b. Example of calculation of a cumulative index with n=6 in batch mode.

Intensity given by the taster		(Difference)^2	Calculations
1st test	2nd test		
X_{11}	X_{12}	$(X_{11}- X_{12})^2$	IpI_t=1+{SUM(1-6)/12}
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}	$(X_{71}- X_{72})^2$	IpI_t=1+{SUM(7-12)/12}
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}	$(X_{131}- X_{132})^2$	$Ipl_t=1+\{SUM(13-18)/12\}$
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 a cumulative index with n=6 in continuous mode.

Intensity given by the taster		(Difference)^2	Calculations	(Difference)^2	Calculations	(Difference)^2	Calculations
1st test	2nd test						
X_{11}	X_{12}	$(X_{11}- X_{12})^2$	$Ipl_t=1+\{SUM(1-6)/12\}$				
X_{21}	X_{22}	$(X_{21}- X_{22})^2$		$(X_{21}- X_{22})^2$	$Ipl_t=1+\{SUM(2-7)/12\}$		
X_{31}	X_{32}	$(X_{31}- X_{32})^2$		$(X_{31}- X_{32})^2$		$(X_{31}- X_{32})^2$	$Ipl_t=1+\{SUM(3-8)/12\}$
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_{81}	X_{82}					$(X_{81}- X_{82})^2$	

2.2. Control of the taster's trueness

In addition to the evaluation of the precision for 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." The systematic error (bias) is a measure of accuracy.

The trueness of tasters 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. control of the precision of the taster).

In the same manner, the performance of the tasters with respect to the panel over time could be included (deviation index) as well, by using the replicate analysis.

Following, the formulas of estimators used for the assessment of trueness are described.

Tables 3.a, 3.b and 3.c. Estimators of each taster trueness

Field of application: taster
Frequency : 9% of analysed samples in case of replicate analysis.

Deviation Index (DI_t)

Replicate analysis

$$DI_{dt} = 1 + \frac{\Sigma\left[(x_{di1} - Me_{di1})^2 + (x_{di2} - Me_{di2})^2\right]}{2n}$$ for defects

$$DI_{ft} = 1 + \frac{\Sigma\left[(x_{fi1} - Me_{fi1})^2 + (x_{fi2} - Me_{fi2})^2\right]}{2n}$$ for fruity attribute

or

$$DI_{t} = 1 + \frac{\Sigma\left[(x_{ci1} - Me_{ci1})^2 + (x_{ci2} - Me_{ci2})^2\right]}{2n}$$ for classified attribute

Where:

- DI_{dt} and DI_{ft} are the deviation indexes of the taster t, for the predominant defect (d) and fruity attribute (f) respectively.
- DI_t is the deviation index of taster t, for the classified attribute (c)
- x_{d1}, x_{d2} are the intensities given by the taster t to the predominant defect (d) in the first and second assessment of sample i,
- Me_{d1}, Me_{d2} are the medians of panel for the predominant defect (d) in the first and second assessment of sample i,
- x_{fi1}, x_{fi2} are the intensities given by the taster t to the fruity attribute (f) in the first and second assessment of sample i
- Me_{f1}, Me_{f2} are the medians of panel for the fruity attribute (f) in the first and second assessment of sample i,
- X_{c1}, x_{c2} are the intensities given by the taster t to the classified attribute (c) in the first and second assessment of sample i,
- Me_{c1}, Me_{c2} are the medians of panel for the classified attribute (c) in the first and second assessment of sample i,
- n is the number of analysed samples.

In addition, these formula can be simplified as follows:

$$DI_{dt} = 1 + \frac{\Sigma\left[(x_{di1} - Me_{di1})^2\right]}{n} \quad DI_{ft} = 1 + \frac{\Sigma\left[(x_{fi1} - Me_{fi1})^2\right]}{n} \quad DI_{ct} = 1 + \frac{\Sigma\left[(x_{ci1} - Me_{ci1})^2\right]}{n}$$

Criteria of acceptance :

$DI_t \leq 3{,}0$ or,

DI_{dt} and/or $DI_{ft} \leq 3{,}0$

If this index is more than 3, refresher training should be arranged for the taster.

Field of application: taster

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

Deviation Index (DI_t)

Analysis of reference materials or characterised samples

$$DI_{dt} = 1 + \frac{\Sigma(x_{di} - TMe_{di})^2}{n}$$ for defects

$$DI_{ft} = 1 + \frac{\Sigma(x_{fi} - TMe_{fi})^2}{n}$$ for fruity attribute

or

$$DI_t = 1 + \frac{\Sigma(x_{ci} - TMe_{ci})^2}{n}$$ for classified attribute

Where:

- DI_{dt} and DI_{ft} are the deviation indexes of the taster t, for the predominant defect (d) and fruity attribute (f) respectively.
- DI_t is the deviation index of taster t, for the classified attribute (c)
- x_{di}, x_{fi} are the intensities given by the taster t to the predominant defect (d) and to the fruity attribute (f) in the assessment of sample i,
- TMe_{d1}, TMe_{fi} are the values of reference sample i for the predominant defect (d) and for the fruity attribute (f).
- $x_c i$, is the intensity given by the taster t to the classified attribute (c) in assessment of sample i,
- TMe_{c1} is the value of reference sample i for the classified attribute (c).
- n is the number of analysed reference samples i .

Criteria of acceptance :

$DI_t \leq 3{,}0$ or,

DI_{dt} and $DI_{ft} \leq 3{,}0$

If this index is more than 3, refresher training should be arranged for the taster.

Field of application: taster

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

Taster's z-score

Analysis of reference materials

$$z-score_{dt} = \frac{(x_{dt} - TMe_d)}{s_d}$$ for predominant defect

$$z-score_{ft} = \frac{(x_{ft} - TMe_f)}{s_f}$$ for fruity attribute

or

$$z-score_{t} = \frac{(x_{ct} - TMe_c)}{s_c}$$ for classified attribute

Where:

- x_{dt}, x_{ft}, x_{ct} are the intensities given by the taster t to the predominant defect (d), to the fruity attribute (f) and to the classified attribute (c) in the assessment of sample,
- TMe_d, TMe_f, TMe_c are the values of reference sample (assigned value) for the predominant defect (d), for the fruity attribute (f) and for the classified attribute (c).
- s_d, s_f, s_c are the standard deviations of the average of all values of the laboratories participating in the certification process of the material, for the predominant defect (d), for the fruity attribute (f) and for the classified attribute (c), or the standard deviation of the method (±0,7).

Criteria of acceptance :
z-score$_t$≤±2,0 in case of Certified Reference Materials or samples from proficiency tests
z-score$_t$≤±3,0 in case of characterized samples

If this index is out of the above limits, refresher training should be arranged for the taster.

Notes :

5. As for the indexes for the control of precision, the sensory lab can calculate either one index for **classified attribute (fruity for EVOO and defect of a higher intensity - predominant defect - for VOO, OVOO (if necessary) and LVOO, <u>determined by the panel</u>)** or one for the defects and another for the fruity attribute separately. In any case, the lab should keep the corresponding fully documented records.

6. The below tables 4 and 5 include the necessary calculations for the estimation of cumulative indexes of trueness, in order to facilitate the work of sensory lab. In addition, the calculation can be performed in batch mode or in continuous mode, as explained before.

