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ORIGINAL RESEARCH ARTICLE

Are specific PDO wines sensorially recognisable? A study in the Beaujolais vineyard with different types of experts

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ABSTRACT

Wine PDOs are based on their place of origin and technical product specifications. Some studies have looked at sensory differences between PDOs, but few have shown real sensory specificities for each PDO. These studies have focused on well-established PDOs, leaving aside the new appellations developed in recent years. This article investigates experts' sensory representation (study 1) and actual descriptions of wines in blind and informed tastings (study 2). To achieve this objective, we used the Beaujolais vineyard as a case study and, more specifically, the new Beaujolais Pierres Dorées PDO. Three groups of experts were recruited and separated according to their professions: Makers, Sellers, and Critics. The results showed that the new Beaujolais Pierres Dorées PDO did not present a specific sensory description, neither in the mental representations of the experts nor during the tasting. Providing information on the PDO of the wine samples did not lead to different descriptions compared to blind tasting. However, wines from the same appellation were described more similarly in the informed tasting than in the blind one, suggesting some assimilation or contrast effects. No effect of the type of experts was observed during the tasting. However, experts store different wine attributes in memory depending on their experience and practice. The Makers stored very precise descriptions, the Sellers a few punchline descriptors, and the Critics were situated between the other two groups with both punchline descriptors and satellite descriptors.

KEYWORDS: PDO wine, sensory description, expertise, RATA, mental representation, tasting, Beaujolais

INTRODUCTION

Wine appellations are mainly based on the Protected Designation of Origin (PDO) indication, which is one of the quality labels recognised by the European Community (Ríos-Reina *et al.,* 2019). A PDO is defined as "*the name of a region, a specific place or, in exceptional cases, a country used to describe a product with the following requirements: (i) its quality and characteristics are essentially or exclusively due to a particular geographical environment with its inherent natural and human factor, (ii) the grapes from which it is produced come exclusively from this geographical area, (iii) its production takes place in this geographical area and (iv) it is obtained from vine varieties belonging to Vitis Vinifera*" (Commission Delegated Regulation (EU) 2019/33, 2018). The PDO system is a hierarchical system with at the base large regional PDOs and at the top smaller PDOs corresponding to the *Crus* (Legouy and Dallot, 2019). Wines are categorised into this system based on their place of origin and the adoption of technical specifications such as allowable grape varieties, minimum levels of alcohol, production methods, maximum yield levels and methods of harvesting. While consumers interpret PDOs as a quality cue and expect to find sensory differences between two wines with different PDOs, the question remains as to whether there are sensory signatures or recognisable sensory characters associated with specific PDOs.

1. Are there sensory signatures associated with specific PDOs?

To address this question, we performed a literature review using four scientific databases: Elsevier, Taylor and Francis, Wiley, and Springer and two scientific wine journals: OENOOne and American Journal of Enology and Viticulture, between the years 2000 and 2022. The keywords "wine PDO", "origin", and "typicity" were used. The titles and abstracts of the articles retrieved during the initial search were reviewed to keep only articles presenting sensory studies. A total of 30 studies were found with this criterion. Then, a second selection was applied to focus on studies investigating sensory differences between PDO wines with the same grape variety within the same country. Nine studies met these selection criteria (Table 1). These studies were classified into three groups based on the type of comparisons carried out. The first two groups involved comparisons of PDOs between vineyards either from the old (France and Spain) or the new (Australia) wine world. The third group included comparisons within a given vineyard, the Loire Valley in France.

1.1 Between-vineyard PDOs sensory profile comparisons.

1.1.1. Old wine world studies

Two studies used a rating scale methodology to assess the intensity of different descriptors within French (Geffroy *et al.,* 2016) and Spanish PDOs (Quijada-Morín *et al.,* 2014). The French study investigated the sensory profile of 21 Gamay wines from four distinct regions (Auvergne, Beaujolais, Loire Valley, and Southwest area). A panel of eight people with prior experience in wine assessment had to evaluate the intensity of 21 sensory descriptors with a five-point rating scale. Results showed that eight descriptors discriminated the regions: *intensity, oxidation level*, *fermentative/amylic*, *fermentative/lactic*, *spicy/peppery*, *fattiness*, *sweetness*, and *acidity*. Six of these eight descriptors were found to be more intense for the southwest region. However, since the selection of wines included only one wine from the Southwest, it is difficult to generalise these results to the entire PDO. Only a few significant differences were observed for the three other regions: the wines from the Auvergne region were perceived as more *spicy/peppery* than the other wines, and the wines from the Loire Valley were more *acidi*c. The Spanish study (Quijada-Morín *et al.,* 2014) evaluated the level of astringency in wines from three Spanish PDOs (Toro, Rioja, and Ribera del Duero). The authors asked wine experts, including winemakers and oenologists, to evaluate the intensity of astringency on a scale from zero to five. Results showed a significant difference in the intensity of astringency, with an average of 2.91 for the wines from Ribera del Duero, 2.22 for the wines from Rioja, and 1.80 for the wine from Toro.

