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Sensory Evaluation of Extra Virgin Olive Oil (EVOO) Extended to Include the Quality Factor "Harmony"

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Abstract: Sensory evaluation of olive oil, meaning the official organoleptic assessment of olive oil respectively the "Panel Test" (PT), is based on the standards of the International Olive Council (IOC), as well as on the Regulation (EC) 640/2008 of the European Commission. These regulations lead to the classification of olive oil as "extra virgin" (EVOO), "virgin" (VOO) or "lampant", which however is not sufficient to clearly discriminate between different quality levels within the grade EVOO. The objective of the study at hand was to develop and validate an objective sensory evaluation method for the quality certification of olive oil within the grade EVOO. A new rating system, including a detailed description and evaluation of the complexity and persistence of flavour, was established. First, a comparison between different profile sheets from various olive oil competitions (Ercole Olivario, Premio Biol, Leone D'Oro Mario Solinas Award, among others) and the official profile sheet from the IOC/EC for the panel test (PT) took place. In consecutive steps the basic test procedure from the panel test (PT) then was extended with additional sensory descriptors. Two trained olive oil panels (the German Olive Oil Panel (DOP) and the Swiss Olive Oil Panel (SOP)) were further educated to profile various green and ripe aroma components and to evaluate the complexity of the perceived aroma components and their persistency (descriptor: "harmony/persistency"). This extended methodology was cross-validated over a time period of 3 years between the two panels (DOP/SOP).

Key words: Extra Virgin Olive Oil (EVOO), sensory quality, panel test, complexity, harmony, persistency, quality certification, competition, trade.

1. Introduction

Around 50% of the world olive oil production is classified as grade "extra virgin" olive oil (EVOO) according to the official statistics (1999/2000) of EC member countries. The classification is granted if the chemical analysis and-even more important-the sensory evaluation conducted by a panel (accredited due to EN ISO/IEC 17025 (2005) [1, 2] of trained olive oil tasters confirms the conformity with the requirements of the Regulation (EC) 640/2008 [3]. The determination of the methodology for the sensory evaluation, which is referred to as panel test (PT) within this regulation, originates from several guidelines and instructions concerning the tasting of olive oils defined from the International Olive Council (IOC) [4-8].

Based on the detection of certain negative attributes as well as the measurement of the intensity of three positive attributes (fruitiness, bitterness and pungency), the PT leads to the "classification" of olive oil from a sensory point of view. Samples that show a median of defects not above zero (= 0) and a median of fruitiness above zero (> 0) are categorized as EVOO, which represents the highest classification level an olive oil can achieve.

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Reality on the international olive oil markets shows that on the classification level "extra virgin" (meaning within one and the same category) a broad range of sensory totally different olive oils is merged together. The reason is that it is sufficient to fulfill the above mentioned minimal requirements for EVOO. But of course there are significant smaller or larger differences among the oils arising from the diversity of origin and olive varieties, from the time and kind of harvest and as well from differences in the production process and the blending itself. As a consequence there exist rather big differences between EVOO's concerning their sensory quality level. These differences are not at all transparent-neither for the consumer nor for purchasing agents working for major companies-but they somehow disappear within this huge category of EVOO's. Retailers in particular take advantage of this, by legally putting olive oils of lower quality on the market as "extra virgin", regardless of major price differences between them compared to much better olive oils within the very same category. And even deodorised oils with absolutely no bitterness, no pungency and only a very low fruitiness are unofficially included into this category, but representing of course only illegal blends. An advanced methodology for transparent quality certification would help to bring transparency to the market [9-11].

About 80% of all olive oils on the market (at least in Europe) are sold in supermarkets and discounters in the category of "extra virgin" [12]. Many distributors are indeed increasing their range for sale with olive oils out of protected designation of origin (PDO) and better products, whereas trade brands or so called "low-price" and "entry-level" olive oils mainly show no-or at least not a pleasant-flavour, which origins from a rather standard or even below-standard harmony, having almost no aromatic complexity. But about 20% of EVOO's on the market are objectively better oils or belong to the premium-level. They are categorized as well as "extra virgin", although these olive oils show highly pronounced harmony and persistency and additionally a broad aromatic complexity.

It is a fact, that there definitely is a lack of objective regulation or at least objective measurement concerning the sensory differences between olive oils, not to mention nutritional value differences. And it is as well obvious that commercial purchasing agents as well as consumers would urgently appreciate help for orientation within the "extra virgin" category.

An adequate approach in order to achieve more differentiation requires further descriptors that are capable to explain the diversity within the category of EVOO. Several olive oil competitions throughout the world, including the International Olive Oil Award-Zurich (IOOA) in Switzerland, the Mario Solinas Award in Spain or Premio Biol in Italy etc., already use in different ways the value of harmony or complexity as additional sensory descriptors. At the moment every competition has its own profile sheet, but nevertheless this course of action should at least create a strong interest in these aspects, both among producers as well as consumers.

Aiming for the possibility to better discriminate olive oils within the category "extra virgin"-especially to prove and justify differences between EVOO's of only standard quality and the range of top EVOO's-additional attributes like "harmony" (H) and "persistency" (P) were defined and included into the sensory evaluation of EVOO's. Furthermore characteristic aroma compounds (AC), which occur in EVOO's, and which are adequate for further description and finally discrimination of these oils, were included as well. To achieve the requirements of a valid data collection, the official profile sheet and the statistical evaluation were extended and developed appropriately for this purpose. Finally this new approach led to a new substructure within the category "extra virgin". The value of "harmony" in this approach is able to discriminate EVOO's in excellent, good, standard and less standard qualities and thereby

helps identifying top quality olive oils from mass market oils with less harmony and lower standard oils which represent the borderline to the subsequent category "virgin" (VOO).

2. Materials and Methods

2.1 Sensory Panels/Tasters

The German and the Swiss olive oil panels are made up of idealistic and engaged members, originating from large and small import companies, traders, distributors and quality control institutions as well as private individuals with an impressive affinity for olive oil. Both panels work completely independently, are self-financing, but non profit institutions. They carry out sensory assessments of olive oil either as Central Location Tests (CLT) in a sensory lab respectively another adequate testing facility [13, 14] or the evaluation takes place "virtually", which means that samples are dispatched and every taster works at home on his / her own test desk in strict accordance with the official regulations and submits single results via e-mail/internet to the panel supervisor (PSV) for final calculation of the panel result.

