METHOD FOR A COMMON LANGUAGE

Quantitative Descriptive Sensory Analysis

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Despite much research over the past 25 years, Quantitative Descriptive Sensory Analysis is used very little in the enology field.

Without examining the reasons for this situation, we will review the advantages of such a method as applied to enology, and to present a concrete case for the implementation of the QDSA method as carried out by the Institut Coopératif du Vin (ICV).

The basis for these reflections and research comes from the ISO 11035 Standard (Figure 1) which specifies the steps involved in building a sensory analysis tool.[1] QDSA is an analytical method with a goal to quantify the intensity of a list of sensations in order to describe a product (in our case, a wine). Each sensation that has to be quantified is connected to a descriptor and every descriptor is defined by a recipe.

Need for common language

Language can be described as a coding system that is useful only if understood unequivocally by all members of the group that utilizes it. Communication between people in the same winery or in the same division, or between people exercising the same types of function in different wineries, is effective only if the same words identify the same perceptions and vice-versa.

For QDSA, perceptions are limited to the sensory, and there is no need to work on abstract concepts. Inventing a new language would not be helpful because we already have one and every new language needs words, definitions, and time to create it. All that is needed is to choose among the existing terms in the current language those that will be useful for expressing perceptions clearly.

There are two main issues:

First, a vocabulary that is a choice of words to express a perception is arbitrary, but a choice must be made to avoid ambiguities. The method cannot allow too many descriptive terms or synonyms without risking oversights, errors, and uncertainties.

Second, translation of the perception. We do not mean translation from one language to another, but rather the translation of sensory perceptions as a whole (visual, tactile, olfactory, and taste perceptions) to the words that describe them. Beyond the quality and the precision of the initial choice of words, training is needed in order to implement the method.

Unlike wine tasting as it is most often practiced, Descriptive Sensory Analysis is not limited to linking words and their definitions, but adds a methodology for learning based on the reproducibility of the training exercises. The standards (or references) are established to serve as tools for training and evaluation.

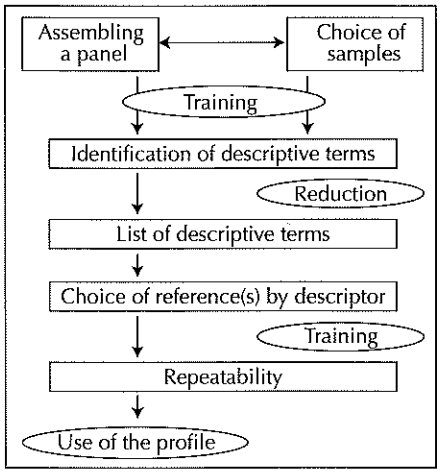

Figure 1: Stages in the ISO 11035 Standard.

The descriptor/attribute terms, their definitions, and the methods for sensory training must be established in the same sequence. Ideally, the training tools could be utilized in a different context, as evaluation tools for the combined mastery of perception and expression.

Two constraints

First constraint: Vocabulary

Hundreds of different terms could be used to describe the sensations perceived during the sensory analysis of a wine. However, despite the risks of confusion or of overlooking some sensations, it is useful to reduce the vocabulary, as the ISO standard anticipates, for at least three reasons:

- **Productivity of the learning phases** — Each descriptive term chosen must correspond to a standard (or reference) recipe, which must allow the user to appropriate the vocabulary, standardize it, and train with it. One can easily understand that the richer the vocabulary, the longer the research. This is true not only at the stage of creating the reference, but also for evaluators who will routinely utilize these recipes.
- **Efficiency of the evaluation** — If the QDSA of a wine is based on 15 descriptive terms, clearly it would go faster than if 30 terms had to be utilized. The winemaking world must also submit to the requirement of productivity. Fewer terms enhance the practicality of using QDSAs in the wine industry, in comparison to academic research.
- **Ease of communication** — The more the descriptive terms, the longer the discussions and the more difficult it is to reach a consensus. Sensory analysis is, most often, a task carried out by several people that allows them to make joint technical or commercial decisions, this is made easier through consensus.

Conversely, it is not desirable to reduce the number of terms selected too much. If the vocabulary is limited, it can no longer describe the

object of the analysis, or it will deal with only a part of the reality. That is why there must be a compromise between the objectives of the sensory analysis and the constraints that are generated. Experience shows, but does not prove, that equilibrium is generally situated between 10 and 20 descriptive terms per QDSA. A human can experience sensory fatigue with a large number of sensations to evaluate.