1.1.2. New wine world studies

Although the Australian PDO system was introduced to mimic the French PDO's system, it diverges from this last system because the hierarchy of wines is based on areas, regions, and sub-regions (Kustos *et al.,* 2020). Souza-Gonzaga *et al.* (2019) compared the sensory profiles of Cabernet-Sauvignon wines from three Australian regions: Coonawarra, Yarra Valley and Margaret River. Rather than asking experts to rate the intensity of descriptors, they performed a content analysis of wine reviews. A total of 2598 wine notes and scores from well-known wine writers were compiled. A sensory lexicon was built by grouping words with the same meaning, yielding 47 terms, out of which 17 differentiated significantly from the three regions. The following regional sensory profiles of Cabernet Sauvignon wines were obtained: Coonawarra wines were more *minty*, *astringent*, *sweet*, and *earthy*; Margaret River wines were more *leafy*, *complex,* and *floral,* and Yarra Valley wines more *herbal*, *green*, with a *medium body*. According to the authors, these specific profiles may be due to the influence of climate. In agreement with this interpretation, the terms "*Oaky*" and "*Dark fruits*" more linked to the decision of the wine makers than to the region were not discriminant. A similar regional effect was reported by Kustos *et al.* (2020) on the sensory profiles of Chardonnay wines from sub-regions of Margaret River and Yarra Valley and of Shiraz wines from sub-regions of Barossa Valley and McLaren Vale. Ten trained panellists evaluated the intensity of 39 descriptors for the Chardonnay wines, and 11 trained panellists the intensity of 41 descriptors for the Shiraz wines on 15-cm scales. A clear difference was observed between the wines from Margaret River and Yarra Valley (22 significant descriptors) as well as between sub-regions of these areas (17 significant descriptors). The regional effect was less clear for the Shiraz wines (17 significant descriptors for the regional comparison and 11 for the sub-regional comparison). A small regional effect was previously reported by Johnson *et al.*

TABLE 1. Review of the different studies dedicated to determining sensory profiles of PDOs.

	Authors	Countries	PDOs / Regions	Grape varieties	Participants	Methods	Results
Studies about sensory profiles of PDOs from different vineyards: old wine world studies	Geffroy *et al.* (2016)	France	Auvergne, Beaujolais, Loire Valley and Southwest	Gamay	Trained panellists	Descriptive profile with 21 descriptors with a 5-point scale	Eight descriptors significant between regions
	Quijada-Morín *et al.* (2014)	Spain	Toro, Rioja, Ribera del Duero PDOs	Tempranillo	Wine experts (winemakers and oenologists)	Intensity of astringency	Intensity of astringency was different between PDOs
Studies about sensory profiles of PDOs from different vineyards: new wine world studies	Johnson *et al.* (2013)	Australia	Barossa Valley, Clare Valley, Heathcote, Great Southern, McLaren Vale, Great Western, Coonawarra, Hunter Valley, Langhorne Creek, Canberra District	Shiraz	Wine experts (winemakers, Masters of Wine, wine writers, academic wine researchers, fine wine retailers and postgraduate oenology students)	Descriptive profile with 24 descriptors with a 15cm scale Hedonic notes on a 9-point scale and quality notes on a 20-point scale	12 descriptors significant between regions Differences in liking and quality between wines but not between regions
	Kustos *et al.* (2020)	Australia	Margaret River and Yarra Valley Barossa Valley and McLaren Vale	Chardonnay and Shiraz	Trained panellists	Chardonnay: descriptive profile with 39 descriptors with a 15 cm scale Shiraz: descriptive profile with 41 descriptors with a 15 cm scale	Chardonnay: 17 descriptors significant between regions Shiraz: 11 descriptors significant between regions
	Souza-Gonzaga *et al.* (2019)	Australia	Coonawarra, Margaret River and Yarra Valley	Cabernet Sauvignon	Wine writers	Descriptive profile with the frequency of citation of 47 descriptors Quality notes with a 100-point scale	17 descriptors significant between regions Difference in medals awarded between regions
Studies about the sensory profile of PDOs from the same vineyard	Cadot *et al.* (2012)	France	Anjou-Villages Brissac and Anjou PDO	Cabernet Franc and Cabernet Sauvignon	Trained panellists	Descriptive profile with 21 descriptors with intensity scale	Seven descriptors correlated with Anjou-Villages Brissac PDO
	Lawrence *et al.* (2013)	France	Anjou, Anjou Rouge, Bourgueil, Chinon, Saumur Champigny, St Nicolas de Bourgueil, Saumur Rouge, Touraine, Vin de Pays du Val de Loire	Cabernet Franc	Wine experts (oenologists, technicians, and researchers)	Descriptive profile with 21 descriptors with a 6-point scale	15 descriptors significant between wines but not between PDOs
	Perrin *et al.* (2008)	France	Loire, Anjou, Saumur and Savennières PDOs	Chenin	Trained panellists Wine experts (winemakers, wine advisors and oenologists)	Descriptive profile with 37 descriptors with a scale from 0 to 10 Napping, Ultra-Flash Profile and Free Profile	Five descriptors are significant between wines but not between PDOs
	Thiollet-Scholtus *et al.* (2014)	France	Anjou-Villages Brissac and Anjou PDOs	Cabernet Franc and Cabernet Sauvignon	Trained panellists	Descriptive profile with 21 descriptors with a 10-point scale	Eight descriptors significant between PDOs

(2013) for Australian Shiraz wines. Panellists were trained to evaluate wines from ten regions using an unstructured 15 cm line scale. Only 12 of the 24 descriptors showed a regional effect, and the magnitudes of the differences in intensity between regions were small (maximum 2.2 points out of 15).

1.2 Within-vineyard PDOs sensory profile comparisons

In the last decades, many studies have been carried out to evaluate the effect of PDOs on sensory profiles within the Loire Valley in France. Among those studies, two failed to demonstrate a PDO sensory signature. In the first one, Perrin *et al.* (2008) asked trained panellists to describe ten Chenin wines from four different PDOs using a list of 37 descriptors with an intensity scale going from zero to ten. Results showed that there were sensory differences between wines but not between PDOs. This absence of the PDO effect was replicated using other methodologies (Napping, Ultra-Flash Profile and Free Profile) with wine experts (winemakers, wine advisors, and oenologists).