7. Besides, one of the systems in greatest use to check taster performance is to include, from time to time, one or several reference samples for analysis (clearly defined, pre-tested oils). Study of the individual variance in the scores obtained by each taster for these check samples makes it possible to determine, from the attendant F value, whether the tasters are keeping up their skills and consistency. Likewise, study of the variance of the mean scores obtained by the panel indicates whether or not it is continuing to function properly.

Table 4. Calculations of cumulative deviation indexes of the taster by using replicate analysis

Intensity given by the taster				Medians of panel				$(Difference)^2$			
Predominant Defect		Fruity		Predominant Defect		Fruity		Predominant Defect		Fruity	
1st test	2nd test	1st test	2nd test	1st test	2nd test	1st test	2nd test	1st test	2nd test	1st test	2nd test
X_{11}	X_{12}	X_{11}	X_{12}	Me_{11}	Me_{12}	Me_{11}	Me_{12}	$(X_{11}- Me_{11})^2$	$(X_{12}- Me_{12})^2$	$(X_{11}- Me_{11})^2$	$(X_{12}- Me_{12})^2$
X_{21}	X_{22}	X_{21}	X_{22}	Me_{21}	Me_{22}	Me_{21}	Me_{22}	$(X_{21}- Me_{21})^2$	$(X_{22}- Me_{22})^2$	$(X_{21}- Me_{21})^2$	$(X_{22}- Me_{22})^2$
X_{31}	X_{32}	X_{31}	X_{32}	Me_{31}	Me_{32}	Me_{31}	Me_{32}	$(X_{31}- Me_{31})^2$	$(X_{32}- Me_{32})^2$	$(X_{31}- Me_{31})^2$	$(X_{32}- Me_{32})^2$
X_{41}	X_{42}	X_{41}	X_{42}	Me_{41}	Me_{42}	Me_{41}	Me_{42}	$(X_{41}- Me_{41})^2$	$(X_{42}- Me_{42})^2$	$(X_{41}- Me_{41})^2$	$(X_{42}- Me_{42})^2$
……	……	……	… …	……	……	……	……	…….	…….	…….	…….
X_{n1}	X_{n2}	X_{n1}	X_{n2}	Me_{n1}	Me_{n2}	Me_{n1}	Me_{n2}	$(X_{n1}- Me_{n1})^2$	$(X_{n2}- Me_{n2})^2$	$(X_{n1}- Me_{n1})^2$	$(X_{n2}- Me_{n2})^2$
								SUM1	SUM2	SUM3	SUM4
								A=(SUM1+SUM2)/2n		B=(SUM3+SUM4)/2n	
								DI_{dt}=(1+A)		DI_{ft}=(1+B)	

Table 5. Calculations of cumulative deviation indexes of the taster by using analysis of reference materials

Intensity given by the taster		Values of reference sample		$(Difference)^2$	
defect	fruity	defect	fruity	Defect	Fruity
X_1	X_1	TMe_1	TMe_1	$(X_1- TMe_1)^2$	$(X_1- TMe_1)^2$
X_2	X_2	TMe_2	TMe_2	$(X_2- TMe_2)^2$	$(X_2- TMe_2)^2$
X_3	X_3	TMe_3	TMe_3	$(X_3- TMe_3)^2$	$(X_3- TMe_3)^2$
X_4	X_4	TMe_4	TMe_4	$(X_4- TMe_4)^2$	$(X_4- TMe_4)^2$
……	……	……	……	…….	…….
X_n	X_n	TMe_n	TMe_n	$(X_n- TMe_n)^2$	$(X_n- TMe_n)^2$
				SUM1	SUM2
				A=SUM1/n	B=SUM2/n
				DI_{dt}=(1+A)	DI_{ft}=(1+B)

2.3. Control of taster's competence (correct both classification and intensity's recognition of samples)

The above estimation of trueness controls only the values given by the tasters in the assessment of a reference material. However, the organoleptic method is qualitative and quantitative method simultaneously, since its application results in the classification of the samples, based in the median of the predominant defect and the presence or not of the fruity attribute. Consequently, the tasters must be controlled:

- for their correct classification of the samples and
- for their correct recognition of the intensities of the perceived attributes.

This is a complete control, since it evaluates both topics, and it is a complement of the previous techniques. It checks the performance of the tasters in just one day, and not along the time.

It can be performed with a similar procedure to that applied by IOC for the evaluation of the results of various panels in the proficiency tests. The recommended procedure is presented below.

The competence of a taster could be checked by using the results of each taster in the last interlaboratory proficiency testing. If it is not possible (for example in the case of a new taster), then the check of taster's competence is performed by analysing organoleptically samples with known reliability data (Certified Reference Materials, samples from proficiency tests or characterized samples).

The samples selected for the control of competence should be preferably of the categories extra virgin, virgin and lampante and have defined reliability data (category statistically significant at 95% confidence level, median of predominant defect or/and fruity, standard deviation (not robust standard deviation) or upper and lower confidence limit for the predominant defect and fruity).

If the taster has classified correctly the sample and the intensity of the predominant defect for categories virgin and lampante and of the fruity for the category extra virgin, given by the taster in each sample is between the upper and lower confidence limit or according to the criteria of acceptance of z-score of taster (see above), then the taster's score is 1. Should not apply any of the preceding cases, the taster's score is 0.

The criterion of acceptance of the z-score is identical to the criterion of 2*s [where s is the standard deviation of the average of all values of the laboratories participating in the certification process of the material or the standard deviation of the method (±0,7) and not the robust standard deviation], so, the taster is evaluated with results which are included in the report of the proficiency tests.

The criterion of the upper and lower confidence limit is stricter than the criterion of acceptance of z-score. It depends on the panel leader to select the most appropriate for the lab criterion.

For each taster, the median of taster's scores is calculated and if this score is 1, then the taster is considered competent for the performance of the organoleptic tests. If the score is 0, while this is not the case with the other tasters, then retraining is required.

Follows an example of the evaluation of taster's competence

Table 6. 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 value	**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*S	**2,4**	**1,0**	**2,5**
Evaluation of the taster			
Score	**1**	**0**	**0**
Median of scores=0 ⇨ taster not competent			

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

3. CONTROL OF THE PERFORMANCE OF PANEL

During the procedures for the control of the performance of each taster, the estimation of precision and trueness of the whole panel can be performed, as well.

3.1. Control of the panel's precision

The estimation of the precision of the panel can be performed during the procedure of replicate analysis for the assessment of taster precision.

In addition, the validation of the tasting day may be carried out by means of the replicate analysis, calculating the normalized error.

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

The validation of the tasting day may be performed by the normalized error, which determines whether the two results of a duplicate analysis are homogenous or statistically acceptable.

The intermediate precision of the panel is controlled by comparing the pairs of medians obtained by analyzing a number of duplicated samples, between 6 and 10, (12-20 analysed samples, in total).

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

Following are the formulas of estimators used for the assessment of repeatability and intra-laboratory reproducibility of the panel.

