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SENSORY ANALYSIS OF OLIVE OIL

STANDARD

GUIDE FOR THE SELECTION, TRAINING AND MONITORING OF SKILLED VIRGIN OLIVE OIL TASTERS

1. PURPOSE

The purpose of this standard is to provide panel leaders with essential rules for selecting, training and monitoring the selected tasters on their panel.

2. SCREENING OF CANDIDATES

Screening shall be carried out by the panel leader who shall personally interview the candidates to become familiar with their personality and surrounding environment. The physio-psychological conditions that have to be met are not very rigorous since, theoretically, any normal person should be able to perform this work. Factors such as sex, age, specific habits (smoking), etc. have been superseded nowadays by others such as health, personal interest and having time available for the work.

During the interview, the panel leader shall explain the characteristics of their task to the candidates and approximately how much time it will take up. He or she shall then glean information from the candidates allowing assessment of their interest and motivation and how much real time they have available. The following questionnaire could help as a reference.

QUESTIONNAIRE

Please answer the following questions:	YES	NO
1. Would you like to be involved in the work on this subject?	.....	.....
2. Do you think this work could contribute to the quality improvement of foodstuffs on the domestic and international fronts?	.....	.....
3. If so, why? 1/		
4. You should be aware of the fact that you will have to taste oils when called upon to do so. Would you be prepared to do this?	.....	.....
5. Would you like to compare your olfactory-gustatory skill with that of your colleagues?	.....	.....
6. Are you available time-wise? Are you independent enough to organise your daily work as you wish?	.....	.....
7. If you are dependent upon a superior, do you think that if you had to absent yourself from your usual job for anything up to half an hour, on several occasions over a successive number of days, you would be allowed to do so?	.....	.....
8. Would you be able to make up for any time lost in your job due to your participation in the sensory analyses?	.....	.....
9. Do you think you should be remunerated for this work?	.....	.....
10. In what way?		

1/ Describe what could be gained from the organoleptic assessment of any foodstuff, or, if you wish, of olive oil.

The panel leader shall use this information to screen the candidates and shall reject those who show little interest in this kind of work, are not readily available or who are incapable of expressing themselves clearly.

3. DETERMINATION OF THE DETECTION THRESHOLD OF THE GROUP OF CANDIDATES FOR CHARACTERISTIC ATTRIBUTES

The panel leader shall carefully choose four oils, one each of which is considered to be representative of one of the following attributes – fusty, winey, rancid and bitter – with as great and clear an intensity as possible.

The panel leader shall prepare a series of samples of each of the oils at descending concentrations (1:2) by making successive dilutions in a medium (refined oil or paraffin).

The series shall be considered completed when no difference can be detected between two successive samples of the series and the medium. The panel leader shall then choose the seven samples prior to these last two from the prepared series.

Enough samples should be prepared for the number of candidates.

Paired comparison tests shall be carried out to establish the mean threshold of the group, up to a total of 8 pairs of samples per candidate which shall be randomly presented in successive, independent tastings (the pairs comprise one each of the seven samples chosen and a blank medium, plus one pair of blank mediums). After each tasting, the candidates shall be asked whether the two samples are identical or different.