Later, Lawrence *et al.* (2013) compared the profiles of 31 Cabernet franc wines from nine different PDOs. Wine experts (oenologists, technicians, or researchers) were asked to evaluate the orthonasal intensity of 21 descriptors for each wine using a 6-point intensity scale. Results showed that 15 odour descriptors discriminated between wines but not between regions. The absence of PDO signatures in these two studies might stem from the high number of PDO evaluated. To avoid this caveat, two other studies focused only on two PDOs: Anjou Rouge PDO and Anjou-Villages Brissac PDO (Cadot *et al.,* 2012; Thiollet-Scholtus *et al.,* 2014). The Anjou-Villages Brissac PDO is considered a premium PDO, whereas the Anjou rouge PDO is perceived as a regional PDO. Both studies used a descriptive analysis technique with the same 21 descriptors. The first results obtained by Cadot *et al.* (2012) showed a strong wine effect (20 out of the 21 descriptors were significant between wines), but only seven were correlated to the Anjou-Villages Brissac PDO with four visual, one olfactive, and one mouthfeel descriptors. The second study (Thiollet-Scholtus *et al.,* 2014) revealed similar results with eight significant sensory attributes: three visual, two olfactory, aroma persistence and two mouthfeel descriptors.

1.3 To sum up

This review showed that grape variety modulates the PDO's sensory effect, as stronger effects were observed for Chardonnay wines than for Shiraz ones. The effects of PDO have been clearly demonstrated for comparisons between vineyards in the new world, but in the old world, the results were not straightforward. This effect is also less clear for within-vineyard comparisons, especially because of strong intra-PDOs variability. The intra-PDO variability is problematic when studying PDO sensory signatures in terms of wine selection. How to ensure that the wines used in the study represent the given PDO? One solution is to select wines considered typical of the specific region or appellation by experts. These experts can be wine experts in general (sommeliers or journalists) or experts of the specific wine selection region, such as winemakers. They are asked to choose wines considered to be the best representatives of the PDOs (Geffroy *et al*., 2016; Johnson *et al*., 2013; Kustos *et al*., 2020; Lawrence *et al*., 2013; Perrin *et al*., 2008). However, this strategy might maximise the sensory difference between PDOs. Another strategy is to ask local experts to select wines from the region or PDO based on the diversity of sensory profiles of wines within this region or appellation. However, this solution assumes that experts have developed a consensual mental representation of the sensory profile of the wines of a region or an appellation. These two methods are currently the most widely used in the literature, but they still raise the question of the objectivity of the choice of the most representative styles.

2. Can we rely on experts' mental representations to evaluate PDOs sensory signatures?

Urdapilleta and Manetta (2011) defined mental representations as "*knowledge or beliefs that are well stabilised in the subject's memory, but which may change as a result of experience or instruction (p.71)"*. Two studies relied on this idea to evaluate whether wine experts have a consensual representation of the sensory properties associated with PDOs. Jose-Coutinho *et al.* (2015) explored experts' mental representations of 12 Portuguese Protected Geographic Indications (PGI). Twenty wine experts (winemakers, wine-science researchers, Masters of Wine, wine judges, wine writers and wine retailers) received the following instruction: "How would you define a typical young commercial white wine from this particular PGI and score each sensory attribute accordingly?" The sensory scales going for 0 (no trace) to 10 (extremely intense) included colour, aroma, and taste attributes. Results showed that only the PGI Minho had a specific sensory signature anchored in the mind of experts. Other PGIs were clustered in two groups: a Southern group, composed of four PGIs, and a Central group, composed of seven PGIs. More recently, Leriche *et al.* (2020) used a focus group methodology to explore wine experts' representation of the sensory characteristics of six PDO wines from the Languedoc vineyard (France). For each PDO, experts (*i.e.,* winemakers, producers, oenologists, merchants, wine merchants, sommeliers, and staff of unions) started by generating individually a list of sensory descriptors that they associated with the PDO. Then, a debate was engaged to obtain a consensual list of descriptors. Results highlighted that only a few descriptors were specific to one or two PDOs (*e.g.,* woody, persistence, density, and floral), and several descriptors were common to all the PDOs studied (*e.g.,* scrubland, tannins, spices, red fruits, black fruits, and ripe fruits).

Results of these two studies showed that contrary to what was previously observed for grape variety (Hughson and Boakes, 2002; Solomon, 1997), experts did not abstract clear sensory concepts from PDO wine tastings. Only some PDOs gave rise to clearly defined concepts associated with specific sensory attributes (*e.g*., PGI Minho, Jose-Coutinho *et al.*, 2015). The majority of PDOs from the same wine region seem to be associated with overlapping sensory concepts with many common sensory attributes. These results could be due, in part, to a lack of agreement between experts on the specific sensory characteristics of PDO wines, which prevents the creation of a shared concept specific to each PDO. This lack of agreement may be because, in these studies, wine experts are considered as a unified group independent of the nature of their expertise. In a recent study, Otheguy *et al.* (2021) showed that three groups of experts (Makers, Sellers, and Critics) constructed different mental representations of Beaujolais wines based on their specific experiences and exposures to wines from this region.

3. PDOs hierarchy: an evolutive system

PDOs are social constructions and, as such, constitute a dynamic and evolutive system (Hinnewinkel, 2004). PDO evolutions are materialised both by the creation of new PDOs and by an evolution in the hierarchy and quality of the wines within a given appellation (Legouy and Dallot, 2019). In France, this can lead to the birth of Complementary

Geographical Denominations (Dénomination Géographique Complémentaire, DGC). This complementary mention corresponds to a well-defined sub-space of an already existing PDO and is affixed after the name of the PDO. For example, the Beaujolais vineyard was originally structured into three main categories: Beaujolais, Beaujolais-Villages and Cru Beaujolais is undergoing some restructuration. In 2017, a DGC called "Pierres Dorées" was developed within the Beaujolais PDO, resulting in the "Beaujolais Pierres Dorées" PDO. With the apparition of this new DGC, the Beaujolais PDO is separated into three subcategories: Beaujolais, Beaujolais Nouveau and Beaujolais Pierres Dorées. The development of DGCs generally results in a move upmarket with higher quality and marketing differentiation from the general PDO. The new DGC Pierres Dorées is being developed to obtain recognition for the wines produced in this region. The objective is to achieve a move upmarket within the Beaujolais appellation. But does that imply the emergence of specific sensory profiles?