Table 7.a, 7b, 7c. Estimators of panel precision

Field of application: panel

Frequency : every 11 tests (percentage 9% of all the samples analysed) or every tasting day (percentage ≥9% of all the samples analysed)

Estimation of Repeatability

Normalized error (En)

$$En_d = \left(\frac{|Me_{d1} - Me_{d2}|}{\sqrt{U_{d1}^2 + U_{d2}^2}} \right) \text{ for predominant defect}$$

$$En_f = \left(\frac{|Me_{f1} - Me_{f2}|}{\sqrt{U_{f1}^2 + U_{f2}^2}} \right) \text{ for fruity attribute}$$

or

$$En_c = \left(\frac{|Me_{c1} - Me_{c2}|}{\sqrt{U_{c1}^2 + U_{c2}^2}} \right) \text{ for classified attribute}$$

Where:

- En_d , En_f and En_c are the normalized errors of the panel, for the predominant defect (d), the fruity attribute (f) and the classified attribute (c), respectively.
- Me_{d1} and Me_{d2} are the medians of the panel, for the predominant defect (d) in the first and second assessment of sample.
- Me_{f1} and Me_{f2} are the medians of panel, for the fruity attribute (f) in the first and second assessment of sample.
- Me_{c1} and Me_{c2} are the medians of panel, for the classified attribute (c) in the first and second assessment of sample.
- U1 and U2, are the respective 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 of the respective medians Me_1 and Me_2 for the predominant defect (d), fruity attribute (f) or classified attribute (c). Occasionally, it could be considered the maximum error allowed by the method or the deviation standard of the method (±0,7).

Criteria of acceptance : En≤1,0

Field of application: panel

Frequency : every 11 tests (percentage 9% of all the samples analysed) or every tasting day (percentage ≥9% of all the samples analysed)

Estimation of Repeatability

Repeatability Index (rIp)

$$rI_{dp} = \left(1 + \frac{\left(Me_{d1} - Me_{d2}\right)^2}{2}\right)$$ for predominant defect

$$rI_{fp} = \left(1 + \frac{\left(Me_{f1} - Me_{f2}\right)^2}{2}\right)$$ for fruity attribute

or

$$rI_{cp} = \left(1 + \frac{\left(Me_{c1} - Me_{c2}\right)^2}{2}\right)$$ for classified attribute

Where:

- rI_{dp} , rI_{fp} and rI_{cp} are the repeatability indexes of the panel p, for the predominant defect (d) , fruity attribute (f) and the classified attribute (c), respectively.
- Me_{d1}, Me_{d2} are the medians of the panel for the predominant defect (d) in the first and second assessment of sample.
- Me_{f1}, Me_{f2} are the medians of the panel for the fruity attribute (f) in the first and second assessment of sample.
- Me_{c1}, Me_{c2} are the medians of the panel for the classified attribute (c) in the first and second assessment of sample.

Criteria of acceptance :

$rI_{cp} \leq 3{,}0$ or,
rI_{dp} and $rI_{fp} \leq 3{,}0$

If this index is more than 3, refresher training should be arranged for the panel.

Field of application: panel

Frequency : every 11 tests (percentage 9% of all the samples analysed) or every tasting day (percentage ≥9% of all the samples analysed)

Estimation of Intermediate Precision

Intermediate Precision Index (RIp)

$$IpI_{dp} = \left(1 + \frac{\sum (Me_{di1} - Me_{di2})^2}{n}\right) \quad \text{for defects}$$

$$IpI_{fp} = \left(1 + \frac{\sum (Me_{fi1} - Me_{fi2})^2}{n}\right) \quad \text{for fruity attribute}$$

or

$$IpI_{cp} = \left(1 + \frac{\sum (Me_{ci1} - Me_{ci2})^2}{n}\right) \quad \text{for classified attribute}$$

Where:

- IpI_{dp} , IpI_{fp} and IpI_{cp} are the indexes of the panel p, for defects (d), fruity (f) and classified attribute (c) respectively.
- Me_{di1}, Me_{di2} are the medians of the panel p for the predominant defect (d) in the first and second assessment of sample i.
- Me_{fi1}, Me_{fi2} are the medians of the panel p for the fruity attribute (f) in the first and second assessment of sample i.
- Meci1, Meci2 are the medians of the panel p for the classified attribute (c) in the first and second assessment of sample i.
- n is the number of analysed samples (n≤20).

Criteria of acceptance :

$IpI_{cp} \leq 3{,}0$ or

IpI_{dp} and $RI_{fp} \leq 3{,}0$

If this index is more than 3, refresher training should be arranged for the panel.

Notes:

8. The notes 1, 2 and 3 referring to the control of precision of each taster, are applied on the control of precision of the panel, as well. It is obvious that in the current chapter the word “taster” is substituted by the word “panel”.

9. The table 8 includes the necessary calculations for the estimation of cumulative index IpI_p (as the table 2), in order to facilitate the work of sensory lab. The technique of the continuous calculation may also be carried out, as described before.

Table 8. Calculations of intermediate precision indexes of the panel

Medians of panel				$(Difference)^2$	
Predominant Defect		Fruity		Predominant Defect	Fruity
1st test	2nd test	1st test	2nd test		
Me_{11}	Me_{12}	Me_{11}	Me_{12}	$(Me_{11}- Me_{12})^2$	$(Me_{11}- Me_{12})^2$
Me_{21}	Me_{22}	Me_{21}	Me_{22}	$(Me_{21}- Me_{22})^2$	$(Me_{21}- Me_{22})^2$
Me_{31}	Me_{32}	Me_{31}	Me_{32}	$(Me_{31}- Me_{32})^2$	$(Me_{31}- Me_{32})^2$
Me_{41}	Me_{42}	Me_{41}	Me_{42}	$(Me_{41}- Me_{42})^2$	$(Me_{41}- Me_{42})^2$
……	……	……	……	…….	…….
Me_{n1}	Me_{n2}	Me_{n1}	Me_{n2}	$(Me_{n1}- Me_{n2})^2$	$(Me_{n1}- Me_{n2})^2$
				SUM1	SUM2
				A=SUM1/n	B=SUM2/n
				$IpI_{dp}=(1+A)$	$IpI_{fp}=(1+B)$

3.2. Control of the panel's trueness

The control of the panel's trueness is the object of external quality control of a laboratory. Nevertheless, the estimation of the trueness of the panel can be performed during the procedure of analysis of reference materials or characterised materials for the assessment of taster trueness, as well.

Following are the formulas of estimators used for the assessment of trueness of the panel.

Table 9.a. and 9.b. Estimators of panel's trueness

Field of application: panel

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

Deviation Index (DI_p)

Analysis of reference materials or characterised samples

$$DI_{dp} = 1 + \frac{\Sigma(Me_{di} - TMe_{di})^2}{n}$$ for defects

$$DI_{fp} = 1 + \frac{\Sigma(Me_{fi} - TMe_{fi})^2}{n}$$ for fruity atribute

or

$$DI_{cp} = 1 + \frac{\Sigma(Me_{ci} - TMe_{ci})^2}{n}$$ for classified attribute

Where:

- DI_{dp} , DI_{fp} and DI_{cp} are the deviation indexes of the panel p, for the predominant defect (d), the fruity attribute (f) and the classified attribute (c), respectively.
- $Me_{di,}$ Me_{fi} Me_{cp} are the medians of the panel p for the predominant defect (d), the fruity attribute (f) and the classified attribute (c) in the assessment of sample i,
- TMe_{d1}, TMe_{fi} and TMe_{cp} are the values of reference sample i for the predominant defect (d), the fruity attribute (f) and the classified attribute (c).
- n is the number of analysed reference samples i .