The German Olive Oil Panel (DOP), founded in 1998, was created as a control institute in order to prevent the distribution of defective olive oils under the classification "extra virgin". The DOP is working in a strategic alliance with "The Association for Care and Support of the Value of Extra Virgin Olive Oils e. V." (IGO). The International Olive Council (IOC) supported the founding of this virtual panel from the beginning. The DOP was recognized by the IOC from 2001 until 2005. Since 2007 the panel is accredited in accordance with EN ISO/IEC 17025 [1, 2] and works at the moment for recognition by the IOC again.

The Swiss Olive Oil Panel (SOP), founded in 2002, was created primarily as a jury for the "International Olive Oil Award–Zurich" (IOOA). This event was founded in the same year by the University of Applied Sciences Zurich (ZHAW) and will take place for the 10th time in the year 2011. In the beginning the main aim was to differentiate the sensory characteristics of different varieties and blends in the higher quality section, including premium class olive oils announced for the competition. In the meantime the panel as well does sensory evaluations of olive oils from all distribution channels in Switzerland. Since 2006 the SOP is accredited in accordance with EN ISO/IEC 17025 [1, 2] and currently received the official IOC recognition.

Both panels cooperate closely concerning training units, exchange of samples and experiences, development of amended methods and profile sheets as well as the implementation of ring tests, involving DOP and SOP, but as well panels from other countries. Each panel consolidates and increases its knowhow with various training workshops throughout the year. Normally at least one of these training units takes place in an olive oil producing country aiming at the gaining of experience out of an intense exchange with local tasters and/or test-panels in combined trainings-sessions as well as the gaining of experience about the sensory typicality of different olive oils produced from different varieties during the visit of local producers.

2.2 Basic Sensory Evaluation (Panel Test)

The IOC, located in Madrid, was founded in 1959 by the United Nations as an intergovernmental organisation. They defined several guidelines and instructions concerning the tasting of olive oil. Therein methodological aspects, the minimally necessary number of tasters [4] as well as the basic vocabulary [8] and the use of a specific profile sheet [5], test glasses [6], test booth [7] and so on are defined. These IOC regulations were-mainly without changes-adopted by the European Commission and are described in the EC Regulation 640/2008 [3] officially as Panel Test (PT). Based on the detection of certain negative attributes as well as the measurement of the intensity of three positive attributes (fruitiness, bitterness and pungency),

this methodology leads to the so called classification of olive oil, at least from a sensory point of view. Three different quality levels can be distinguished, namely: EVOO, VOO and "lampant" olive oils. A fourth quality level, that is positioned between the categories "virgin" and "lampant", namely "ordinary" olive oils, does only exist under IOC regulation. The classification "olive oil", which means a blend of refined olive oil combined with virgin olive oil, is not yet obliged to undergo the panel test, but intentions to develop a special method to test these oils at the moment are pending.

The sensory requirements for VOO and EVOO are the following:

- Oils that show a median of defects not above zero (= 0) and a median of fruitiness above zero (> 0) are categorized as EVOO, which is the highest classification level an oil can achieve.
- Oils that show a median of defects up to 3.5 (on a 10 point scale) and a median of fruitiness above zero (> 0) are categorized as VOO.

2.3 Extension of Basic Sensory Evaluation

The idea to extend the basic sensory evaluation of olive oil was initiated by the DOP in 2003.

In the beginning a lot of panel training was necessary to integrate the evaluation of the descriptor "harmony/persistency" into the basic methodology, since this attribute requires a familiarity of the tasters to the typical green and as well ripe aroma components of olive oils, which were not so well known at that time. Special training lectures have been held in order to teach panellists to recognize these typical aroma components and to develop an understanding of the possible complexity of olive oil flavour. Furthermore the persistency of positive descriptors and the amount of balance between these attributes were aimed during training sessions-and of course the differentiation of all these aspects.

In a next step the comparison of top quality EVOO's with cheaper EVOO's, that showed less or no "harmony/persistency", were included into the training program in order to skill the tasters for standard and below standard olive oil qualities and reach from a statistical point of view sufficient confidence levels [15, 16]. In the beginning a robust coefficient of variation (CVr) for "harmony/persistency" was set to below 20%, which is required for all other positive and negative attributes on the profile sheet. But it was unlike to be reached, especially if the borderline for detecting certain defects by the panel members was very narrow for a valid median. EVOO's with a valid median for a defect therefore seemed not to need a value for "harmony/persistency", so it was reset to "zero". But nevertheless samples especially from mass market distributors with partly unpleasant taste but no median for one of the negative attributes as well as top quality oils in competitions need the possibility to be discriminated more precisely. Therefore the required CVr for the attribute "harmony/persistency" was reduced to 10% or below. Tasters which differ from the panel-mean of "harmony/persistency" by more than 1.5 are either moderated by the panel-supervisor or can be eliminated as outlier in the column of "harmony/persistency" only. Since the minimum number of tasters for a statistically valid result of a panel test (PT) is 8, it was defined that a valid result for "harmony/persistency" requires at least 6 tasters that remain for the final result of "harmony/persistency".

Finally the panel-results for "harmony/persistency" calculated on the one hand as median and on the other hand as mean were compared during a time period of one year by the DOP. The result was that the values showed only marginally differences up to ± 0.2 and since the CVr was reduced to "10% or below" the differences were even reduced to ± 0.1. As a consequence it makes no difference which value is used for evaluating the result of "harmony/persistency".

This extension of the basic sensory evaluation of olive oil was developed further since 2004 by the SOP and DOP in cooperation. While the SOP was able to concentrate more on better quality oils up to the

"premium" category, due to their focus on the olive oil competition "International Olive Oil Award-Zurich" (IOOA), the DOP received oils from the entire German and International markets, from discounters as well as distributors including all quality levels.