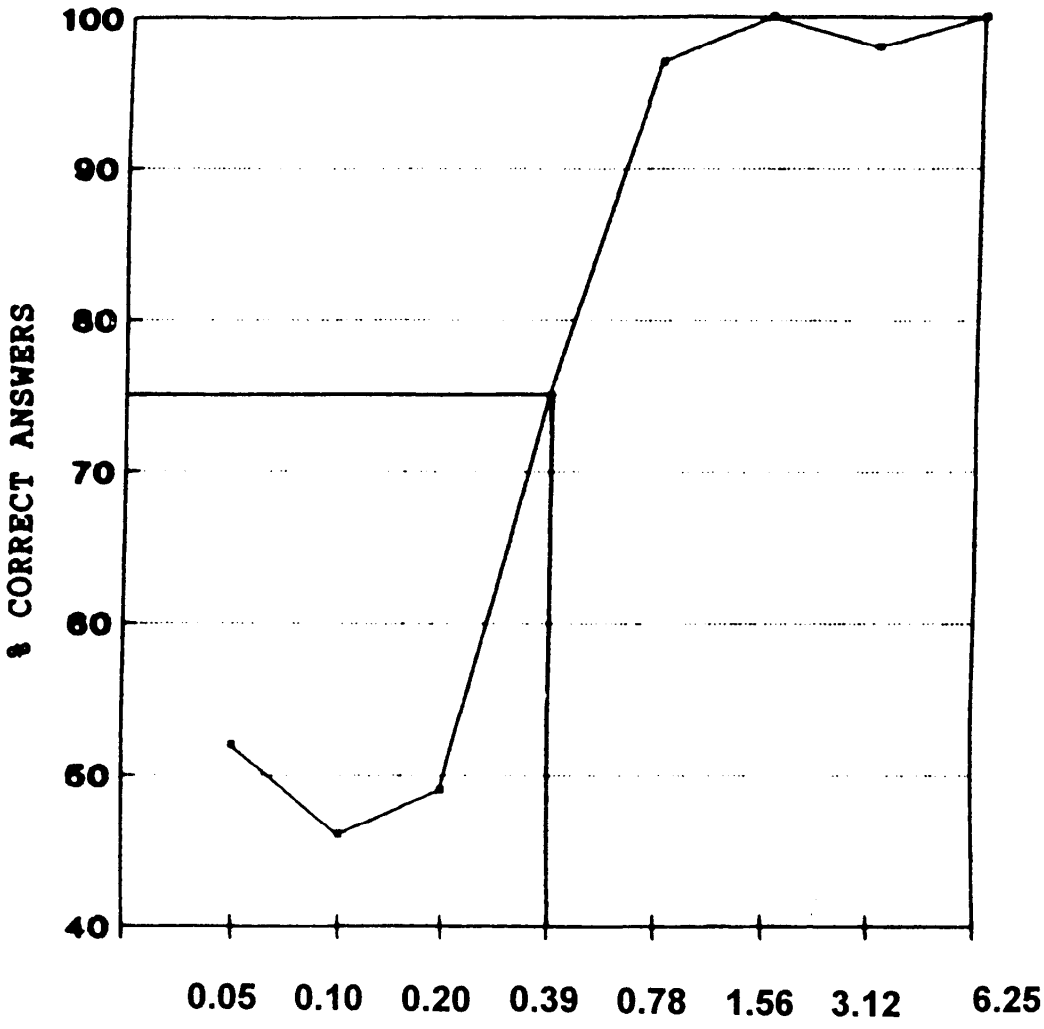
Upon completion of the test, the panel leader shall note down the correct answers of the set of candidates for each concentration and shall express them as a percentage. The leader shall plot the concentrations tested along the x-axis and the percentages of correct answers along the y-axis and then, by interpolation of the curve, shall determine the detection threshold which is the concentration corresponding to 75% correct answers. A practical example of this procedure is given in Figure 1.

This "threshold concentration", which may be different for each initial oil because it depends on the intensity of the attribute present, should be similar for the different groups of candidates to various panels; it is not linked to any habit or preference. Consequently, it is a point of reference common to any normal human group and may be used to homogenise the various panels on the basis of their olfactory-gustatory sensitivity.

If the above procedure is repeated for the three remaining attributes on the basis of their respective thresholds which are also calculated as indicated above, scales with similar aromatic intensities for each stimulus will be obtained for all the laboratories, even though the defects of the initial oils may be perceptible at different intensities.

This threshold concentration shall be C10 in the series of samples prepared to select tasters by the intensity rating method (section 4).

Figure 1



4. SELECTION OF TASTERS BY THE INTENSITY RATING METHOD

In the selection procedure, there should be two to three times more candidates than those required for the panel so that the people with the best sensitivity or powers of discrimination can be picked out. It is always advisable to use the same product as the one that is to be subsequently analysed.

When selecting the method, it should not be overlooked that, apart from being effective, the procedure adopted should be as economical as possible as regards the quantity of oil, the number of samples to be used and the time spent on selection. The effectiveness of a selection procedure lies in the choice of the optimum levels of the following three dependent variables: (a) "cost" determined by the number of tests, (b) "proportion" of potentially suitable candidates who by chance have been unfortunately eliminated during screening and (c) "proportion" of candidates who by chance have got through the selection process although unsuitable material.

The selection procedure chosen is as described by F. Gutiérrez Rosales *et al.* (2).

Products Required

- Liquid paraffin (DAB, PhEur, BP, USP) or oily medium without taste or odour (recently refined olive oil or another similar oil).

- Oils: fusty, winey, rancid and bitter.

4.1. Procedure

Start the selection process with 25 candidates, in accordance with the methodology described hereafter for each stimulus:

On the basis of the threshold concentration obtained for the group, proceed as follows:

Prepare a series of 12 samples in such a way that the "threshold concentration" holds the 10th place in this scale. Naturally, the 11th and 12th concentrations will be more diluted, as a result of which it will be more difficult to detect the presence of the oil possessing the selected attribute.