Table I: Reference recipes for ICV standards

Descriptor	Recipe (mineral water — always the same brand)	Level corresponding to the ICV scoring scale
Mid-palate weight	Cellulose gum (CMC) with a high degree of polymerization — high viscosity, in solution of 1 g/L (prepared in a double boiler at 65° — dissolved with constant light stirring)	Maximum
Acidity	For red wine: tartric acid in a 0.6 g/L concentration For white or rosé wine: a mixture of 0.4 g/L tartric acid and 0.2 g/L malic	Maximum Middle of the scale
Roughness or tannic intensity	Aluminum salt — potassium dodecahydrate, concentration 1.2 g/L	Maximum
Astringency	Aluminum salt — potassium dodecahydrate, concentration 1.2 g/L	Maximum
Dryness	White food-grade ground chalk solution, at 50 g/L	Maximum
Bitterness	Anhydrous caffeine at 0.3 g/L	Maximum

Second constraint: Standard recipes (or references)

The standard recipes should be easy to reproduce, to let the greatest number of tasters train and evaluate themselves as often as possible. The better the language is mastered and shared, the more effective it is. It will help greater understanding of the obstacles and the issues, including evolution of the choices made by people in the wine industry.

There are two main "extreme" options:

- Recipes based on the wine molecules, alone or in combination, known to participate in the perception being studied. For example, tartaric acid or a tartaric acid/malic acid mixture are in the standard recipe for acidity.

This option has the advantage of the recipes being reproducible as long as the products utilized are perfectly purified or always have the identical composition. It is what the ICV has chosen for the majority of the standard (or reference) recipes for taste perceptions. However, these products are not always conveniently accessible, especially rare or expensive products. Those that are accessible may not be very stable over time. Stability is often a problem with aromatic molecules.

- Recipes based on everyday products are available almost everywhere. For example, a simple burnt match extinguished in water is used in the recipe for the "Sulfur off — Burnt Match" standard. The advantage of this method is the ease of making the recipes.

A scale and a graduated test tube are usually all the equipment needed. The ICV chose this system for the majority of the standard (or reference) recipes for olfactory (aroma) perceptions. There is a disadvantage due to the risk of poor reproducibility, which is often the case with sensory sensations.

Initial testing of several recipes follows the method presented in the standard and must lead to a consensus. Starting with the initial terms,

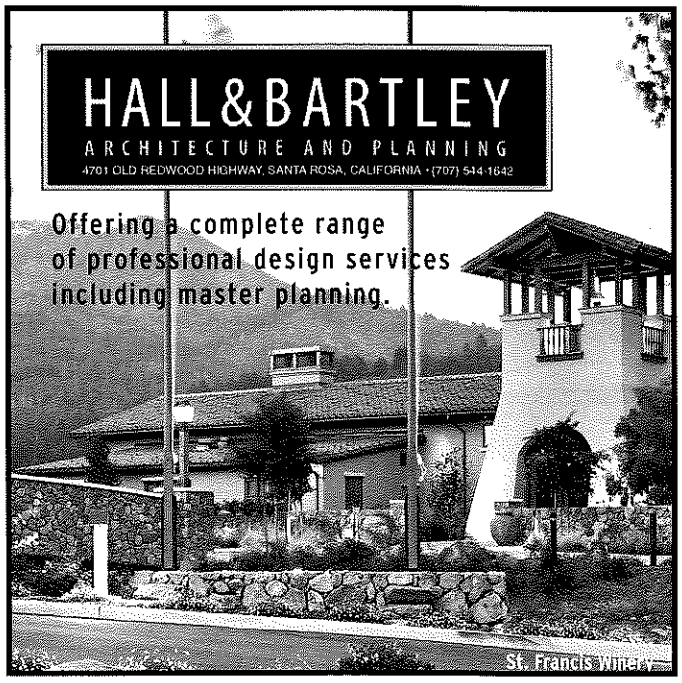

Table II: Recipes for standards common to white, red and rosé wines

Descriptor	Recipe (mineral water — always the same brand)	Specificity
Sulphur off burnt match	Light a match and extinguish immediately in 25 mL water	Preparation with no waiting time
Leek-like sulphur-off	10 g frozen cauliflower florets 2 g fresh leek 100 mL water	Preparation with no waiting time
Chemical	2 µ L isoamyl acetate in 1 L water	One hour before
Sap	3 g fresh Maestro® wood chips, French oak 0.5 g Maestro® Allegro® wood chips (burnt), from France 1 g fresh Maestro® sawdust 25 mL water	One hour before
Toasted	4 g Maestro® Allegro® wood chips (high toasting), French oak 1 whole roasted coffee bean	One hour before
Vanilla	1 g Maestro® Allegro® wood chips (high toasting), French oak 1 mL natural vanilla liquid extract, Vahiné® brand	One hour before