4. Objectives of the study

The main objective of the present study was to understand if the evolution of the PDO system was paralleled by an evolution in the wine sensory profiles. To meet this objective, we used the Beaujolais vineyard as a case study. Our strategy was to compare the sensory profiles of wines from the new Beaujolais Pierres Dorées PDO with more traditional PDOs from the Beaujolais vineyard. Based on previous work, we used two sensory approaches: one based on experts' mental representations (study 1) and the other on actual tasting (study 2). For the tasting, we used both blind and informed tasting with the idea of accessing and studying the mental representations of the experts in an indirect way. Our rationale was that the changes in wine descriptions between the two conditions provide insightful information on the contents of the sensory concepts developed by the experts. Because previous work showed that wine experts might not be a unified group (Otheguy *et al.,* 2021), a second objective of the present study was to understand to what extent differences in experts' training and experience influence their representations and evaluations of the sensory characteristics of PDO wines. Three groups of experts participated in the study: Wine makers from the Beaujolais vineyard, wine sellers and wine critics.

5. Hypotheses

The hypotheses of the first study were:

- H1) through their experience with wines labelled with the mention Beaujolais Pierres Dorées, wine experts have developed a specific representation of these wines.
- H2) winemakers in the Beaujolais region, more familiar with the new Beaujolais Pierres Dorées PDO, may have a clearer picture of these wines than wine sellers or wine critics.

The hypotheses of the second study were:

- H3) the development of the new Beaujolais Pierres Dorées PDO, resulting from the evolution of the vineyard, leads to specific sensory characteristics of the wines, different from the Beaujolais PDO wines already in place.
- H4) the experience of experts with PDO Beaujolais Pierres Dorées wines could lead to expectation effects. Thus, we expected to observe greater differences between Beaujolais and Beaujolais Pierres Dorées PDO wines during the informed tasting compared to the blind tasting.
- H5) winemakers in the Beaujolais region, more familiar with the new Beaujolais Pierres Dorées PDO, could better discriminate between Beaujolais and Beaujolais Pierres Dorées PDO wines during tasting than wine sellers and wine critics.

STUDY 1: REPRESENTATION OF BEAUJOLAIS PIERRES DORÉES PDO WINES

This study aimed to access the sensory representation that experts have of the red wines of the Beaujolais Pierres Dorées PDO in comparison with other PDOs from the Beaujolais vineyard.

MATERIALS AND METHODS

1. Participants

Fifty-two wine experts (38 men and 14 women) with an average age of 49 years old were recruited. Three panels were formed based on the experts' main professional activity. The first panel, named Makers, was composed of 19 individuals who make, supervise, or advise on all the stages and oenological practices in the Beaujolais vineyard (*e.g.,* winegrowers, cellar masters, oenologists, and vine advisors). The second panel, named Sellers, was composed of 15 individuals who participated in the direct trade of wine bottles with consumers in stores or restaurants in the Beaujolais region (*e.g.,* sommeliers and wine merchants). The third panel, named Critics, was composed of 18 individuals who have written articles, published books, or blogs about Beaujolais wines (*e.g.,* wine critics and journalists). They were preferably recruited at the regional level and then at the national and international levels, checking in advance that they were all French-speaking and had knowledge about the Beaujolais wines. A questionnaire was sent *a posteriori* to the participants to obtain information on their training and experiences with Beaujolais PDO and Beaujolais Pierres Dorées PDO wines. Only 83 % of the participants completed it. Experts' characteristics are reported in black in Table 2.

2. Procedure

Imaginary sensory profiles of five PDOs from the Beaujolais vineyard were obtained using the Rate-All-That-Apply (RATA) method. RATA is a variant of the CATA (Check-All-That-Apply) method (Ares *et al.,* 2014). With RATA, wine experts had to select pre-determined descriptors and rate their intensity to describe the wines. The list of descriptors

TABLE 2. Experts' characteristics of study 1 (black) and 2 (red).

Panel	Makers (n = 19 / 15)	Sellers (n = 15 / 12)	Critics (n = 18 / 11)
Gender (Men/Women)	12 / 7 10 / 5	12 / 3 10 / 2	14 / 4 9 / 2
Mean age (min/max)	50 (30 / 79) 51 (30 / 79)	46 (26 / 76) 49 (27 / 76)	51 (31 / 75) 52 (31 / 75)
Content of the training courses attended			
Winemaking	13 / 13	0 / 0	3 / 1
Agronomy	1 / 1	0 / 0	1 / 0
Wine tasting	0 / 0	1 / 1	6 / 4
Wine trading	3 / 3	1 / 1	0 / 0
Sommelier	0 / 0	5 / 4	0 / 0
Self-educated	1 / 1	4 / 4	6 / 4
Wine producing law	0 / 0	0 / 0	1 / 1
Culture and wine	0 / 0	0 / 0	1 / 1
Estimation of the Beaujolais wine tasting experience			
For 5 years	0 / 0	2 / 2	4 / 3
For ten years	1 / 1	2 / 2	1 / 1
For twenty years	4 / 4	2 / 2	6 / 2
For more than twenty years	11 / 10	5 / 4	5 / 5
Estimation of the quantity of Beaujolais wine bottles tasted per year			
About 50	2 / 2	5 / 5	6 / 5
About 100	2 / 2	2 / 2	0 / 0
More than 100	12 / 11	4 / 3	10 / 6
Estimation of the Beaujolais wine drinking experience			
For five years	0 / 0	2 / 2	4 / 3
For ten years	1 / 1	1 / 1	2 / 2
For twenty years	3 / 3	3 / 3	5 / 1
For more than twenty years	12 / 11	5 / 4	5 / 5
Estimation of the quantity of Beaujolais wine bottles drank per year			
About 50	5 / 5	7 / 7	12 / 7
About 100	8 / 7	2 / 2	3 / 3
More than 100	3 / 3	2 / 1	1 / 1
Origin of the knowledge with Pierres Dorées Beaujolais wines			
"I produce it"	3 / 3	0 / 0	0 / 0
"I sell it"	2 / 2	3 / 2	0 / 0
"I taste it"	13 / 11	7 / 6	10 / 5
"I consume it"	8 / 6	6 / 5	11 / 7
"I just heard about it"	2 / 1	3 / 3	3 / 3
Number of years of knowledge about Beaujolais Pierres Dorées wines			
Less than a year	0 / 0	0 / 0	1 / 1
One to five years	7 / 7	6 / 6	4 / 4
Five to ten years	9 / 8	5 / 4	11 / 6