Criteria of acceptance :

$DI_{cp} \leq 3{,}0$ or
DI_{dp} and $DI_{fp} \leq 3{,}0$

If this index is more than 3, refresher training should be arranged for the panel.

Field of application: panel

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

z-score panel

Analysis of reference materials

$$z-score_{dp}=\frac{\left(Me_{dp}-TMe_{d}\right)}{s_{d}}$$ for predominant defect

$$z-score_{fp}=\frac{\left(Me_{fp}-TMe_{f}\right)}{s_{f}}$$ for fruity attribute

or

$$z-score_{cp}=\frac{\left(Me_{cp}-TMe_{c}\right)}{s_{c}}$$ for classified attribute

Where:

- Me_{dp} Me_{fp} and Me_{cp} are the medians of the panel p for the predominant defect (d), for the fruity attribute (f) and for the classified attribute (c) in the assessment of sample,
- TMe_{d}, TMe_{f} and TMe_{c} are the values of reference sample (assigned value) for the predominant defect (d), for the fruity attribute (f) and for the classified attribute (c).
- s_{d}, s_{f} and s_{c} is the standard deviation of the average of all values of the laboratories participating in the certification process of the material, for the predominant defect (d) and for the fruity attribute (f), or in general, the standard deviation corresponding to the TMe. Occasionally, it could be considered the maximum error allowed by the method or the deviation standard of the method (±0,7).

Criteria of acceptance :

$z\text{-score}_{p} \leq \pm 2,0$

If this index is out of the above limits, refresher training should be arranged for the panel.

Notes :

10. The note 5 referring to the control of taster's trueness, are applied on the control of panel's trueness, as well. It is obvious that in the current chapter the word "taster" is substituted by the word "panel".

11. The table 10 includes the necessary calculations for the estimation of cumulative index DI_{p} (as the table 5), in order to facilitate the work of sensory lab. The continous mode can also be applied.

Table 10. Calculations of cumulative deviation indexes of the panel by using analysis of reference materials

Intensity given by the taster		Values of reference sample		(Difference)^2	
defect	Fruity	defect	fruity	Defect	Fruity
Me_1	Me_1	TMe_1	TMe_1	$(Me_1- TMe_1)^2$	$(Me_1- TMe_1)^2$
Me_2	Me_2	TMe_2	TMe_2	$(Me_2- TMe_2)^2$	$(Me_2- TMe_2)^2$
Me_3	Me_3	TMe_3	TMe_3	$(Me_3- TMe_3)^2$	$(Me_3- TMe_3)^2$
Me_4	Me_4	TMe_4	TMe_4	$(Me_4- TMe_4)^2$	$(Me_4- TMe_4)^2$
……	……	……	……	…….	…….
Me_n	Me_n	TMe_n	TMe_n	$(Me_n- TMe_n)^2$	$(Me_n- TMe_n)^2$
				SUM1	SUM2
				A=SUM1/n	B=SUM2/n
				DI_{dp}=(1+A)	DI_{fp}=(1+B)

4. QUALITY CONTROLS 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", ie if the results produced are continuously within control limits.

The predominantly used quality control charts are those of Shewhart and of these the most common are $\bar{X}$ charts (mean value) and $\bar{R}$ charts (Range).

In sensory analysis, the evolution of the performance of each taster and the whole panel must be checked thorough time. To do this, the values obtained during the procedures for the control of the performance of each taster and the panel, could be placed in quality control charts, as part of the internal quality control. The quality charts facilitate to monitor the performance of each taster and panel, throughout time.

The laboratory should define which actions will perform (corrective and/or preventive) whether one result is outside of the limits, or several consecutive results are obtained at the same side (positive or negative) of the central value, but into the limits, since in this case, the laboratory may present any kind of systematic error (bias).

The quality control charts used in sensory analysis could be grouped as follows:

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

As it was referred in above paragraphs 2.1., 2.2. and 3.1., the indexes based on replicate analysis are repeatability, intermediate precision and deviation indexes of tasters and normalized error, repeatability and intermediate precision indexes 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 indexes of panel and tasters based on analysis of reference materials should be included, since they are always positive number, as the before mentioned indexes are.

The "trend charts" is a type that can be used to illustrate the experimental results, when the quality control is based on the assessment of conformity by performing duplicate measurements of a sample.

The minimum value of these indexes (except of the normalized error) is one (1) and the maximum value is three (3). Consequently, the x axis intersects the axis y to 1. The minimum value of normalized error is 0 and the maximum is 1, so the x axis intersects the axis y to 0.

On the vertical axis the value of the index is placed and on the horizontal axis the code of the sample or the date of the analysis that each time to ensure traceability.

Below, some models are presented including the criteria for the interpretation of the charts (as explained before, the laboratory should define the criteria for implementing the preventive and corrective actions).

Figure 1. Quality control chart for the deviation index of taster in the fruity attribute