the panel applying the method must identify the descriptive term that corresponds to each of the references and be able to reproduce this identification.

Simultaneously with this validation of one or more recipes, and with their future utilization for training and evaluation in mind, it is useful to test the impact of the following actions:

- **Dilution** — Based on different recipes that might represent the standard, select one that allows tasters to identify the descriptive term at low levels of concentration and with a similar quantified response from all tasters. If the dilution does not work, it is more difficult to train the tasters to correctly utilize a quantified marking scale, and this could result in them conducting a Descriptive Sensory Analysis (DSA) instead of a QDSA. Dilutions allow for high, medium, and low intensity scales, as the scale is used to quantify individual attributes. This is different than simply stating an attribute is or is not present in a wine.
- **Blending with wine** — If the perceptions that change with the addition of the recipe ingredients to a uniform reference wine are those that correspond to the standard, the reference will be particularly interesting. This is the equivalent of measured additions as an element of validation in chemical analyses.
- **Combinations with each other** — If the combination of several references leads to the expression by each taster of the descriptive terms attached to each of the references, there is an im-

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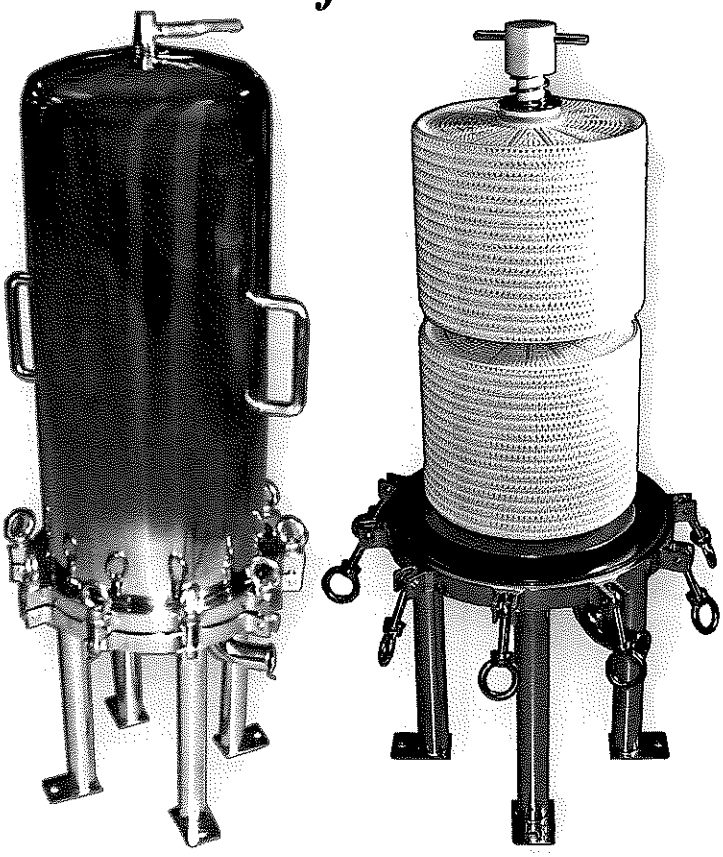

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portant opportunity to create training and evaluation exercises.

Example of methodology to create standard recipes for references

For the past three years, the ICV has been working to find a standard (or reference) recipe for the descriptive term of the "mid-palate weight" sensation first defined by the internal panel as "the sensation of filling the mouth with a standardized quantity of wine (10 milliliters).[4] This is the first descriptor to quantify after putting the wine in the mouth.

Take one sip and do not move the wine with the tongue or by sucking in air. Keep the head straight, do not move the tongue. Evaluate (perception) and note (expression) the intensity of the tactile pressure of the wine on the lingual (tongue), sublingual (palate), labial (internal part of the lips), and jugal mucosa (internal part of the cheeks) within three seconds after putting the wine in the mouth."