2.4 Advanced Methodology

The extension of the basic sensory evaluation (panel test) of olive oil lead to the following validated advanced methodology, integrating the following aspects:

2.4.1 Aroma Description

A quantitative aroma description, referring to the ortho- as well as retronasally perceived olfactory components of an olive oil, uses (in the study at hand) a graded 4-point scale to measure the intensity, leading from 0 (zero), which means that one or more components are "not detectable" to 1 (one), which means that one or more components are "slightly detectable", 2 (two), which stands for a "noticeable" sensation of one or more components and finally 3 (three), which describes an "intense" sensation of one ore more particular aroma components. The use of a more detailed scale would be possible, but would require even more training effort of each panellist. Aroma components listed on the profile sheet support tasters in finding and recognizing more common aromas more easily. The list is divided into the sections "green" and "ripe", which facilitates the selection by the tasters and provides a link to the decision on whether the fruitiness of an olive oil is more "green" or more "ripe" or both in equal parts. To illustrate the results, spider-web-diagrams, using scales of four (in the study at hand) up to ten graduation points, are suitable.

The following list (Table 1) shows a selection of green and ripe aroma components used from DOP and SOP. The advanced profile sheet (Fig. 1) allows the panelists as well to make remarks on additional aroma descriptions and their intensities.

An aroma description is a set of positive olfactory sensations (perceived ortho-as well as retronasally), that is characteristic for an oil, depending on the variety of olives and either reminiscent of green or of ripe fruit.

Table 1 Aroma components (green, ripe) in olive oil.

Green Aroma Components	Ripe Aroma Components
Freshly cut / mown grass, green leaves	Nuts (dried nuts, almonds or pine-kernel / -skin)
Nuts (unripe nut-, almond- or pine-skin / -shell)	Vegetables (ripe tomato, cooked artichoke, etc.)
Vegetables (green tomato, green artichoke, etc.)	Fruit (ripe apple, ripe banana, etc.)
Fruit (green apple, green banana, etc.)	Mushrooms
Herbs	Melon
Citrus	Candied fruit

2.4.2 Evaluation of Harmony and Persistency

Harmony is the degree of balance of all positive characteristics or-in the case of lower quality–the degree of disharmonic balance, including gustatory, olfactory, tactile and kinesthetic stimuli. Harmony on the one hand includes the presence and intensity of positive attributes (fruitiness, bitterness, pungency and the presence of aromatic components; perceived ortho- as well as retronasally), and on the other hand includes also the complexity of these positive characteristics. Thus harmony in the DOP and SOP understanding and definition does not have exactly the same meaning as the IOC defined term "balance" respectively the new official characteristic "well-balanced". The latter simply describes oils that show no lack of balance between olfactory, gustatory and tactile sensations and in other words none of the medians for bitterness and pungency are allowed to be two points higher than that for fruitiness. Unfortunately this means that olive oils with negligible flavours can be legally described as "well balanced"-which leads to a really confusing declaration for consumers.

Harmony is evaluated quantitatively on a 10 cm scale (Fig. 2). For the evaluation, the characteristic and the number of pleasant aroma components are taken into account: the higher the impression of their complexity as well as the balance between the other positive attributes: fruitiness, bitterness and pungency, the higher the rating on the harmony scale. Harmony