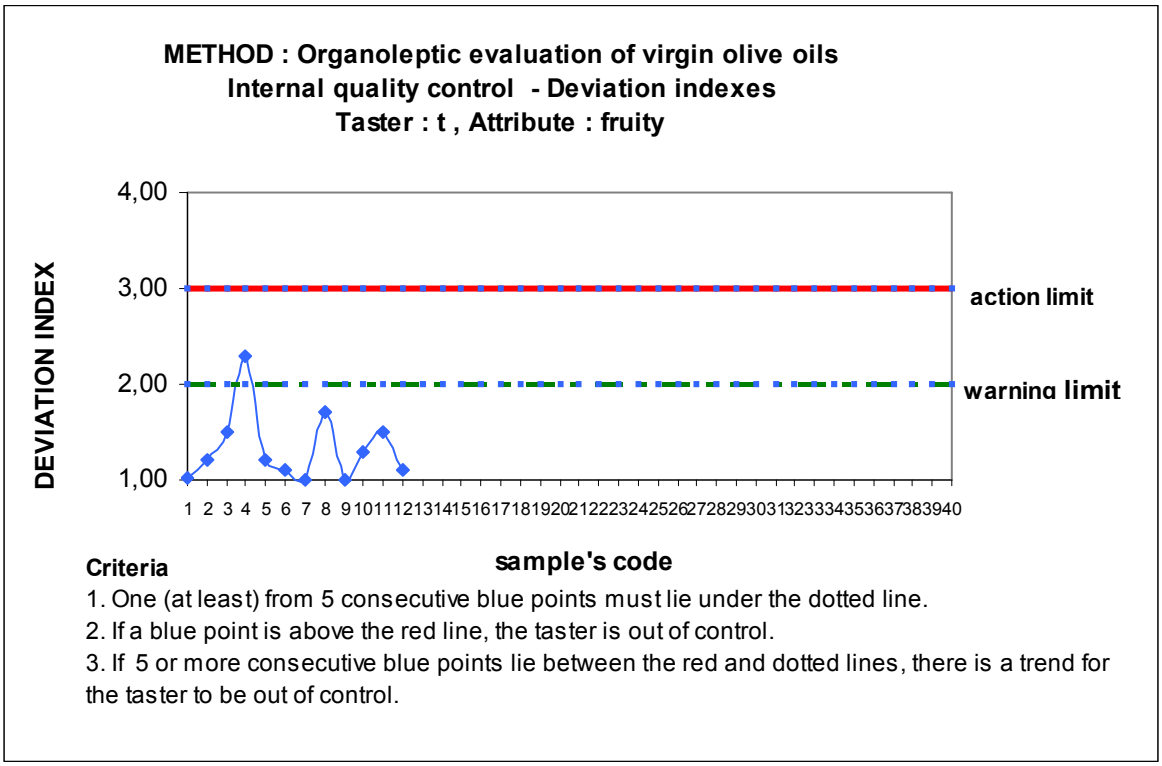
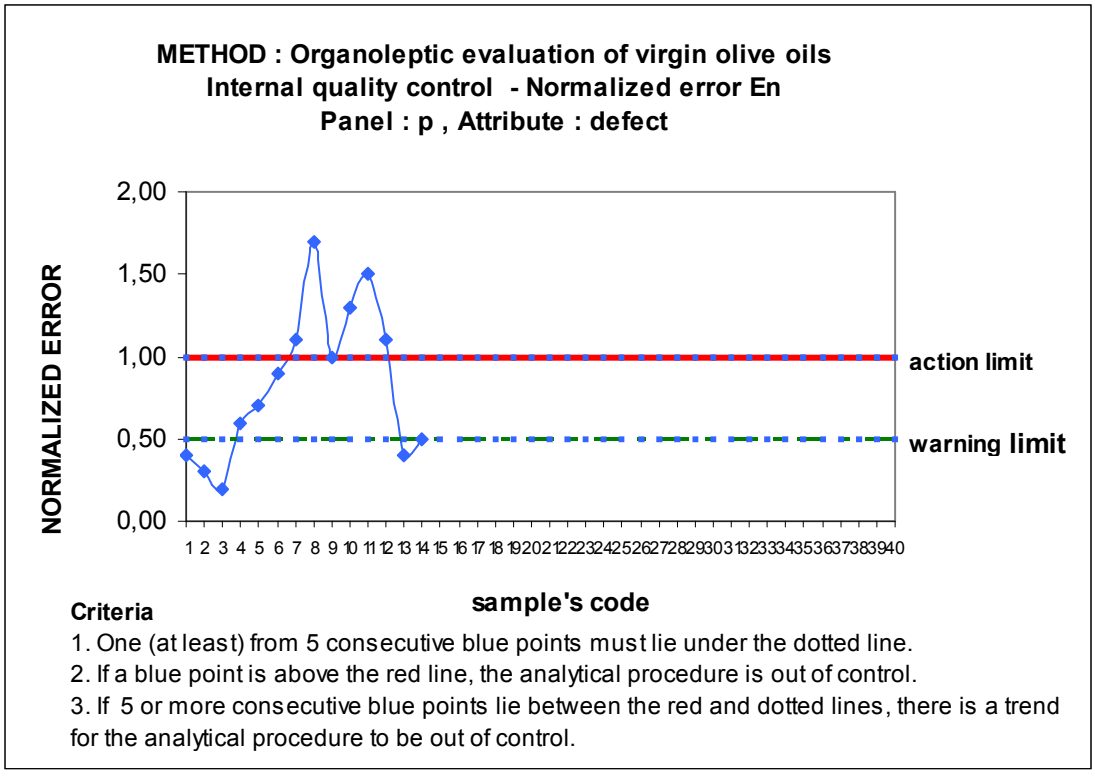


Figure 2. Quality control chart for the normalized error of panel in the defects



4.2. Quality control charts for indexes based on analysis of reference materials.

As it was referred in above paragraphs 2.2. and 3.2., the main indexes based on the analysis of reference materials are the z-score and the deviation index of taster and panel.

● Deviation index

The graphs are performed as explained in 4.1

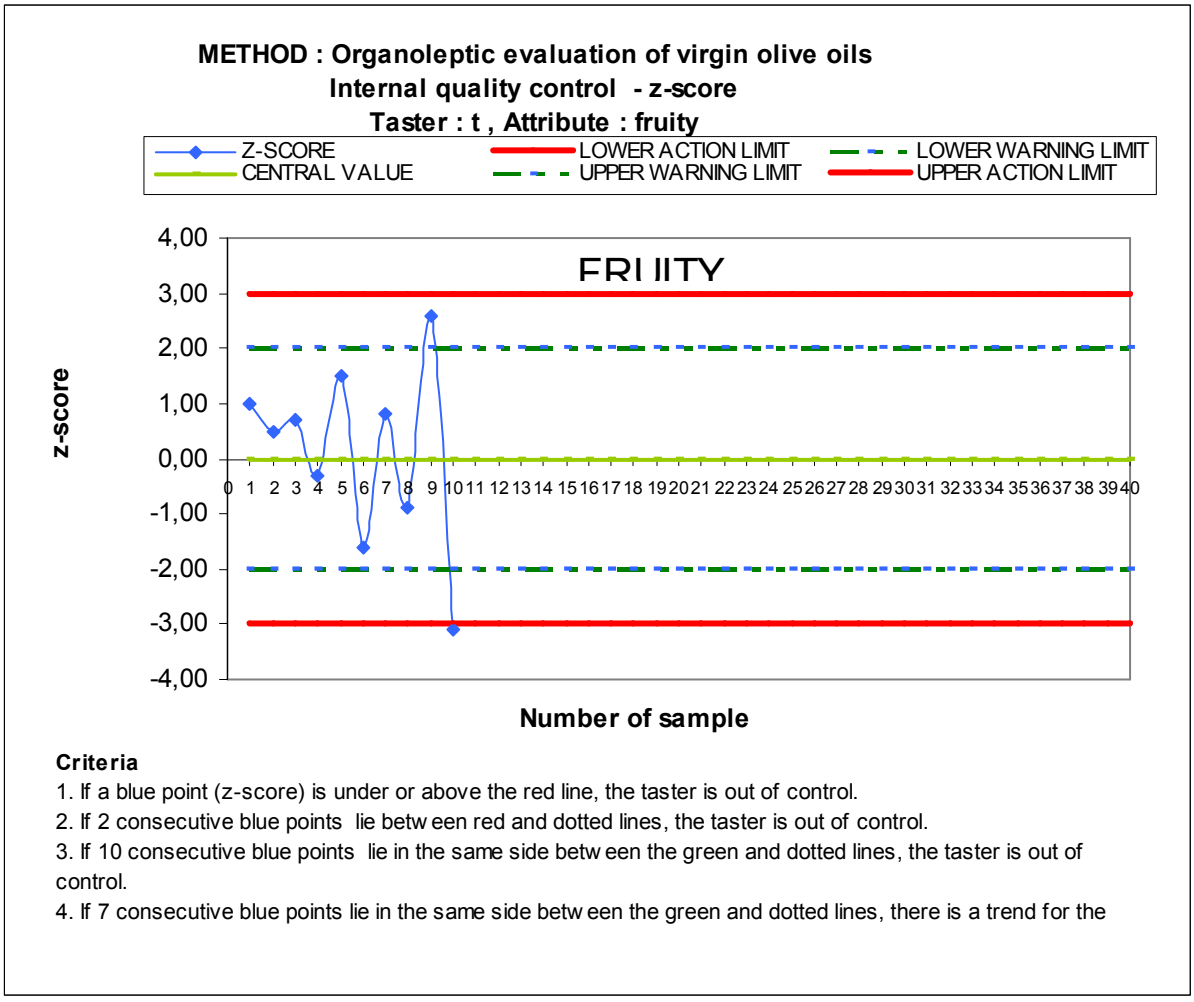
● z-score graphs

Taking into account that this index has positive or negative values, its control chart could be a similar to $\bar{X}$ chart.