Table III: Recipes for standards specific to white wines

Descriptor	Recipe (mineral water — always the same brand)	Specificity
Citrus	1/4 of a slice of lemon, 0.5 cm thick 10 mL of the juice in a can of grapefruit sections in syrup 30 mL water	One hour before
Exotic fruit	1 mL grapefruit syrup 1 mL pinapple syrup 50 mL water	One hour before
Fruit in syrup or white fruit	5 mL of the juice in a can of apricots in syrup 4 mL of the juice in a can of pears in syrup 5 mL of the juice in a can of peaches in syrup 30 mL water	One hour before
Candied fruit	5 g candied fruit (choose all colours) 10 mL water	One hour before

This standard and its definition do not provide an ideal recipe that could work for generating that defined sensation. In order to define a recipe that corresponds to the definition, the method called "Design of Experiment" (DoE) is very useful.[2,3,5] This is a factorial method that allows the researcher to:

- reduce the number of trials;
- measure which parameters are the most important (key factors);
- determine the interactions among the parameters;
- increase the precision of the results; and
- create a mathematical model of the experiment.

The ICV chose different elements to create a standardized reference for "mid-palate weight": ethanol, glycerol, gum arabic, sugar, and carboxymethyl cellulose (cellulose gum or CMC, in the form utilized as a thickener in agri-food industries) were tested.

The responses of the panel to several combinations of these factors are noted individually on a scale from 1 to 4. Each taster attributes the score 1 or 2 or 3 or 4 to each of the combinations tested in a blind tasting, while following the procedure presented above. Through their responses, the key factors and their interactions are identified.

By designing successive experiments, we gradually approach a recipe that best represents the sensations listed and described in the definition of "Mid-palate weight." In this case, pure CMC gave the best results. This emphasizes the importance of choosing the initial ingredients. For example, if we had not considered CMC, we would have ended up with a different recipe from the one retained, potentially almost as valid.

After the recipe has been created, the repeatability and reproducibility of the panel's results regarding the link

Table IV: Recipes for standards specific to rosé wines

Descriptor	Recipe (mineral water — always the same brand)	Specificity
Yeast	0.25 g active dry yeast (always the same) 150 mL water	One hour before
Apricot	1 piece of canned apricot in syrup 1 dried apricot 50 mL water	One hour before
Blackcurrant	8 mL crème de cassis syrup 6 mL blackcurrant coulis (fruit purée) 100 mL water	One hour before

between the reference and the sensation identified must be validated.

ICV standards and reference recipes

The definitions of the ICV's taste standards have changed little since 1994:

- To the "mid-palate weight" descriptor, at the end of the first sentence, "The sensation of filling the buccal cavity with a standardized quantity of wine (10 milliliters)," was added "as defined by a solution of cellulose gum."
- The "Acid" descriptor is now defined as "The acid sensation as defined by a solution of tartaric acid (for red wines) or by a mixture of solutions of tartaric and malic acids (for white or rosé wines) in water." The rest of the definition remains unchanged.
- The "Roughness" descriptor was extended to rosé wines with the same definition as for white wines.

The recipes in Table I are currently utilized and can be prepared the day before.

Taking into account the aromatic characteristics of still, dry wines according to the color (red, rosé or white), the ICV designed three lists of aromatic standards, each corresponding to a color of wine. This is especially important as a change in the medium can create an aromatic change (hence changing the desired perception). Some standards are shared among the lists. Tables II, III, IV, and V show the recipes that correspond to the maximum levels on the ICV intensity scale.

Design of a training program

In order to become familiar with the QDSA method and the various descriptors, working sessions are offered to those preparing to be on a tasting panel. This training lets panel members learn the olfactory and taste descriptors, and become familiar with utilizing the scales.