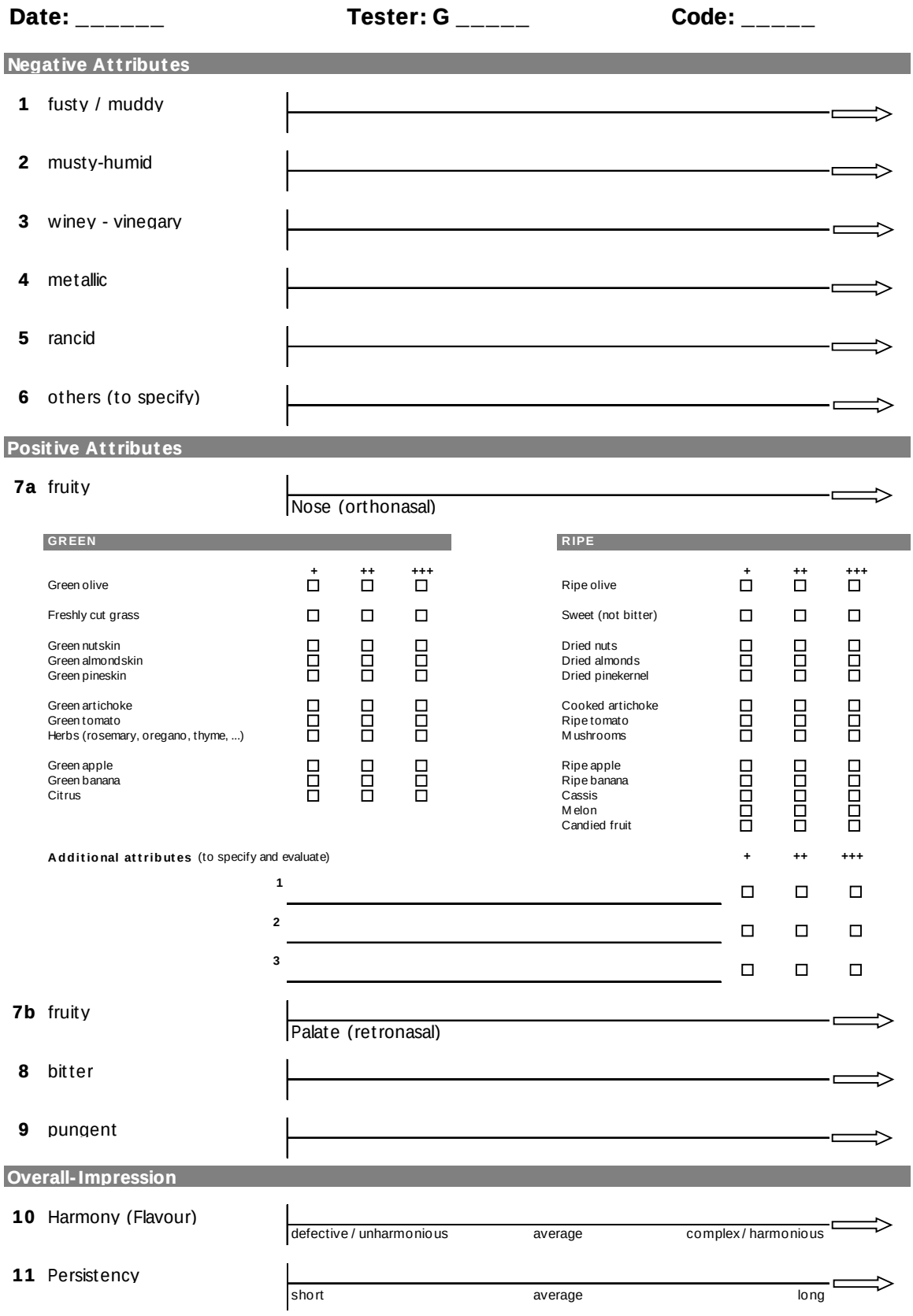

Fig. 1 Advanced profile sheet, SOP [17].

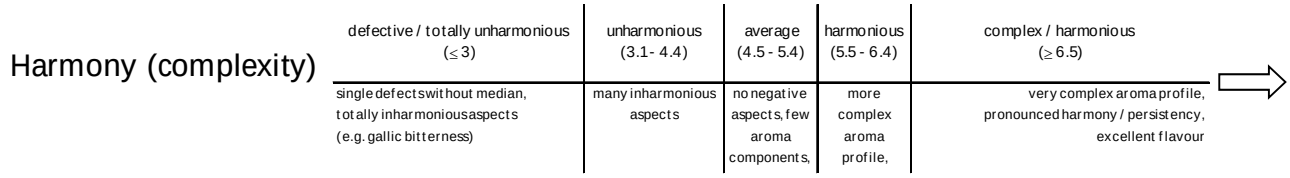

Fig. 2 Harmony scale of the advanced profile sheet (including explanations) [17].

values are statistically analyzed using the median or the mean.

The area between 4.5 and 5.4 is the range for standard EVOO's without defects, but also without almost any characteristic aroma components and therewith a (rather poor) complexity. Below this standard harmony results go down to 3.1 or even less. These oils are more and more disharmonious and panelists might notice single defects, but there is not yet a chance for a defect with a valid panel result (median). Above standard harmony the better and best sensory qualities might receive means/medians up to 6.4 and above, which represent very good to excellent (rather premium) olive oils.

Depending on the profile sheet used, persistency can be part of the harmony (balance) or can be separately defined. Either way, it describes the lasting nature, or the length of time that retronasally perceived (positive) sensations persist in the mouth and the senses.

Persistency, like harmony, is quantitatively evaluated on a 10 cm scale. The longer the sensations of certain positive attributes (fruitiness, bitterness, pungency and the presence of aroma compounds or even the complete harmony impression) last, the higher is the rating on the persistency scale. Persistency values are, like harmony values, statistically analyzed using the median or the mean.

In both cases (harmony and persistency) the transition between the different scale ranges is smooth. One indicator for the quality of the data is the robust coefficient of variation (CVr) for harmony and persistency, which has to be strictly below 10%. Another indicator avoids disturbances due to values that are too extreme. For this purpose, single results that exceed a standard deviation of 1.5 have to be eliminated as outliers. And the third indicator is that the minimum number of valid single results must be at least 6, otherwise the panel-supervisor needs to moderate to ensure a valid panel result (see section 2.4.1).

By all means intensive training is necessary to guarantee a good panel-performance concerning the evaluation of harmony and persistency, including the fact that the panel needs to gain experience with the complete range of extra virgin olive oils which are available on the market in order to realize and memorize the differences between them.

For the calculation of a summarized value for harmony and persistency it must be borne in mind that harmony combines more important criteria than persistency. The statistical weight of harmony therefore is 2, while that of persistency is only 1. The weighted combination gives the final value for "harmony/persistency" in the SOP's way of working. The DOP generally combines harmony and persistency already as one attribute for sensory evaluation, therefore further calculation or weighting is not necessary. Both principles of operation are validated.

2.5 Advanced Profile Sheet

Based on the panel test, the extended sensory assessment of olive oil supports the advancement. Crucial in order to discriminate olive oils within the category of EVOO's, the advanced methodology integrates the aroma profile as well as the description of harmony and depending of the requirements-as well of persistency. To do so, the official profile sheet of the latest IOC standard and the Regulation (EC) 640/2008 [3] have been developed further (Fig. 1).

The advanced profile sheet you can see in Fig. 1 is used mainly by the SOP during the International Olive Oil Award-Zurich and the advanced profile sheet (without aroma description) of Fig. 3 is used by the DOP.

