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Discriminating the fruity nuances in red wines with untrained assessors using CATA methodology

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The fruity aroma of red wines plays an important role in both wine quality and consumer liking. However, the perceptual reality of red- and black-berry fruity nuances remains a complex sensory concept. This work used Check-All-That-Apply (CATA), a fast, intuitive method in which panelists check attributes from a predefined list, to investigate whether untrained assessors can perceive the fruity nuances of red wines. Given its practicality for the wine industry, this work showed that untrained panels, coupled with CATA, can effectively distinguish red wines from different regions based on fruity nuances.

Fruity aroma of red wine: a complex sensory concept

The fruity aroma of red wines is defined by a wide range of descriptors, from fresh red- and black-berry fruits to ripe fruits, including candied and cooked fruits[1]. Fruity sensory spaces clearly differ between white wines, described with notes of yellow fruits and citrus, and red wines, described with notes of red- and black-berry fruits[2]. Several authors highlighted a link between sensory attributes and the typicality of some red wines, such as red- and black-berry fruits or fruit ripeness, and their quality[3]. From the consumers' point of view, many authors have investigated the link between consumer liking and associated sensory attributes, and researchers found that fruity attributes were positively correlated with liking[4].

The fruity aroma of red wine is often analyzed using quantitative descriptive analysis (QDA), especially sensory profiles based on intensity scores via scaling. Furthermore, QDA is time-consuming and requires intensive training of the panel on the selected descriptors, which is not practical for professionals[5]. CATA methodology is increasingly used in enology as an alternative to QDA and is growing in popularity, as it is intuitive, quicker, and does not require specific training for the panel. Moreover, this approach can be applied to all types of panels (professionals, experts, trained, semi-trained, untrained, or consumers)[6].

The purposes of this study were: (1) to inform professionals in the wine sector as to whether the CATA method is effective when used in conjunction with a panel of untrained panelists; (2) to demonstrate whether this method can distinguish red wines based on their fruity nuances.

Red wine selection and CATA procedure

Five commercial single-varietal red wines made from the Carmenère, Grenache, Nebbiolo, Petit Verdot, and Xinomavro grape varieties were collected. Among the five single-varietal red wines, three were planted in regions with higher temperatures than Bordeaux (the Mediterranean Basin) and came from different countries: Greece (Xinomavro), Italy (Nebbiolo), and Spain (Grenache). The other two red wines were made from grape varieties planted in the Bordeaux vineyard (Carmenère and Petit Verdot). Carmenère wine was presented twice, under different codes, to assess panel consistency. These wines were produced using grapes from the 2019 vintage. All olfactory analyses were conducted in 2023.

Generally, CATA uses a multiple-choice questionnaire that presents a list of terms to characterize the samples. Participants simply select all the terms they consider most appropriate for describing the samples, after which the frequency with which each term is cited is determined[6]. In this work, the CATA test was performed according to a questionnaire, adapted from another work[7], including five fruity olfactory attributes, and was proposed to the participants (n = 74; students from Bordeaux Sciences Agro) (Figure 1). The descriptors, which correspond to the lexical field of fruity nuances frequently described in red wines, were selected at an early stage during a preliminary evaluation of the wines carried out by three experts and were subsequently grouped by fruit family: fresh red-berry fruits, fresh black-berry fruits, jammy red-berry fruits, jammy black-berry fruits, and cooked fruits. Participants were shown a picture corresponding to each attribute. Participants received six samples one by one, including a duplicate sample (Carmenère 1 and 2, the same wine presented twice under different codes), and were instructed to select the attributes they perceived as corresponding to the evaluated sample. The data were analysed using XLSTAT (version 2023.1.6.1410) and open-source R scripts[7], which included the chi-square test (to measure the independence between attributes and products, thus assessing analysis robustness), Correspondence Analysis (CA) and Cochran's and Sheskin's tests (https://doi.org/10.57745/SYT7QU). CATA data were arranged in a contingency table for CA to obtain a 2D representation of the spatial repartition of the six wine samples and the five attributes.

CODE DEGUSTATEUR (en majuscule) :
(4 premières lettres de votre nom + 4 premières lettres de votre prénom)
(The first 4 letters of your last name + the first 4 letters of your first name)

CODE SERVEUR (en majuscule) :
(4 premieres lettres du nom de votre serveur + 4 premières lettres du prénom de votre serveur)
(the first 4 letters of your server's last name + the first 4 letters of your server's first name)

Age :
Genre / Gender :
Formation :

Degustation olfactive - Uniquement au nez (with the nose only)

Vous allez déguster olfactivement sept vins. Cochez toutes les cases qui correspondent aux descripteurs du vin codé. Sur la dernière ligne, attribuez une note entre 1 et 9 pour l'appréciation globale du vin codé (1 = mauvais et 9 = excellent).

You are about to smell 7 wines. Check the boxes that correspond to each wine. On the last line, give a score between 1 and 9 for the overall appreciation of the coded wine (1 = bad and 9 = excellent).

Descripteurs :	Code Vin :	Code Vin :	Code Vin :	Code Vin :	Code Vin :	Code Vin :	Code Vin :	Descripteurs :
Confiture de fruits rouges *Jammy red-berry*	☐	☐	☐	☐	☐	☐	☐	Confiture de fruits rouges *Jammy red-berry*
Fruits cuits (type pruneaux) *Cooked fruit (Prune)*	☐	☐	☐	☐	☐	☐	☐	Fruits cuits (type pruneaux) *Cooked fruit (Prune)*
Fruits rouges frais *Fresh red-berry*	☐	☐	☐	☐	☐	☐	☐	Fruits rouges frais *Fresh red-berry*
Confiture de fruits noirs *Jammy black-berry*	☐	☐	☐	☐	☐	☐	☐	Confiture de fruits noirs *Jammy black-berry*
Fruits noirs frais *Fresh black-berry*	☐	☐	☐	☐	☐	☐	☐	Fruits noirs frais *Fresh black-berry*

FIGURE 1. CATA questionnaire.