was obtained based on the descriptions of the red wines of the Beaujolais PDO and Beaujolais Pierres Dorées PDO present in the last ten editions of the Hachette wine guide. A list of terms and their frequency of occurrence was first compiled. Next, two independent researchers reduced the list by regrouping terms into categories. For example, descriptors related to the floral aromas of *violet* and *peony* were categorised under the *floral* descriptor. A total of 20 descriptors covering odour/aroma (*blackcurrant, cherry, concentrated, expressive, floral, raspberry, spicy, strawberry, vegetal*, and *woody*), taste (*acid, bitter*, and *sour*), and mouthfeel (*astringent, balanced, complex, fresh, long, round,*

and *supple*) sensations was selected. A pre-test was carried out to judge the relevance of the descriptors chosen to obtain the final questionnaire. The RATA questionnaire was created with the TopDegust software (IFV, France) and sent by email to each expert.

The instructions for the online questionnaire were the following:

"Imagine yourself tasting a red wine of the indicated appellation. I am going to ask you to describe this wine by checking off only the descriptors that, for you, best describe it. For each descriptor checked, I ask you to rate its intensity on a scale from 1 ("not very intense") to 5 ("very intense"). If you wish, you can also add other descriptors by checking the "Other descriptors" box. "

Four PDOs were included in the questionnaire: Beaujolais PDO, Beaujolais-Villages PDO, Morgon PDO and Moulin-à-Vent PDO, in addition to the Beaujolais Pierres Dorées PDO. As this study focused mainly on the Beaujolais Pierres Dorées PDO, the following presentation order was used for all experts: Beaujolais Pierres Dorées PDO, Beaujolais PDO, Beaujolais-Villages PDO, Morgon PDO and Moulin-à-Vent PDO.

3. Data analysis

Only descriptors with a frequency of more than 20 % of the panels of the three experts were kept. All descriptors, except for acid and bitter, met this criterion. The descriptors added by the wine experts to the RATA list were not considered because they were often used by only one wine expert. Next, the RATA data were analysed using analysis of variance ($\alpha = 5$ %). A 3-way mixed design ANOVA with judge nested in the type of expert as a random factor and type of expert and PDO as fixed factors (*J < type of expert > *PDO)* was carried out using the PROC GLM procedure of SAS 9.4 (SAS Institute, Cary NC). As the data were unbalanced, the type III Sum of square error was considered. Newman–Keuls pairwise comparisons were carried out when a significant effect was observed. The ANOVA was carried out on two dependent variables: frequency of use of descriptors and intensity score of descriptors.

RESULTS

1. Frequency of use of descriptors

Results showed a significant effect of PDO in the use of descriptors ($F(4,196) = 26.91$, $p < 0.0001$). The Newman–Keuls pairwise comparisons showed that globally more descriptors were checked to describe the two "Crus Beaujolais" PDOs, Moulin-à-Vent PDO (6.8 descriptors on average) and Morgon PDO (6.4 descriptors on average) than the Beaujolais PDO (4.8 descriptors on average) and Beaujolais Pierres Dorées PDO (4.6 descriptors on average). The number of descriptors checked to describe Beaujolais-Villages PDO was not significantly different from other PDOs, with an average of 5.7 descriptors. A main effect of the type of experts was also observed ($F(2,196) = 8.17$, $p < 0.001$). The Newman–Keuls pairwise comparisons showed that the Makers used significantly more descriptors (7.4 on average) than the other two types of experts: the Critics used 5.8 descriptors and the Sellers 3.8.

2. Intensity scores of descriptors

The ANOVA showed a significant main effect of PDO for 12 descriptors (Figure 1) and a significant main effect of type of experts for eight descriptors (Figure 2). A type of expert*PDO significant interaction was observed for four descriptors (Figure 3). The detailed results are presented in additional material (Additional table 1).

2.1 Main effect of PDO

Pairwise comparisons showed a separation between the regional PDOs (Beaujolais PDO, Beaujolais Pierres Dorées PDO and Beaujolais-Villages PDO) and the "Crus Beaujolais" PDOs (Morgon PDO and Moulin-à-Vent PDO). The regional PDOs were described as *sourer* ($p < 0.0001$), *fresher* ($p < 0.0001$), with more *strawberry* ($p < 0.0001$) and *raspberry* ($p < 0.0001$) aromas and were *suppler* ($p < 0.0001$) than the "Crus Beaujolais" PDOs.