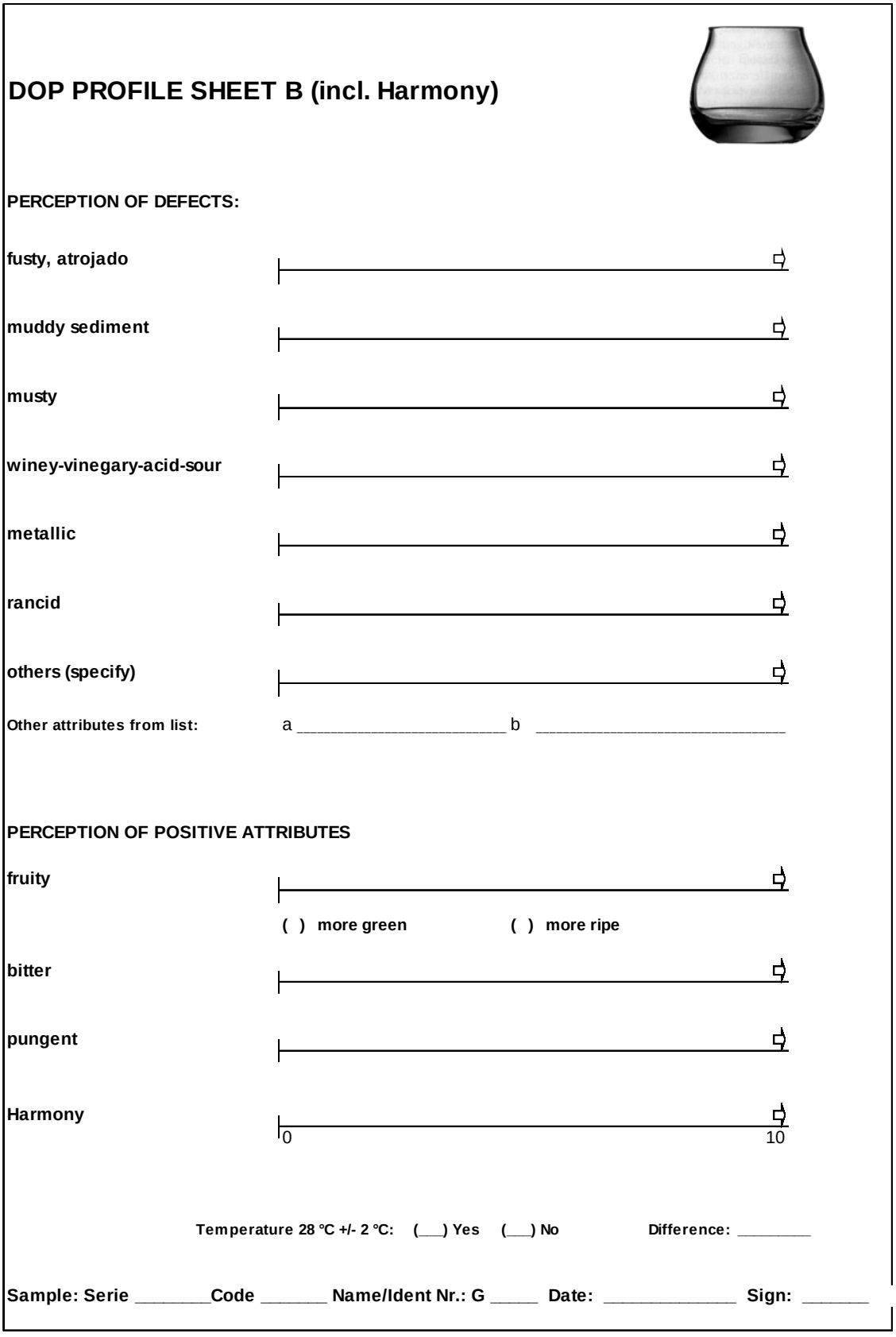

Fig. 3 Advanced Profile Sheet, DOP [17].

3. Results and Discussion

For the study at hand the reliable data from the years 2007 up to 2009 have been collected: a total of 1,449 results. 984 results originate from Germany, 555 from Switzerland. All samples have been declared as EVOO's, based on the organoleptic assessment of one of the both panels (Fig. 4).

3.1 Justification

Together 35% of the EVOO's analysed by SOP and DOP show a standard harmony with a score between 4.5 and 5.4, which represents an acceptable value on the 10 cm scale. The majority of these samples are sold in discount-shops and supermarkets. 19% of the EVOO's show better or good harmony with a score between 5.5 and 6.4 on the 10 cm scale, while 26% of the samples show a harmony which scores higher than 6.4 and let expect a very good quality respectively reach the premium category. This quality differentiation on the harmony scale highlights the reason why the pure information, that an olive oil is an EVOO in accordance to the IOC Standard and the Regulation (EC) 640/2008 is not at all very informative and moreover does as well not at all discriminate high standard olive oils from less harmonious and less qualitative ones. Below the standard level, 18% of the EVOO's analysed by SOP and DOP show a harmony between 3.1 and 4.4 on the scale with less sufficient down to unpleasant qualities while 2% of the EVOO's show even a harmony that scores less than 3.0. In these two categories below standard single sensory defects were defined by some panellists, but even with a moderation of the results no valid median for a defect emerged.

In the framework of the official organoleptic assessment, which provides only the category EVOO, a possible quality differentiation within this grade relates to the general description of the flavour of the regarded olive oils.