The central value is zero, the warning limits for the index are ±2, and the action limits are ±3. The laboratory should define the corrective or/and preventive actions which will be performed whether one result is outside of 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 lab 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 throughout time.

Below, an example of the graph and some criteria for its interpretation are presented.

Figure 3. Quality control chart for z-sore of taster in the fruity attribute.



Criteria

1. If a blue point (z-score) is under or above the red line, 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

4.3. Quality control charts of quality control samples

It is well known that quality control samples are samples similar to the unknown, but with a known content of the measured component, which are prepared secondary by a standard procedure of lab and used for the control of an analysis. Theirs graphic representation is the well known $\bar{X}$ chart.

As it was referred in paragraph 1.2, in sensory tests, the use of certified or of secondary reference materials is difficult, due to the large quantity required for carrying out an organoleptic test and the changes that occurs in the organoleptic characteristics of a sample during storage. However, it is possible these samples to be prepared and to be reserved in the refrigerator in separate bottles of 150ml for at least one year. The frequency of the use of these samples could be the same as in the case of the use of reference

materials (once per month) or every 20 unknown samples. The measurements of the quality control samples are recorded in a $\bar{X}$ chart.

In this chart, the vertical axis represents the median of fruity or defect, and the horizontal axis only identified the date of the analysis or sample's code. These charts could be double, to illustrate both fruity and negative sensory attributes (fruity to the positive axis, defect to the negative axis). The criteria for the interpretation of these charts are those used in the quality charts of any analysis.

Moreover, because in the sensory analysis the correct identification of the intensity and the correct classification should be checked, it is appropriate to be adopted at the same time 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 courante: 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 courante does not exist,

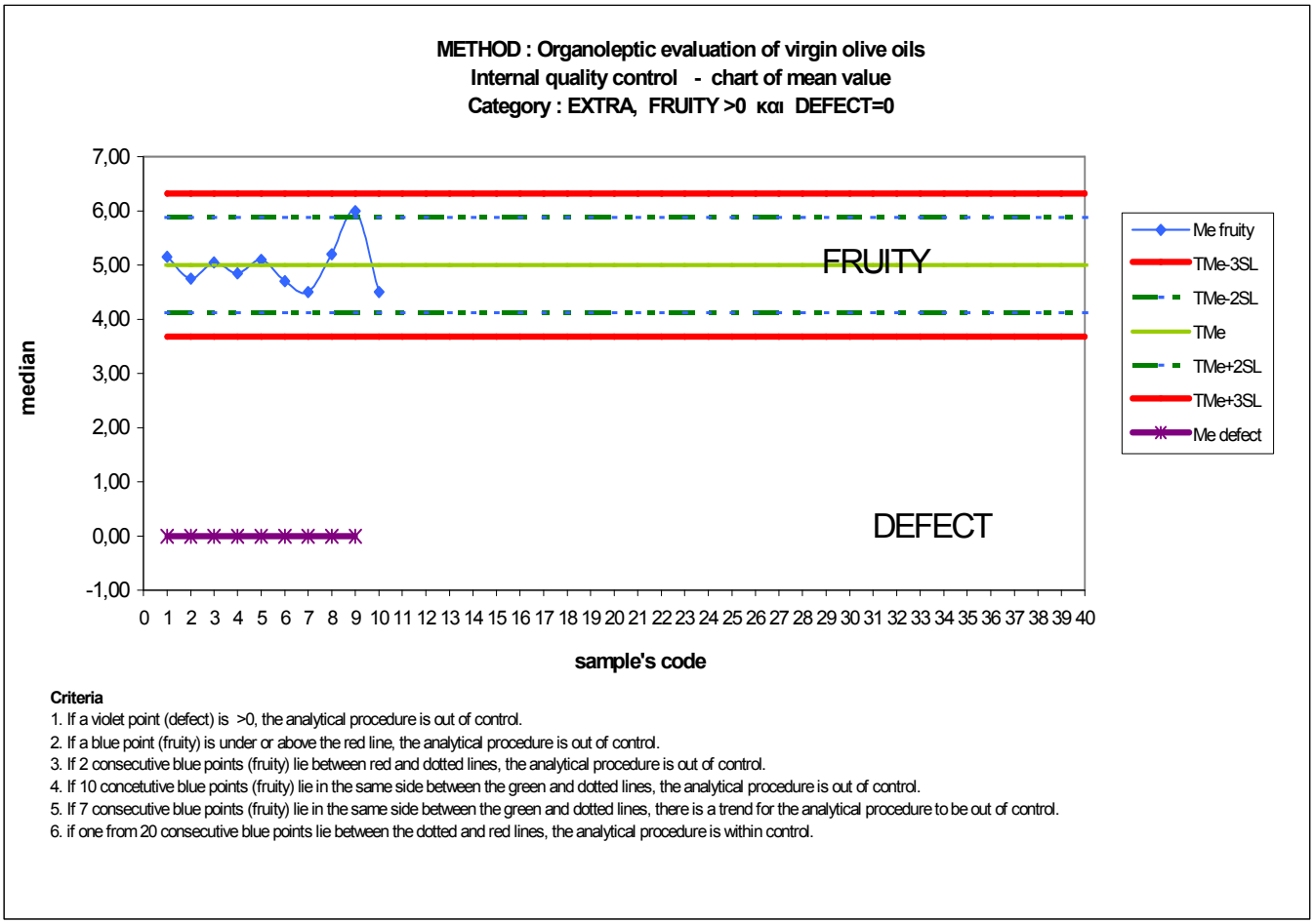
- Category lampante: If fruity>0 and defect <3.5, the analytical procedure is out of control.

Below, some examples of quality control charts for each category are presented including examples of the criteria for the interpretation of the charts.