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Red wines discrimination according to their fruity nuances

Figure 2 shows the CA analysis: wines located close to one another share similar characteristics, while attributes located near a given wine indicate higher citation frequencies for that wine. The axes covered 88.62 % of the total variability. In addition, the duplicate samples Carmenère 1 and 2 were close, highlighting good panel consistency. Figure 2 shows that assessors discriminated the wines by contrasting red-berry fruit notes with black-berry and cooked fruit notes, as indicated by axis 1, which explained the highest percentage of the data set's variability (77.6 %). Axis 2 opposed the cooked fruit attribute to the black-berry fruit notes, but this does not carry much weight (11.02 %). In addition, assessors associated the wines made from Xinomavro and Nebbiolo with fresh and jammy red-berry fruit notes, while the wines made from Petit Verdot, Grenache, and Carmenère 1 and 2 were characterized by fresh and jammy black-berry fruit and cooked-fruit aromas.

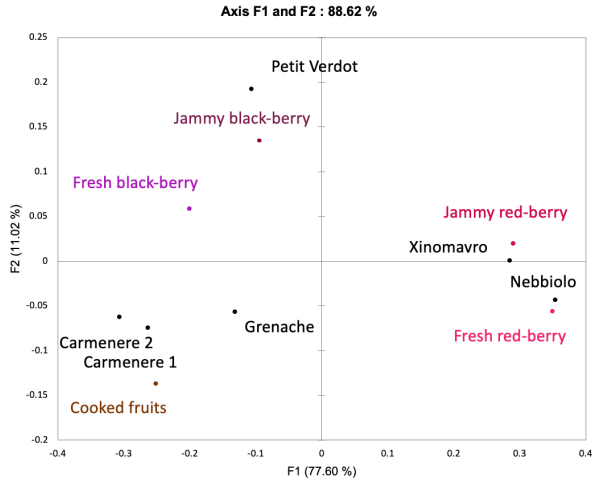


FIGURE 2. Correspondence Analysis (CA) conducted on the Check-All-That-Apply test (CATA) data obtained with 74 untrained assessors; wine labels in black, attribute labels in color.

These aromatic profiles are also shown on a spider graph (Figure 3). Cochran's Q test applied to attribute citation frequencies showed significant effects for four attributes: fresh red-berry (p-value < 0.0001), jammy red-berry (p-value < 0.0001), fresh black-berry (p-value = 0.002), and cooked fruits (p-value = 0.047). The detailed significant differences, tested by Sheskin's pairwise comparisons, are given in supplementary Table S1. Figure 3 shows that the wine made from Grenache was mostly described as having both cooked-fruit and fresh black-berry aromas. Wines made from Xinomavro and Nebbiolo were significantly perceived to have higher levels of fresh, jammy red-berry fruit notes than Carmenère 1 and 2 red wines. However, the panel described the Grenache and Petit Verdot red wines as having higher fresh black-berry fruit notes than the Nebbiolo. These results suggest that the untrained panel easily recognized red- and black-berry fruit notes but was less proficient at identifying jammy and cooked fruit notes. These would probably require some training to be used more effectively.

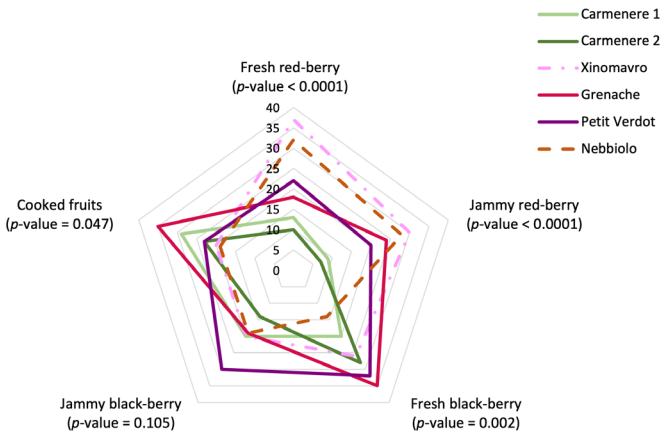


FIGURE 3. Spider maps of citation occurrences for the five olfactory attribute citations, obtained from CATA tests; p-values were calculated using Cochran's Q test, n = 74 untrained assessors.

Finally, to determine the number of participants necessary for a statistically robust CA, a chi-square test was applied, as described previously[7]. These results showed that the variables 'attributes' and 'products' were strongly dependent (p-value < 0.05) once the number of panelists reached 50, thus supporting the validity of categorizing wine fruity aromatic profiles using untrained assessors, in our case, n = 74 panelists.

Conclusion

Although the fruity aroma of red wines is a complex sensory concept, the CATA methodology can be useful and powerful for evaluating perceptual differences in fruity nuances in red wines, even with untrained panels. Untrained assessors, who do not share common perceptual and cognitive representations of fruitiness in wines, could differentiate wines according to these nuances of red- and black-berry fruits. The notions of jammy and cooked fruit were less discriminative for the untrained panel. Therefore, it would be interesting to conduct further analyses by comparing this methodology with a QDA approach using a trained panel, to see how they perceived the fruity notes and discriminated the wines. Moreover, the selected wines were made in different countries, which can facilitate the perceptual discrimination among the samples. From a future perspective, it could be interesting to use this methodology with a set of red wines made from Bordeaux.■

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Source: This article presents original research results (that have not been published in a peer-reviewed scientific journal).

The supplementary Table S1 is available here: https://ives-technicalreviews.eu/article/view/10509/56034

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