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Table V: Recipes for standards specific to red wines

Descriptor	Recipe (mineral water — always the same brand)	Specificity
Vegetal or herbaceous	25 mL fresh bell pepper solution (at 50 g/L) 25 mL frozen green bean solution (at 60 g/L)	The basic solutions are prepared the day before. The mixture is prepared with no waiting time.
Berry or red fruit	4 g frozen raspberries, crushed 1 g blackcurrant coulis (fruit purée) 4 g frozen blueberries, crushed 10 mL water	Preparation with no waiting time.
Jammy	21 g sour cherry jam 12 g plum jam 1 g strawberry jam	All jams are the same brand. Preparation with no waiting time.
Prune	1 dried prune	Preparation with no waiting time.
Black pepper	6 black peppercorns 25 mL water	One hour before

Training must be repeated every year to maintain the high performance of the panel members. Several types of exercises can serve as the basic training program.[6] Variations can be developed to evaluate the performance of the panel members.

a) Presentation of the olfactory and taste standards — Each standard is presented to the panel members, who are introduced to the olfactory and taste sensations associated with each descriptor. For the taste standards, the evaluation procedure for the sensations in the mouth for each flavor is shown/repeated when each solution is presented.

b) Blind identification of the olfactory and taste standards — In order to help panel members remember the standards that have just been presented to them, a series of NON-identified samples containing an aroma (or flavor) added to water are offered. Each panel member must smell (or taste) the sample and identify the descriptor that has been added. At the end of the exercise, samples are revealed and presented once again, so that the tasters can continue to work on descriptors that gave them trouble.

When the training is advanced and the tasters begin to know the standards, the exercise can be made more complex by preparing samples with a concentration different from the standard, by working with a wine instead of water, or by making mixtures of aromas or flavors, in water or wine.

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c) Classifying olfactory and taste standards — The purpose of this type of exercise is to train the panel to evaluate the various levels of intensity of a descriptor to better develop the use of an intensity scale for each descriptor. This is one value of QDSA. The tasters are given a series of samples containing the same aroma (or flavor), which have been prepared at different concentrations in water. They are told the identity of the aroma (or flavor), and they must rank the samples from weakest to strongest.

At the end of the exercise, the concentrations are revealed and the samples are presented once again, so the tasters can continue to work on descriptors that gave them trouble. Initially, the samples are prepared in water, with very different concentrations. Then, to improve the panel's performance, the exercises could be presented with the concentration levels closest to each other and/or with mixtures prepared with a wine.

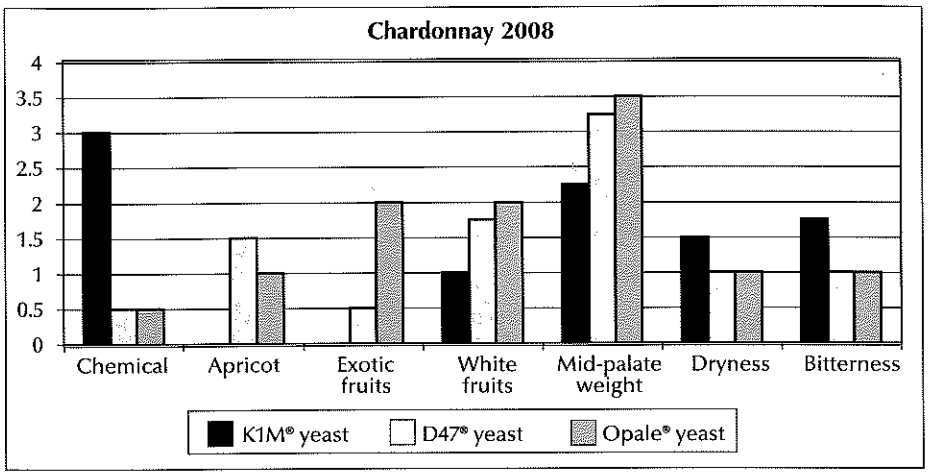

Figure 2: Characterization of a yeast trial by QDSA (ICV, R&D 2008)

d) Thresholds for detection and identification of olfactory and taste standards — This type of exercise ascertains whether certain members of a given group of experts are more or less sensitive to a flavor or aroma. This enables the training to be personalized for certain tasters who

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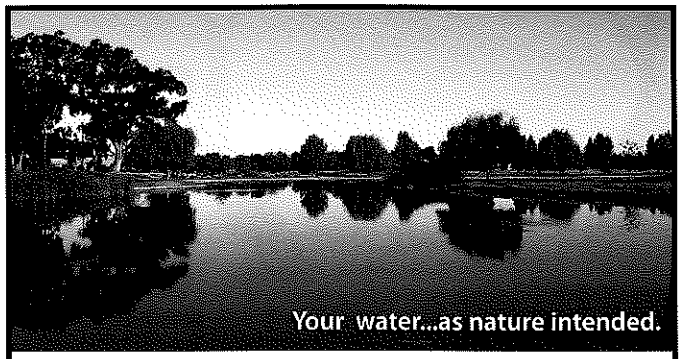

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need to improve their performance for a given descriptor. It also enables the tasting notes allocated by the least sensitive panel members to be weighted appropriately.