Taking the C_{10} concentration as the basis, the remaining samples can be prepared in accordance with the following formula:

$C_{10} \times a^n$, where "a" is a constant, the dilution factor, which is equal to 1.5, and "n" is the exponent which varies between 9 and -2.

Example: if the threshold obtained for rancid oil is 0.39, then $C_{10} = 0.39$. Since "a" = 1.5, the series of samples would have the following concentrations:

Sample	1	2	3	4	5	6	7	8	9	10	11	12
Conc.	14.99	10.00	6.66	4.44	2.96	1.97	1.32	0.88	0.58	0.39	0.26	0.17

(1) Prepare 12 coded tasting glasses (one series per candidate) and pour 15ml of each of the concentrations prepared into each glass.

(2) It is advisable to leave these glasses covered with a watch-glass in the tasting room at a temperature of 20–25°C for at least an hour before starting the tests in order for the oil to reach ambient temperature.

(3) The leader shall then arrange the 12 tasting glasses of each series in a row in descending order of concentration.

The next step is to ask each candidate to perform the test on their own, in accordance with the following instructions:

4.2. Instructions for candidates

The 12 tasting glasses lined up in front of the candidates contain dilutions of the fusty/muddy sediment and/or winey and/or rancid and/or musty and bitter stimuli. The distinguishing factor between the contents of the tasting glasses is their intensity. The glass with the greatest intensity is on the far left-hand side and the rest of the glasses are placed in descending order of intensity towards the right. The last tasting glass on the right may have such a weak intensity as to be impossible to detect.

Proceed as follows: Become familiar with the odour and taste of each of the tasting glasses in the series. To do so, begin smelling and tasting at the right-hand side (no. 12) and try to retain the intensity of all the odours and tastes, without becoming overtired.

When you feel that you have got used to the scale of concentrations of the odour and taste, leave the room.

Meanwhile, the leader shall remove one of the tasting glasses from the series and shall place it on a level with the last one on the right-hand side (no 12), moving all the others together so as to fill in the space left. Then return to the room and carry on with the test.

The test involves the following:

The tasting glass withdrawn from the series has to be put back in its exact place. To do so, smell and taste it and compare it with the others as often as wished, bearing in mind that if it is to be replaced correctly its intensity must be stronger than the sample on its immediate right and weaker than that on its left. This test will be repeated with three other glasses.

Each candidate shall be issued a form, in addition to the instructions just described, in order to make the test and the collection of the replies easier.

SELECTION OF CANDIDATES

Test no. ..... Attribute .....

The glass taken out belongs to position no. .....

Date ..... Name .....

4.3. Obtaining the results

The panel leader shall record the data for each of the candidates in the following manner to facilitate their arrangement:

Name of candidate	**Attribute studied**	**Number of order given (K')**	**Exact no. of order (K)**	**Grading $(K' - K)^2$**
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....

4.4. Statistical scoring procedure

In this particular selection case, the tasting glasses that have to be replaced in their exact position shall be the same for all the candidates. According to the statistical calculations done for this purpose, they shall correspond to the following positions in the order of the series as regards each attribute:

Fusty (Fy)/Muddy sediment (Ms) and/or Winey (W) and/or Rancid (Ra) and/or Musty (Mu) and Bitter (Bt)

Glass no.	Glass no.	Glass no.	Glass No.
(10,5,7,2)	(11,3,8,6)	(7,4,10,2)	(6,3,11,9)

The number corresponding to the position of the glasses in the order of the series may not vary since the statistical calculations for this test have been done with an eye to the probability of the glasses being randomly replaced in their exact position.

In order to make it extremely difficult for any information to be passed on from one candidate to another, the panel leader shall ensure that:

1) **THERE IS NO POSSIBLE MEANS OF CONTACT BETWEEN THE CANDIDATES. DIFFERENT CODES SHALL BE USED FOR EACH CANDIDATE.**

2) **THERE IS NO WAY IN WHICH THE CANDIDATES CAN FIND OUT THE POSITION OF THE GLASSES WHICH HAVE BEEN WITHDRAWN.**

3) **EVEN THOUGH ALL THE CANDIDATES SHALL BE PRESENTED WITH THE SAME GLASSES INDICATED EARLIER ON, THE ORDER IN WHICH THEY ARE HANDED OVER TO EACH CANDIDATE SHALL VARY.**

Each candidate shall then be given a score, depending on their performance, in the following manner:

Let e^i_1, e^i_2, ... e^i_{12} be the 12 glasses with the 12 corresponding concentrations of attribute "i" (i may be any one of the 4 attributes: fusty, winey, rancid and bitter) arranged in descending order of intensity.