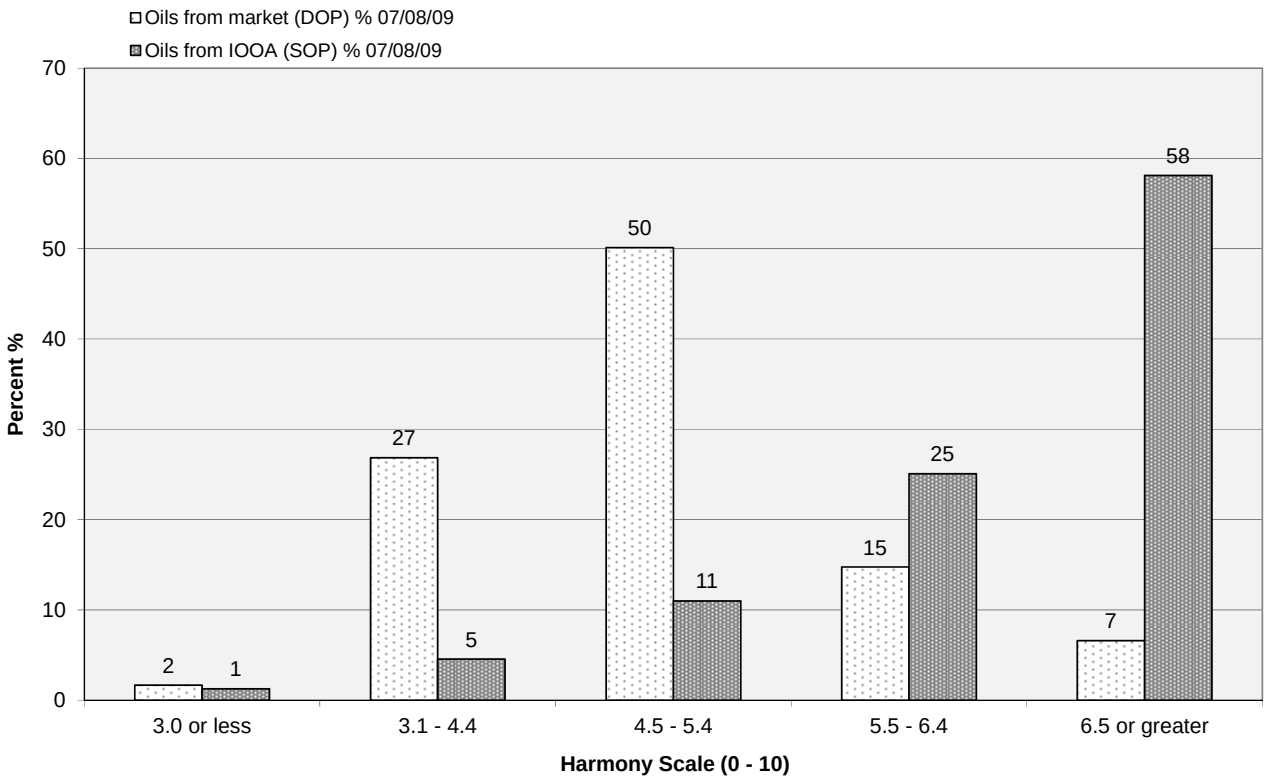

Fig. 4 Detailed results from DOP and SOP (n = 1,449).

(1) "Not acceptable" < 3.0: The panel result shows various individual defects, but no significant median for a defect; there might be some single or even strange defects for which the panels do not have any references. The oils can contain totally disharmonious aspects, such as an intensive gallic bitterness. Ultimately oils in this category are more virgin than extra virgin.

(2) "Not sufficient" 3.1-4.4: Mainly EC-blends or blends with EVOO from the EC and as well non-EC countries out of the low price category that show many disharmonious aspects. (Price in this category apparently has more influence than taste on decisions from distributors and producers.)

(3) "Sufficient/standard" 4.5-5.4: This group exists mainly of oils with no negative aspects at all, but also nothing exciting concerning the presence of aroma components. The oils are often overripe and not always perfectly blended. (Nevertheless the price/taste relation of these oils in German speaking countries often remains acceptable.)

(4) "Good" 5.5-6.4: These oils are above average in flavour. They show a more complex aroma profile that can be traced back to the variety used or a well-done blending.

(5) "Very good/premium" > 6.4: Oils with a very complex aroma profile, a pronounced harmony and persistency and therefore a flavour which reaches from very good up to excellent.

One can take into account the above mentioned 1,449 samples as a whole, but the harmony values originated by the two panels should be as well carefully assessed separately. Since background and reasons for the organoleptic assessments and therefore the kind of the samples are quite different in Germany and Switzerland, it is proven, that the advanced methodology is valid for the evaluation of EVOO's with a rather standard quality as well as for EVOO's with premium quality. In both cases it is very useful to discriminate different quality levels within the EVOO category. The following detailed analysis of the samples shows this multi-functionality of the advanced methodology.

3.1.1 Oils from Market (Light Grey Columns, Evaluated by the DOP in Germany)

The figures from Germany show a typical survey of the market situation, which is quite similar to all other Central European markets. The results reflect the general market situation: About 80% of consumers buy in large self-service retailer-shops with mainly moderate and low price products and in discounters, while approximately 20% of consumers pay attention to better and very good sensory quality in more distinguished buying areas [14].

All of the analysed olive oils have passed the panel test and are classified as "extra virgin", but the evaluation of harmony separates the sensory qualities in sections which still show significant differences in quality. The majority (50%) of the olive oils analysed have a harmony between 4.5 and 5.4 on the scale and represent standard sensory quality. 27% of the olive oils are of rather low quality. 22% of the olive oils show good to very good quality. Even in the standard category between 4.5 and 5.4 there are remarkable differences. As a consequence, "harmony" as a descriptor within the sensory evaluation of olive oils, has become more important for quality benchmarks in German speaking countries than the intensities of the attributes fruitiness, bitterness and pungency. In many cases producers have already to follow the standards for "harmony" since they became part of the contracts of several distributors. In the meantime panels that include "harmony" within their sensory evaluation of olive oils, like the DOP and the SOP, are often asked for an organoleptic assessment before bottling, because the producers are interested in the guideline-function of the quality indicator "harmony". The spectrum of oils which are passing the sensory evaluation of the DOP in Germany is very large and includes EVOO from all the Mediterranean countries as well as oils from overseas.

Using the advanced profile sheet (Fig. 3) the DOP lies

focus on "harmony" through the use of one additional uncategorised line scale in order to evaluate the complementary value "harmony". To make sure that panellists act like sensory assessors for all descriptors while evaluating olive oils, the idea of doing a final judgement by each taster in form of one single figure at the end of the evaluation was rejected. In the final test report it is mentioned that the value of harmony is not part of the Regulation (EC) 640/2008 [3].

3.1.2 Oils from IOOA (Dark Grey, Evaluated by the SOP in Switzerland)

Compared with Germany the figures from Switzerland mainly originate from another background. The International Olive Oil Award—Zurich invites producers, importers and retailers every year to participate in this specific olive oil competition. In this way many of the best extra virgin olive oils on the Swiss market as well as many samples coming directly from producing countries, are collected for a special organoleptic assessment which includes-besides the classification of olive oil according to the Regulation (EC) 640/2008 [3]—on the one hand the evaluation of harmony and persistency and on the other hand the description of the oils with regard to their aromatic components. The competition is organised in a three-step system. First of all a screening (first step) takes place. Three SOP panellists check all participating olive oils in order to find defect ones and in order to register the intensity of fruitiness for the upcoming tastings. These results have no statistical relevance for the final evaluation, but have only an orientating character. In a second step, during two weeks, panel tests take place to evaluate the oils using the advanced methodology (see 2.4) as well as the advanced profile sheet (Fig. 1). All tests are blind tastings and the results are statistically relevant. A maximum of 50% of these olive oils are selected for the final panel test (third step) to confirm their extraordinary quality and to define the winners of Golden Olives, Silver Olives and Awards. Tests are as well blind tastings and results are statistically relevant. Award categories are divided into light, medium and intense fruitiness. The main factor for the definition of the winners in the different categories is the "harmony" (consisting of the descriptor harmony as well as persistency). Exact benchmarks for the "Golden Olives", "Silver Olives" and the Awards are defined from year to year by the panel leader of the SOP.