The tasters must smell (or taste) a series of samples that contain an aroma (or flavor) and that are presented in the order of increasing concentrations. They cannot go back to a sample already presented and must, immediately after having smelled (or tasted) the sample, note their perceptions indicating whether they perceived a flavor and whether they can identify it. The detection and identification thresholds for each descriptor can thus be established.

e) Individual realization of wine profiles and group correction — This exercise allows each panel member to become familiar with the scorecard utilized for the QDSA evaluation of wines. It also makes obvious any eventual distortions or disagreements among members of a group.

Two anonymous wines are presented to panel members; one is the control and the other is the control with the addition of a flavor and an olfactory standard. The tasters are asked to individually establish the organoleptic profile of each wine according to the QDSA principles. Together, the panel then compares the profiles established by each taster, and at the end the sample wines are revealed.

f) Triangle tests for olfactory and tasting standards — The tasters have three coded samples containing the aromas or flavors, of which two are identical. Tasters must select the one they consider different and identify the source of the difference.

Identification exercises can be utilized as evaluation exercises if they are not followed by revealing the sample. Similarly, ranking exercises can be utilized for evaluation, if they are carried out for "anonymous" standards that the tasters are asked to identify. The statistical treatment of certain exercises,[6] notably the scoring of a wine profile, also allows the group's performance to be evaluated.

When designing training programs certain rules must be followed:

- Work with homogeneous groups of panel members who have the same skill level with QDSA.
- Take into consideration the group's skill level (the training cycles already followed).
- Give preference to training sessions held in the morning, when tasters are most receptive.
- Alternate taste and olfactory tests to avoid sensory fatigue.
- Choose themes according to the specificities of the group, notably the type of wines for which they will create the QDSA profiles.

Multiple professional applications

The first application is the sensory analysis of wines taken individually. Every enologist knows the importance of this work for comparing techniques, preparing blends, evaluating competing products, and so on. The reproducibility of the QDSA is improved with the application of a testing method and the possibility of retraining when needed.

Communication with colleagues or coworkers working elsewhere increases the value of this central technical act. That was the main concern of ICV when the company began work on the topic 20 years ago: being able to communicate R+D results and various information to more than 50 enologists working for ICV and to more than 1,000 wineries working with ICV's technical and scientific support.

See Figure 2 for an illustration of a QDSA performed four months after winemaking. We can observe clear differences for certain descriptors. One of the resulting questions is whether these differences will continue, intensify, or diminish over time. Another issue would be to anticipate possible blends according to the markets, or the storage or ageing conditions.

QDSA is useful at every winemaking step. In winemaking, sulfur off-flavors have been an indicator for many years in deciding on aeration and nitrogen additions. Conduct training with the standard recipes during the year or just before harvest is, in that case, a new "tool" for the winemaker.

The mastery of evaluation by QDSA of such descriptors as mouthfeel, tannic intensity, and dryness opens the possibility of manipulating the length of maceration and extraction techniques by measuring the evolution of these sensations over time.

Contrary to what some people may believe, it does not take long to carry out a sensory profile consisting of three or four relevant descriptors, even during the busy winemaking period. Although the form may cover 15 or 16 descriptors, the winemaker is not obliged to evaluate every one of them in any situation. One can take from the method what is useful for a given objective, since during harvest time decisions must be made quickly and based on reason.

Conclusions

QDSA is a necessary tool for winemakers not only in the construction of a business strategy, but also in the

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ongoing evaluation of wines during the winemaking process.

Even if each person in a winery is aware of the importance of this tool, there is still a high risk that winery workers will create their own language. It would be useful if at least the basic descriptive terms (the definitions and training/evaluation recipes) were shared, along with the methods of creating the standard/descriptor pairs. Then if the selected standards were published (both definitions and recipes), everyone in the industry could integrate them in their QDSA methodology.

This direction does not eliminate one of the risks mentioned above — the multiplication of descriptors, with each person thinking theirs is more relevant than the next person's. To avoid this situation, common sense and a form of self-restraint would be beneficial. The associations of enologists, winemakers, and regional and national inter-professional groups can take into account the validation of the QDSA references and their evolution.