Let e^{i}_{K} be one of the glasses picked and K' the position it is allocated

by the candidate when replaced in the series. Therefore, the values of K and K' are whole numbers between 1 and 12 inclusive, corresponding to the real place number of the glass chosen and that allocated by the candidate respectively.

Let T (maximum permitted deviation) be a value set beforehand, which in our case is equal to 3, so that if $|K' - K| > T$, the candidate is automatically rejected 1/.

If, on the contrary, $|K' - K| \leq T$, theoretically the candidate is accepted and may go on with the test since he or she is able to put the stimulus back into its exact position or at least very near it.

In this case, the score awarded a candidate who has assessed a set concentration, for instance in the fusty series (Fy), shall be equal to the square of the difference between the exact number of the glass in the order of the series and the position in which the candidate has replaced it. That is to say:

$$P_h (Fy) = (K' - K)^2$$

Since this operation will be conducted by each candidate on four concentrations of the series of each attribute, the partial score for the attribute (e.g. Fy) would be:

$$Z^{Fy} = P^{Fy}_{h} + P^{Fy}_{j} + P^{Fy}_{l} + P^{Fy}_{m}$$

1/ The panel leader should press the candidate to proceed reasonably, that is to say without losing any sensitivity through olfactory or gustatory fatigue.

Some examples are given below to facilitate comprehension of this operation.

Example no. 1: Let us assume that the answers given by candidate A for the four stimuli withdrawn from the series for attribute (i) are as follows:

Exact position of the glass in the series (K)	Position in which it was replaced by the candidate (K')	Deviation from the exact position (K' - K)
7 4 10 2	7 5 6 4	7 - 7 = 0 4 - 5 = -1 10 - 6 = 4**(*)** 2 - 4 = -2

(*) This candidate is rejected because he or she has obtained a score of T > 3 in the test.

Example no. 2: Let us assume that a candidate rearranges the glasses for an attribute as follows:

Exact position of the glass in the series (K)	Position in which it was replaced by the candidate (K')	Deviation from the exact position (K' - K)
7 4 10 2	7 4 7 3	7 - 7 = 0 4 - 4 = 0 10 - 7 = 3 2 - 3 = -1

This candidate is not rejected, having obtained a score of:

$$Z^i = 0^2 + 0^2 + 3^2 + (-1)^2 = 10$$

The candidate's final score, sealing their acceptance or rejection for selection as a taster, depending on the responses to the four attributes under consideration, would be as follows:

$$P^{Fy}_{h} + P^{Fy}_{j} + P^{Fy}_{l} + P^{Fy}_{m} = Z^{Fy}$$

$$P^{W}_{h} + P^{W}_{j} + P^{W}_{l} + P^{W}_{m} = Z^{W}$$

$$P^{Rd}_{h} + P^{Rd}_{j} + P^{Rd}_{l} + P^{Rd}_{m} = Z^{Rd}$$

$$P^{Bt}_{h} + P^{Bt}_{j} + P^{Bt}_{l} + P^{Bt}_{m} = Z^{Bt}$$

$$\text{Final } Z = Z^{Fy} + \ldots + Z^{Bt}$$

Where: Fy = Fusty
W = Winey
Rd = Rancid
Bt = Bitter

It is now a question of determining up to what maximum value for Z the candidate can be considered to have good levels of perception, olfactory and gustatory retention and intellectual organisation to give the correct answer for the four stimuli considered. Obviously, Z always has a non negative value and Z = 0 means that the candidate has recognised and correctly quantified the whole of the 16 intensities presented (four for each attribute). Values of Z other than zero indicate that the candidates have recognised the scale areas from which the selected intensities have been picked, but within these areas they have been unable to replace the concentration in its exact position because their ability to discriminate the scale of intensity presented to them for one or more of the stimuli is not satisfactory.

Therefore, a critical value (Z_c) will have to be determined such that should the candidates randomly replace all the glasses inside the areas they had recognised beforehand, the probability of a final Z score, less than Z_c, is a sufficiently small quantity α which can be set beforehand. In other words, it must be ensured that the probability, using this procedure, of selecting a taster for the panel who does not show sufficient discriminatory power for the intensities of the stimuli used in the selection process is less than α .

When the value for α is set (in our case at 0.05), Z_c is obtained from the probability distribution of the Z variable, which in turn depends on the probability distributions of the P variable (K').

Following the relevant statistical calculation, the value for Z_c comes to 34.

When the Z score for all the candidates has been obtained, any candidates whose score lies above 34 shall be eliminated.