On the contrary, the "Cru Beaujolais" PDOs were seen as more *astringent* ($p < 0.0001$), *woodier* ($p < 0.0001$), more *complex* ($p < 0.0001$), more *concentrated* ($p < 0.0001$), *spicier* ($p < 0.0001$) and *longer* ($p < 0.0001$) than the regional PDOs.

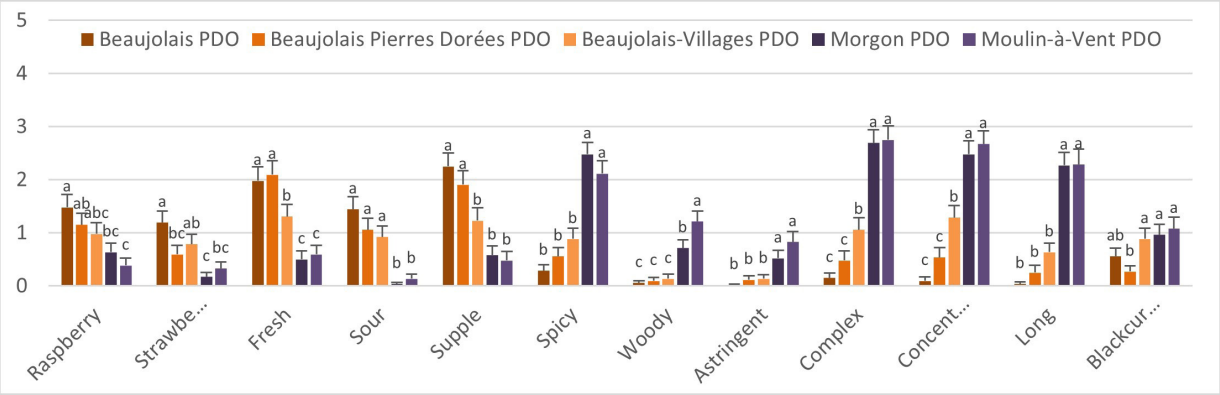


FIGURE 1. Results of the ANOVA for the 12 significant descriptors between all PDOs.

The separation between regional PDOs and "Crus Beaujolais" PDOs was not clearly identified for the descriptor *blackcurrant*. Results showed that the intensity of this descriptor was lower for the Beaujolais Pierres Dorées PDO than the Beaujolais-Villages PDO and the two "Crus Beaujolais" PDOs ($p < 0.005$).

Globally, the sensory profile of Beaujolais Pierres Dorées PDO was closer to the profile of the Beaujolais PDO than that of the crus PDOs. The pairwise comparison highlighted only a significant difference between Beaujolais Pierres Dorées and Beaujolais PDO for the descriptor: *strawberry* (Figure 1): the Beaujolais PDO wines received higher intensity scores (mean = 1.48) than the Beaujolais Pierres Dorées PDO ones (mean = 1.15).

2.2 Main effect of the type of experts and interaction between the type of experts and PDO

Figure 2 shows the main effect of the type of expert for the eight significant descriptors. Except for the descriptor *astringent*, pairwise comparisons showed lower intensity scores for the Sellers than for the two other groups of experts. The Makers gave higher intensity scores for *astringency*, *complex*, *concentrated*, and *long* than the Critics.

For the other descriptors, no difference was observed between Makers and Critics. This pattern of results, however, is modulated by the presence of significant interactions (Figure 3). The differences observed between types of experts for the descriptors *spicy*, *astringent*, and *long* hold only for the two "Crus Beaujolais." A significant interaction between the type of expert and PDO was also observed for the descriptor *woody,* which was higher for the Makers than for other experts but only for the Moulin-à-Vent Cru.

DISCUSSION

The objective of this study was to evaluate if wine experts had developed a sensory concept of Beaujolais Pierres Dorées PDO. Our hypothesis was that through experience with Beaujolais wines labelled with the mention "Pierres Dorées", wine experts might have derived a specific sensory representation of these wines (H1). Our results showed that for all groups of experts, the regional PDOs (Beaujolais PDO, Beaujolais Pierres Dorées PDO and Beaujolais-Villages PDO) were opposed to the Crus Beaujolais (Morgon PDO and Moulin-à-Vent PDO) both in terms of frequency of use and intensity of descriptors. This opposition concerned

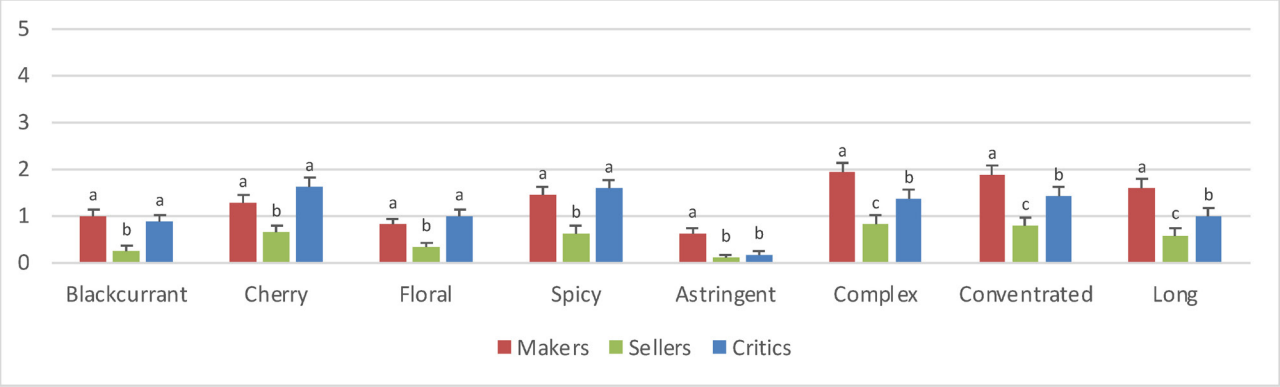


FIGURE 2. Results of the ANOVA for the eight significant descriptors between the three types of experts.