In these charts:

- **TMe is the "assigned value" of the quality control sample**
- **S_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. It could be also used the standard deviation of the method (± 0,7).**

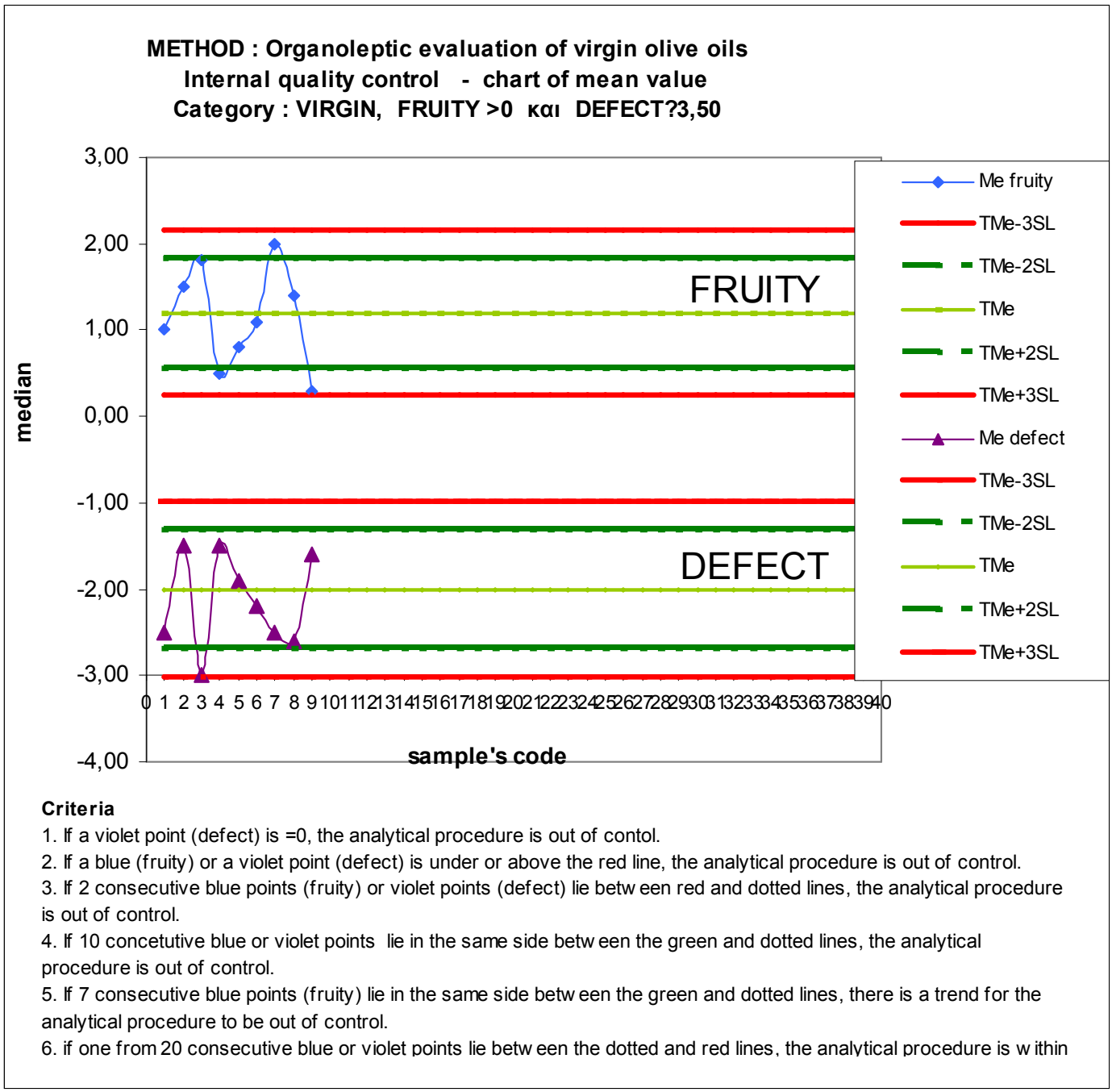
Figure 4. Quality control chart for the category extra virgin



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.

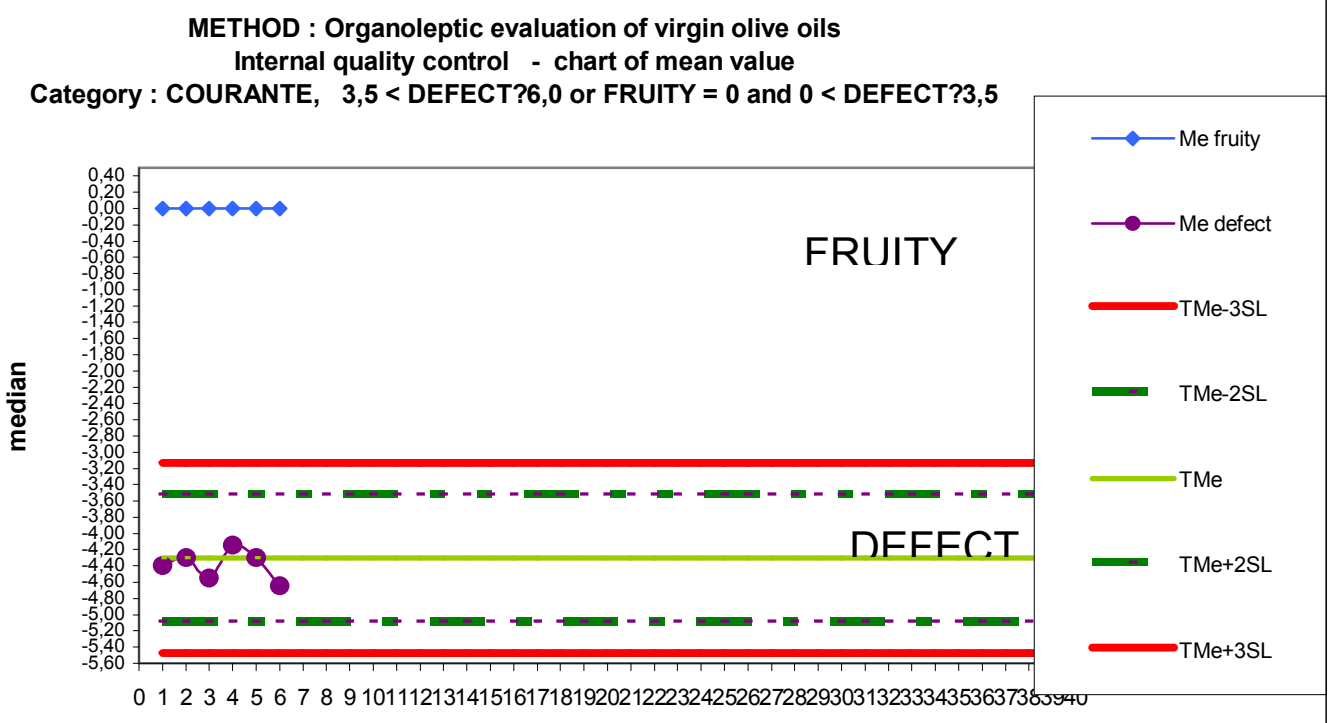
Figure 5. Quality control chart for the category virgin



Criteria

1. If a violet point (defect) is =0, 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 betw een red and dotted lines, the analytical procedure is out of control.
4. If 10 concetutive blue or violet points lie in the same side betw een the green and dotted lines, the analytical procedure is out of control.
5. If 7 consecutive blue points (fruity) lie in the same side betw een 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 betw een the dotted and red lines, the analytical procedure is w ithin