The SOP is working with a profile sheet (Fig. 1) which includes-beside the different aromas-two lines, one for the harmony and one for the persistency. Which are finally calculated (weighted) together, counting "harony" two times (2) and persistency only one time (1).

3.2 Validation and Harmonisation

Finally, of course, it is absolutely vital to guarantee that reliable data are generated by this advanced test method. Therefore above all the aim is to ensure certain basic conditions concerning the assessment activities of the panelists in Germany and Switzerland, as well as the resulting data.

In the case of aroma profiling, at least 30% of tasters have to recognize the same attributes, e.g. green apple, banana or fresh almonds, in order to approve these aroma components as part of the organoleptic description of the oil. Included into this profiling is the allocation into the categories "green", "ripe" or "green/ripe". In the case of the "additional" descriptor "harmony/persistency", intense training of all individual panelists as well as the whole panel is absolutely essential. The panel has to consist of at least 8 and at the most 12 panelists. The robust coefficient of variation (CVr) has to be below 10 % and single results that exceed a standard deviation of 1.5 in either direction have to be eliminated as outliers. The panel supervisor can either moderate the harmony value with single tasters or is allowed to eliminate single harmony results as outliers but the minimal number of valid results has to be at least 6, because harmony values originating from less than 6 tasters

are too subjective and statistically not sufficient. In harmony categories below 3.0 a non-valid harmony is possible. And for oils with a valid median for a defect the harmony value is reset to "zero".

Fig. 5 shows an example of a result table including harmony and persistency values of the SOP. One can easily see, that all eleven tasters did not detect any defects, do find homogeneous results concerning fruitiness, bitterness and pungency (rel. robust std. dev. < 10%) and describe the olive oil as noticeable "green". As well the values for harmony and persistency are quite homogeneous, but the single values of two tasters (G 12 and G 39) deviate more than 1.5 from the panel mean. Therefore they were eliminated as outliers in the final result for the weighted harmony and persistency.

Of course, intensive panel training is also necessary to make sure that the test method is comparable between different panels. For this purpose, intense training workshops for the two panels (DOP/SOP) have taken place and are still ongoing, including a systematic monitoring of the results and training activities, since the beginning of the use of the advanced methodology. Special aspects within the monitoring are all positive attributes, the aroma components and, as far as possible, all basic negative attributes as well. Moreover regular inter-laboratory comparison tests with other trained olive oil panels out of producing countries (Italy, Greece, Spain, etc.) are part of the training of both panels but at the moment still without the extended aspect of "harmony".

In order to validate the introduced advanced methodology, special panel proficiency tests between the DOP and SOP have been and still are carried out. The results show, that the difference between the results of the two panels lies well below 1, which is a rather a low difference and confirms the good state of training of both panels as well as very good compliance in the use of the descriptors, including the attribute "harmony".

Sample Code	**Swiss Olive Oil Panel / SOP** Fachpanel Olivenöl der Zürcher Hochschule für Angewandte Wissenschaften (ZHAW)													Date
Example	**Fusty - Muddy**	**Musty**	**Winey**	**Metallic**	**Rancid**	**Other**	**Fruity**	**Bitter**	**Pungent**	Greenly-Fruity	Ripely-Fruity	**Harmony (H)**	**Persistency (P)**	**H & P** (weighted 2:1)
Taster	**none - intense**						**none - intense**			**slightly (1) / noticeable (2) / intense (3)**		**negative - standard - positive**		
G 10	0.0	0.0	0.0	0.0	0.0	0.0	4.0	1.8	1.3	1		7.6	7.6	7.6
G 12	0.0	0.0	0.0	0.0	0.0	0.0	4.1	2.8	2.7	1		6.0	6.0	
G 29	0.0	0.0	0.0	0.0	0.0	0.0	4.5	2.6	3.3	3		7.1	6.8	7.0
G 30	0.0	0.0	0.0	0.0	0.0	0.0	5.5	2.0	4.4	2		8.1	7.7	8.0
G 33	0.0	0.0	0.0	0.0	0.0	0.0	5.0	2.4	3.0	2		8.5	8.1	8.4
G 39	0.0	0.0	0.0	0.0	0.0	0.0	5.2	2.4	3.1	3		9.2	9.1	
G 46	0.0	0.0	0.0	0.0	0.0	0.0	4.2	1.9	2.7	2		7.6	7.4	7.5
G 47	0.0	0.0	0.0	0.0	0.0	0.0	4.0	1.7	1.4	1		6.6	6.0	6.4
G 61	0.0	0.0	0.0	0.0	0.0	0.0	4.5	2.5	4.3	3		8.9	8.8	8.9
G 65	0.0	0.0	0.0	0.0	0.0	0.0	4.0	1.8	3.0	1		7.6	7.5	7.6
G 71	0.0	0.0	0.0	0.0	0.0	0.0	5.4	2.1	3.3	1		6.8	6.5	6.7
Median	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**4.50**	**2.10**	**3.00**	**2.00**	**#ZAHL!**	**7.60**	**7.50**	**7.57**
Rel. Robust std. dev. (%)							**6.51**	**7.98**	**5.58**	**20.94**	**#ZAHL!**	**4.96**	**4.65**	**3.94**
Mean	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**4.58**	**2.18**	**2.95**	**1.82**	**#DIV/0!**	**7.64**	**7.41**	**7.56**
Stand. Dev.	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.56**	**0.36**	**0.93**	**0.83**	**#DIV/0!**	**0.94**	**0.98**	**0.74**
75-Quantil	0.00	0.00	0.00	0.00	0.00	0.00	5.10	2.45	3.30	2.50	#ZAHL!	8.30	7.90	7.97
25-Quantil	0.00	0.00	0.00	0.00	0.00	0.00	4.05	1.85	2.70	1.00	#ZAHL!	6.95	6.65	7.00
Interquartile Interval	0.00	0.00	0.00	0.00	0.00	0.00	1.05	0.60	0.60	1.50	#ZAHL!	1.35	1.25	0.97
Robust standard dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.17	0.17	0.42	#ZAHL!	0.38	0.35	0.30
Upper C.I.	0.00	0.00	0.00	0.00	0.00	0.00	5.07	2.43	3.33	2.82	#ZAHL!	8.34	8.18	8.15
Lower C.I.	0.00	0.00	0.00	0.00	0.00	0.00	3.93	1.77	2.67	1.18	#ZAHL!	6.86	6.82	6.98
Tasters N	11	11	11	11	11	11	11	11	11	11	0	11	11	9
% Denom.	100	100	100	100	100	100	100	100	100	100	0	100	100	82

Fig. 5 Example of a result table of the SOP, including harmony and persistency values.