See the scores for candidates A and B for an example:

Attribute	Candidate A	Candidate B
Fusty (Fy) Winey (W) Rancid (Rd) Bitter (Bt)	$Z^{Fy} = 10$ $Z^{W} = 10$ $Z^{Rd} = 10$ $Z^{Bt} = 4$	$Z^{Fy} = 12$ $Z^{W} = 11$ $Z^{Rd} = 15$ $Z^{Bt} = 0$
	$\Sigma = 34$	$\Sigma = 38$

Given that the two candidates considered have respective Z values of 34 and 38, candidate A will be retained whereas candidate B will be rejected. When all the candidates with a score above 34 have been eliminated, the remainder shall be classified according to their Z values until the twelve best candidates have been chosen.

5. TRAINING OF TASTERS

The chief aims of the training stage** are:

a) to familiarise the tasters with the multiple olfactory-gustatory-tactile variants found in virgin olive oils;

b) to familiarise the tasters with the specific sensory methodology;

c) to heighten individual skill in recognising, identifying and quantifying the sensory attributes; and

d) to improve sensitivity and retention as regards the various attributes considered, so that the end result is precise and consistent assessments.

(**) N.B. **(provisionally adopted by Decision No DEC-18/100-V/2013)** : If the tasters have to bring their nose close up to the edge of the tasting glass, or inside it, to perceive the attribute they must mark the section of the straight line corresponding to the intensity of perception of 3.5 or less. This intensity will also serve as a reference for the intensity perceived via the retronasal pathway, which may be even higher for certain attributes. In such cases, the tasters will score above 3.5.

This is designed to homogenise the application of the scale by the tasters and should be done solely for those attributes permitting classification.

The training stage normally entails a number of sessions, depending on the possibilities open to the panel and the study, during which, after individually analysing the oils, the tasters discuss the difficulties they have encountered with the panel leader and comment on the attributes and their intensities so as to unify replies.

The standard reached in training after a set number of sessions is assessed in terms of the percentage increase in the exact replies - should discriminatory trials be used - or by analysing the variance in the average individual values of the panel when tests using a scale are implemented.

The practical utility of this training period is considered very important and even essential if repeatable, reproducible sensory data are to be obtained.

Periodic calibration is recommended to improve data quality by decreasing variability among assessors. Calibration is performed on the basis of known samples (reference samples available from the IOC, samples distributed during IOC proficiency tests). Some of the procedures employed for the purposes of quality control are (see COI/T.28/Doc. No 1 September 2007):

(a) replicate analysis of samples in a specific percentage of all the samples analysed;
(b) inclusion of randomly repeated samples in the sample testing system at adequate intervals;
(c) use of reference materials and characterised materials as part of the quality control system.

6. PERFORMANCE CHECK OF TASTERS WITH THE AID OF A REFERENCE SAMPLE

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.

It is recommended to use the repeatability index (RIp) and deviation index (DI) to improve the performance of the panel and the quality of results (COI/T.28/Doc. No 1 September 2007, Guidelines for the accreditation of sensory testing laboratories with particular reference to virgin olive oil according to standard ISO/IEC 17025:2005) and to check the performance of the assessors during the tasting session.

Performance indices

The repeatability index is defined as:

$$RI_p : 1+\frac{\sum(x_{i1}-x_{i2})^2}{n}$$

RIp is the repeatability index of the assessor, xi1 is the value of the intensity of the attribute which the assessor gave in the first assessment of sample xi, xi2 is the value in the second, etc. and n is the number of samples. If this index is more than 3, refresher training should be arranged for the assessor.The repeatability index determines how assessors perform against themselves over time. However, it is also necessary to evaluate their performance with respect to the panel over time. In this case, assessor performance is evaluated against the value for the panel. The deviation index is defined as follows:

$$DI : 1+\frac{\sum\left[(x_{i1}-\bar{x}_{i1})^2+(x_{i2}-\bar{x}_{i2})^2\right]}{2n}$$

where xi1 and xi2 mean the same as for the repeatability index and $\bar{x}_{i1}$ and $\bar{x}_{i2}$ are the panel medians. As in the case of the repeatability index, refresher training should be arranged for the assessor if this index is more than 3.

Assessor performance should be evaluated on a continuing basis at each tasting session. The panel leader should keep a record of the historical performance of the assessors in an appropriate database as well as in tabulated form.

Bibliography:

1. American Society for Testing and Materials (A.S.T.M.), Special Technical Publication no 440, p. 53
2. Selección de catadores mediante el método de clasificación por intensidad, F. Gutiérrez Rosales et al. Grasas y Aceites Vol. 35, 1984.
3. COI/T.28/Doc. No 1 September 2007, Guidelines for the accreditation of sensory testing laboratories with particular reference to virgin olive oil according to standard ISO/IEC 17025:2005.

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