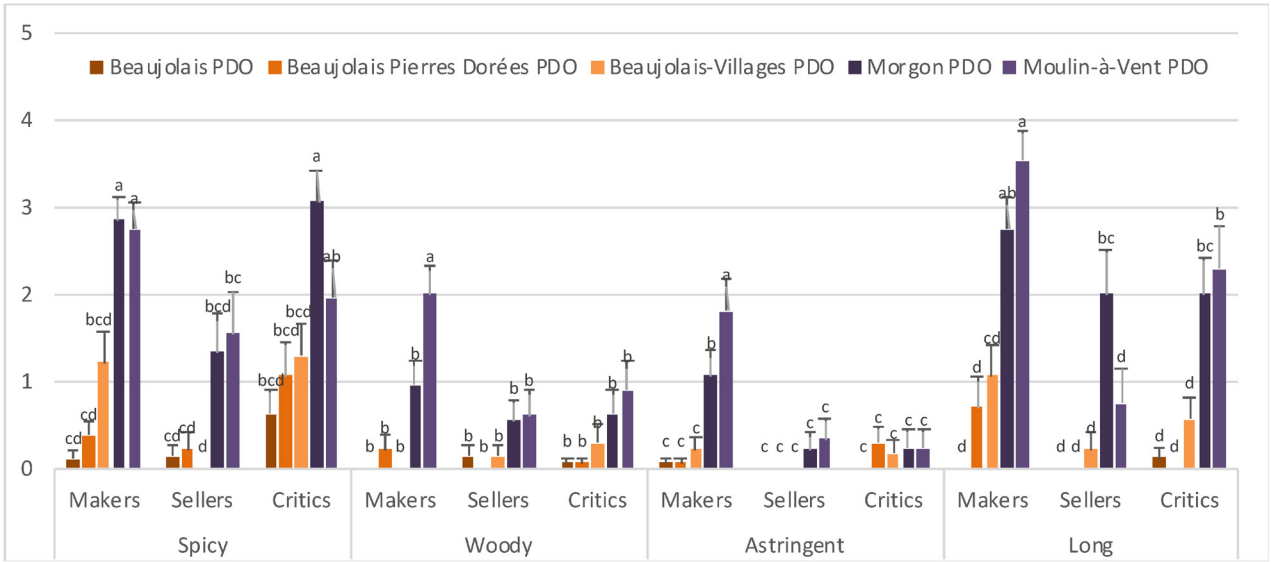


FIGURE 3. Results of the interaction type of experts*PDO.

not only the aromatic descriptors but also the structure and mouthfeel descriptors. This separation between regional PDOs and Cru Beaujolais PDOs suggests that all experts have developed a mental representation of the hierarchy of Beaujolais wines opposing regional and Cru PDOs based on descriptors such as *spicy*, *complex*, *concentrated*, and *long*, which have been previously associated with quality (Valentin *et al.,* 2016). On the other hand, no specific sensory terms seem to be associated with specific crus,

The new Beaujolais Pierres Dorées PDO was clearly differentiated from the Cru Beaujolais PDOs but not from the regional appellations. Only one descriptor (*strawberry*) was different between Beaujolais PDO and Beaujolais Pierres Dorées PDO. All experts agreed that Beaujolais Pierres Dorées PDO is associated with a wine that is less "*strawberry*" than the regional Beaujolais PDO. This could be related to the fact that Beaujolais Nouveau PDO wines, and by extension Beaujolais wines, are perceived as fruity with banana or strawberry aromas (Antalick *et al.,* 2014). In other words, the strawberry aroma may act as a symbol representing regional Beaujolais. The lower intensity of strawberries associated with Beaujolais Pierres Dorées PDO could be taken as a willingness to distinguish this new mention from regional Beaujolais wines. It could also reflect the quality upgrading marketing communication associated with the emergence of new appellations. In a previous study on winemakers' representation of Anjou-Villages Brissac PDO (premium wines) and regional Anjou Rouge PDO (Loire Valley, France), Cadot *et al.* (2012) also found that the difference between these two PDOs was based on two qualitative descriptors: *robustness* and *ripe fruits*. Our hypothesis H1 was, therefore, not validated since the experts did not develop a specific concept related to the Beaujolais Pierres Dorées PDO.

A second objective of this study was to evaluate the effect of training and experience on experts' sensory representation of Beaujolais wines. We expected that the Makers from the Beaujolais areas, more familiar with the new Beaujolais Pierres Dorées PDO (see Table 2), would have a clearer representation of these wines than the Sellers or the Critics (H2). Overall, the Makers used more descriptors than the two other types of experts to describe the PDOs. In their professional life, Makers perform, supervise, or give advice on all the stages of oenological practices in the Beaujolais vineyard. This familiarity results in increased knowledge about the product and a more detailed representation of its sensory properties (Alba and Hutchinson, 1987). The Makers, therefore, had a more precise representation of the Beaujolais PDOs in general because of their greater familiarity with these wines. By comparison, the Sellers used fewer descriptors to describe the five PDOs suggesting a less detailed mental representation of Beaujolais wines. Again, this might be linked to their daily practice. Most of the time, they must focus on the main characteristics of a wine to sell it or to recommend it to clients. To optimise their knowledge, rather than storing detailed representations as the Makers, they may have stored in memory wine prototypes (Brochet and Dubourdieu, 2001) of each PDO and associated these prototypes to a few "punchline descriptors ". Such sketchy representations would allow them to present the wines to their customers quickly. The Critics were in the middle, sometimes closer to the Makers and sometimes to the Sellers. They used "punchline descriptors" as the Sellers to describe the wines but also specific aroma descriptors as the Makers. In their profession, Critics need to highlight the descriptors that are most present in the wines but also other descriptors that are less salient to communicate their complete impression of the wines.