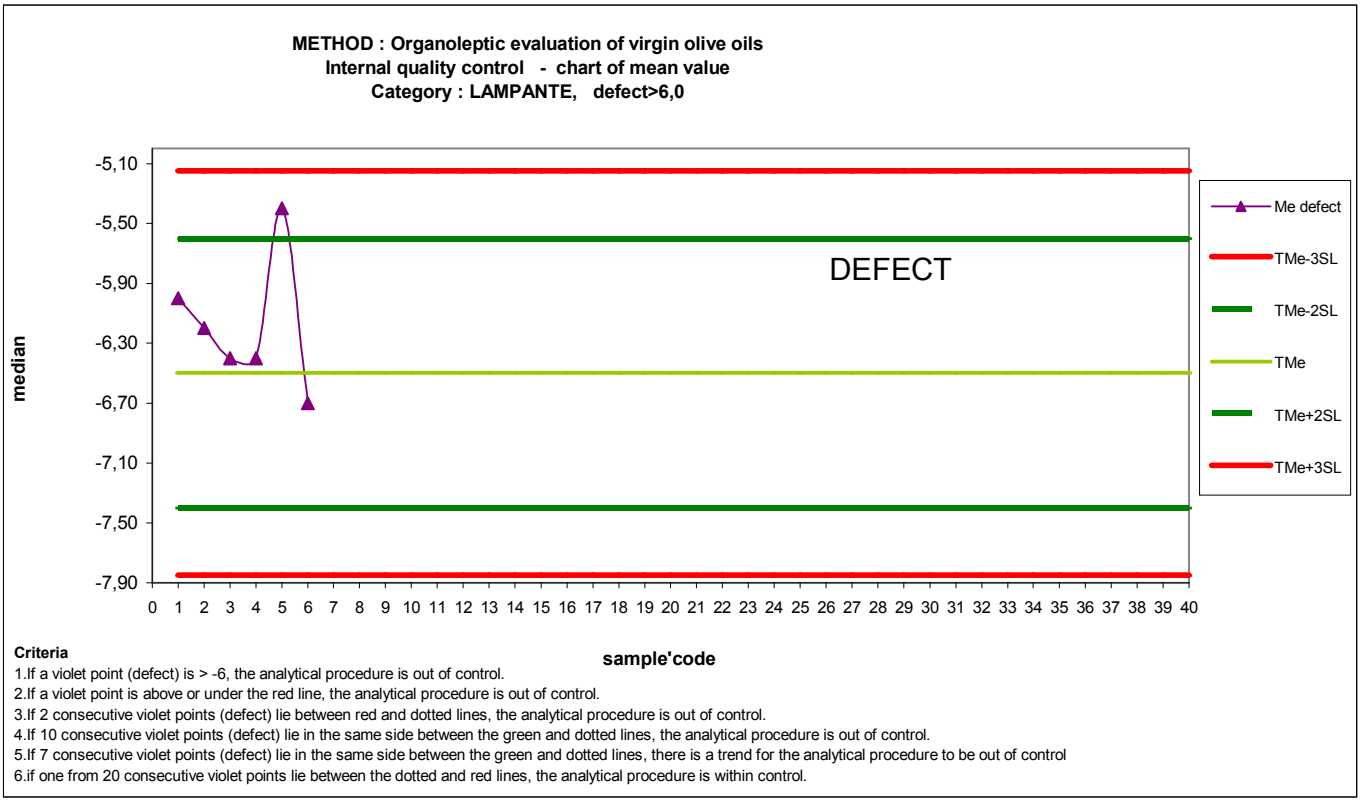
Figure 6. Quality control chart for the category courante



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.

Figure 7. Quality control chart for the category lampante

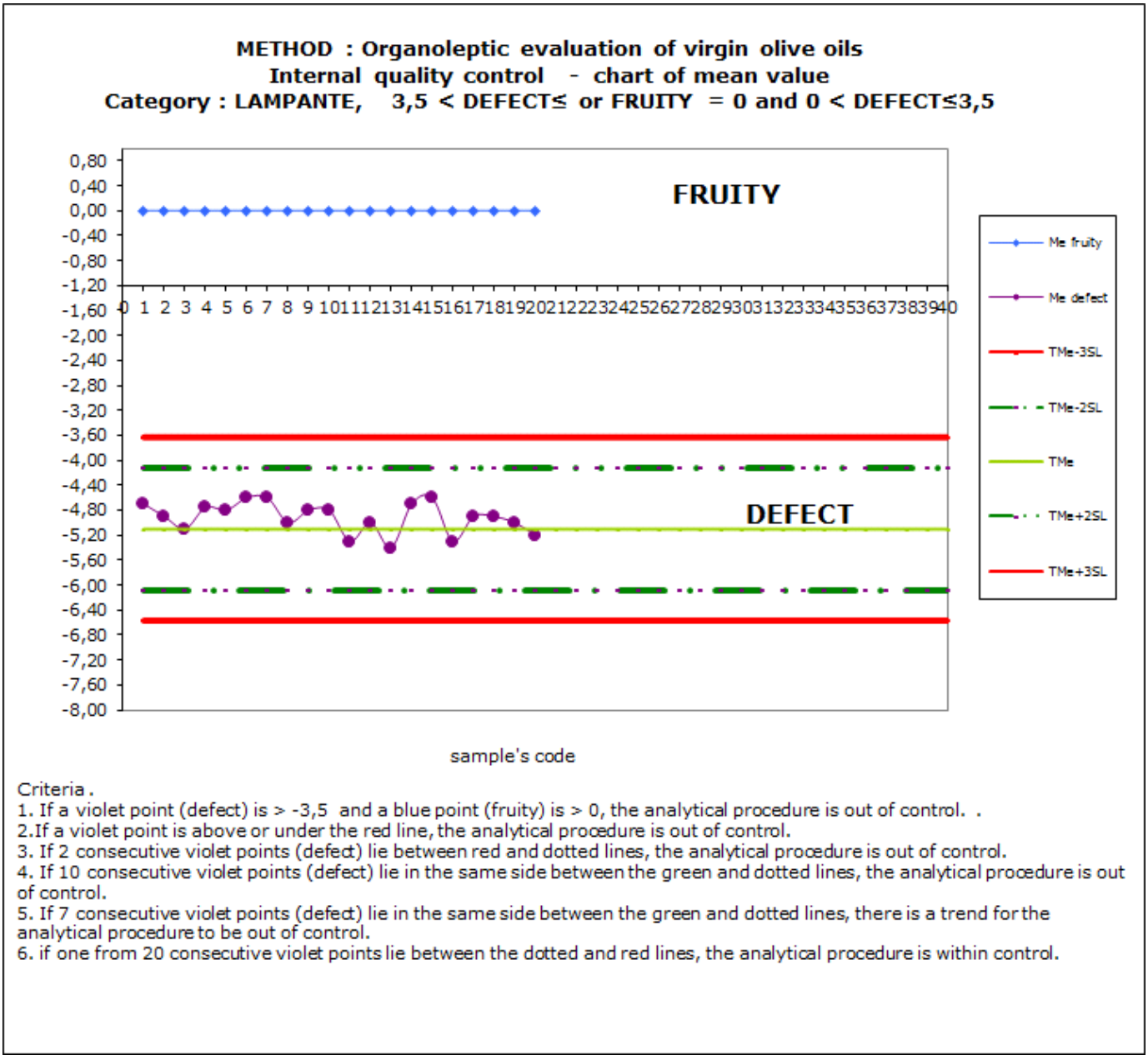


Criteria

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 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.

Figure 8. Quality control chart for the category lampante

(in case that the category courante 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.