4. Conclusion

The value of "harmony" is an objective sensory descriptor and implements real progress in discriminating different quality levels within the grade of EVOO. Oils within the grade of EVOO no longer have to be described in rather emotional and subjective expressions which are not at all reproducible. In parts of Europe the evaluation of the descriptor "harmony" as a quality parameter has already become a benchmark for distributors and retailers of lower and medium price EVOO's which acts as insurance for good or relevant quality within this market segment. "Harmony" is as well a suitable parameter for discriminating different quality levels in olive oil competitions in the segment of excellent premium oils.

With support of the quality value "harmony", market participants all over the world can discuss more easily about EVOO's with producing and bottling companies compared to just talking about "quality" without any kind of reference system and justification. It is now up to retailers to act painstakingly and to require and use this valuable opportunity to differentiate olive oils within the grade EVOO in their daily business.

In the future, the category of EVOO should be limited to a certain range of "harmony", for example above 3.5 or above 4.0. Samples with a harmony value below 3.5 should be subdivided in an additional own category (not VOO).

Taking into account the regulations for the labelling of EVOO's, consumers at the moment do not have very many opportunities to differentiate the reasons for remarkable price differences between standard, good and excellent qualities, or between oils with an excellent flavour and no flavour at all. So far results of the advanced methodology are still not taken into account in labelling and therefore cannot support consumers directly in their choice. But, consumer test magazines in German speaking countries as well as radio and TV channels in the meantime use the advanced methodology to assure an objective ranking in the framework of their test designs, independently of the intensities of the three positive attributes fruitiness, bitterness and pungency as well as the classification. As a consequence the quality especially of low price brands increased already remarkable compared to results from the last 5 to 10 years.

Both the SOP and the DOP already use this comprehensible advanced methodology successfully for quality differentiation. They compile statistically firm, reproducible and therefore reliable information. In both panels the methodology is part of their laboratory accreditation according EN ISO/IEC 17025 (2005) [1].

In the opinion of the DOP and the SOP, the most important thing is that more and more olive oil panels throughout the world should respond to this suggestion of an advanced panel test methodology and would adopt this test method into their daily work. This would mean a real "added-value" to their sensory evaluation of olive oil referring to the much more detailed and therefore realistic objective results they would achieve, that would be at the same time a perfect practical basis for decision makers.

To go on, a taskforce of the International Olive Council (IOC) should initiate an international pilot study with 12 panels including the SOP and the DOP to crosscheck this new method, to discuss the practical use in more countries and to evaluate eventually existing weaknesses and strengths of this approach. In the end there should be a reliable method for all panels which helps to enhance the value of the product EVOO.

References

[1] Anon., General requirements for the competence of testing and calibration laboratories, EN ISO/IEC 17025, 2005.

[2] Anon., Accreditation for Sensory Testing Laboratories, EA-4/09, 2003.

[3] Commission Regulation (EC), No 640/2008 of 4 July 2008 amending Regulation (EEC) No 2568/91 on the

characteristics of olive oil and olive-residue oil and on the relevant methods of analysis, 2008.

[4] International Olive Council, Sensory analysis of olive oil-General methodology for the organoleptic assessment of virgin olive oil, COI/T.20/Doc. No. 13/Rev. 1, 1996.

[5] International Olive Council, Sensory analysis of olive oil-method for the organoleptic assessment of virgin olive oil, COI/T.20/Doc. No. 15/Rev. 2, 2007.

[6] International Olive Council, Sensory analysis of olive oil-standard-glass for oil tasting, COI/T.20/Doc. No. 5/Rev. 1, 2007.

[7] International Olive Council, Sensory analysis of olive oil-standard-guide for the installation of a test room, COI/T.20/Doc. No. 6/Rev. 1, 2007.

[8] International Olive Council, Sensory analysis of olive oil-standard-sensory analysis: general basic vocabulary, COI/T.20/Doc. No. 4/Rev. 1, 2007.

[9] F.J. Pérez Elortondo, M. Ojeda, M. Albisu, J. Salmerón, I. Etayo, M. Molina, Food quality certification: an approach for the development of accredited sensory evaluation methods, Food Quality and Preference 18 (2007) 425-439.

[10] I. Etaio, M. Albisu, M. Ojeda, P.F. Gil, J. Salmerón, F.J. Pérez Elortondo, Sensory quality control for food certification: a case study on wine method development, Food Control 21 (2010) 533-541.

[11] I. Etaio, M. Albisu, M. Ojeda, P.F. Gil, J. Salmerón, F.J. Pérez Elortondo, Sensory quality control for food certification: a case study on wine, Panel training and qualification, method validation and monitoring, Food Control 21 (2010) 542-548.

[12] Association for Consumer Research (GfK), Household Panel, Nuremberg, 2006. (in German)

[13] H.T. Lawless, H. Heymann, Sensory Evaluation of Food-Principles and Practices, Chapman & Hall, New York, 1998.

[14] M. Meilgaard, G.V. Civille, B.T. Carr, Sensory Evaluation Techniques, CRC Press, Boca Raton, 2006.

[15] M. O'Mahony, Sensory Evaluation of Food-Statistical Methods and Procedures, New York, 1986.

[16] H. Stone, J. Sidel, Sensory Evaluation Practices, Elsevier, Food Science and Technology, 2004.

[17] A. Bongartz, D. Oberg, Organoleptic assessment of extra virgin olive oil combined with sensory evaluation of harmony and persistency including aroma description, unpublished, 2009.