The International Organization of Vine and Wine (OIV) can play a major role. It has the organization, the expertise, and the necessary methods of validation to recognize the methodology, validate the basic descriptive terms (and their recipes), and enrich this basis with new terms and/or new references. ■

The authors would like to acknowledge the research involvement of Aude Berger, Justine Poudevigne, and Régis Aliot, notably for their contribution to designing a standard for mouthfeel.

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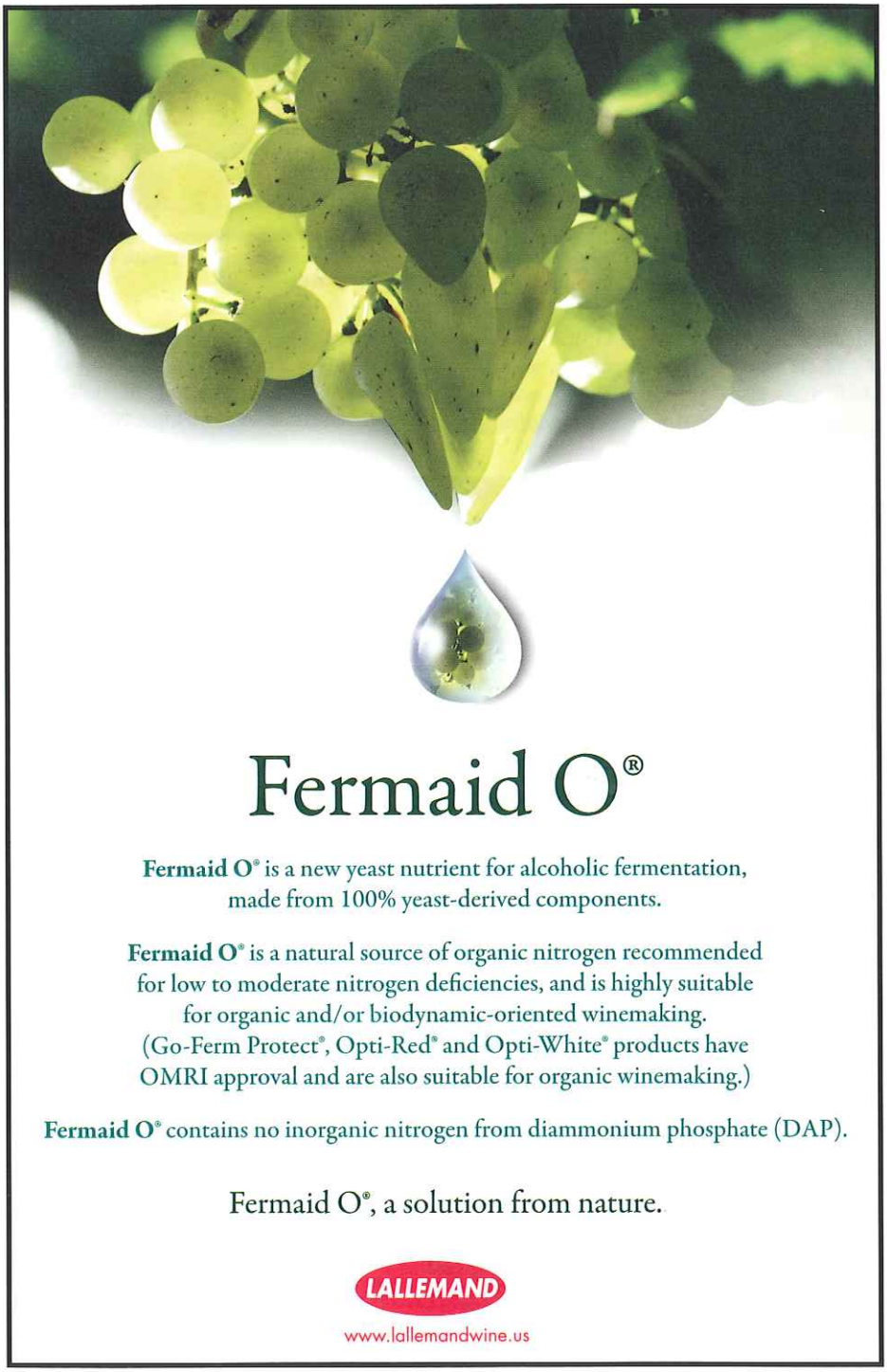
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