Although, as was already demonstrated by Otheguy *et al.* (2021) using a graphical elicitation task, Makers, Sellers, and Critics have different mental representations of Beaujolais wines, this does not include Beaujolais Pierres Dorées PDO wines. More specifically, contrary to what we expected, the more detailed sensory representation of Beaujolais wines developed by the Makers did not extend to the new Beaujolais Pierres Dorées PDO. This might be due either to a lack of experience with this new mention or to a lack of sensory signature of the actual Beaujolais Pierres Dorées PDO wines. To evaluate this last hypothesis, the same experts were asked to describe wines from Beaujolais Pierres Dorées PDO and Beaujolais PDO based on actual tasting sessions.

STUDY 2: SENSORY DESCRIPTION OF BEAUJOLAIS PIERRES DORÉES PDO

The aim of study 2 was to compare the sensory description of Beaujolais PDO and Beaujolais Pierres Dorées PDO wines obtained for the three types of experts. This study also investigated the information effect on the wine experts' descriptions.

MATERIALS AND METHODS

1. Participants

Seventy-three percent of the panel of study 1 have accepted to participate in study 2 (29 men and 9 women) with an average age of 51 years old. Among the 38 participants, 15 were wine makers, 12 were wine sellers, and 11 were wine writers. Experts' characteristics are reported in red in Table 2.

2. Wines

Two different red PDOs were used for this study: Beaujolais PDO and Beaujolais Pierres Dorées PDO. For each PDO, five wines were selected. As mentioned in the introduction, the selection of wines is a crucial step in PDO studies. To optimise the generalisability of our results, we used a randomisation strategy. First, a total of 10 commercial wines in each PDO were drawn at random from the harvest declaration for the 2018 vintage. A tasting selection was conducted to judge the wines and to eliminate those with potential defects (*e.g.*, oxidation, reduction, spoilage micro-organisms). A group of seven wine experts, composed of oenologists and wine technicians, from the Institut Français de la Vigne et du Vin (IFV) and SICAREX Beaujolais team

in Villefranche-sur-Saône was recruited. During this tasting, four wines were eliminated from the selection.

Next, a second random draw was carried out on the remaining wines to constitute two sets of five wines: Set A composed of five Beaujolais PDO wines and Set B composed of five Beaujolais Pierres Dorées PDO wines. Then, each bottle was repackaged in an inert, oxygen-free atmosphere into transparent 5cL Vinottes® samples to avoid wasting wine and to facilitate the procedure.

3. Procedure

This study was conducted individually, with each expert supervised by the same experimenter. All wine samples were tasted by an oenologist to ensure that the reconditioning did not cause any defects before each tasting session. Each expert participated in tastings following two conditions: first, a blind tasting without any information about the wines, and second an informed tasting with information about the PDO of each wine (Beaujolais PDO or Beaujolais Pierres Dorées PDO). The same RATA sensory questionnaire as for the imaginary study was used for the two tastings.

The wine samples were coded with a three-digit code, and each bottle was covered with a black sock. The wines were served at ambient temperature in black ISO glasses to focus only on aromatic and gustative descriptors. For each tasting, the ten wine samples from the two sets were randomly presented according to a Williams Latin square.

4. Data analysis

The same two dependent variables as in study 1 were used. All descriptors were kept as their frequency was higher than the 20 % threshold. As in the first study, the descriptors added by the wine experts to the RATA list were not considered as a single wine expert often used them. Next, the RATA data were analysed using analysis of variance ($\alpha = 5$ %). A 4-way mixed design ANOVA with judge nested in the type of expert and wine nested in PDO as random factors and type of expert, PDO and condition as fixed within-subject factors (*J < type of expert > *Wine < PDO > *Condition)* was conducted using the PROC MIXED procedure of SAS 9.4 (SAS Institute, Cary NC)). Newman–Keuls pairwise comparisons were conducted when significant effects were observed (alpha = 5 %). A Multiple Factor Analysis (MFA) was then carried out using the R statistical software version 4.0.3 for Windows (R Core Team, 2020) with the *FactoMineR* package (Lê *et al.,* 2008) to illustrate the influence of the information on wine tasting.

RESULTS

1. Frequency of use of descriptors

Results showed no significant difference in the use of descriptors between the two PDOs (5.59 descriptors on average for the Beaujolais PDO and 5.81 descriptors on average for the Beaujolais Pierres Dorées PDO). No significant effect of the type of experts was observed. The Makers used 6.10 descriptors on average, the Sellers 5.37, and the Critics 5.64. No significant difference in the use of descriptors was observed between the blind tasting condition (5.72 descriptors on average) and the informed tasting condition (5.68 descriptors on average).

2. Intensity scores of descriptors

Significant main effects were observed at the 5 % level for the PDO and the condition factors. These main effects are modulated by several significant interactions (PDO*condition, type of expert*condition and type of expert*condition*PDO). No significant main effect of expert type and no significant PDO*expert type interaction was observed. The detailed ANOVA results are presented in additional material (Additional table 2).

With regards to the PDO factor, the Beaujolais PDO was perceived as significantly less *bitter* and less *spicy* than the Beaujolais Pierres Dorées PDO. Concerning the condition effect, a significant effect was observed for the descriptor *bitter* with a higher intensity in the blind tasting than in the informed one. The effect of PDOs was modulated by the effect of the condition for two descriptors: *complex* and *vegetal* (Figure 4). In the informed tasting condition, the Beaujolais Pierres Dorées PDO was rated as more *complex* than the Beaujolais PDO. In the blind tasting condition, the Beaujolais Pierres Dorées PDO was more *vegetal*, while in the informed tasting, it was less *vegetal* than the Beaujolais PDO.

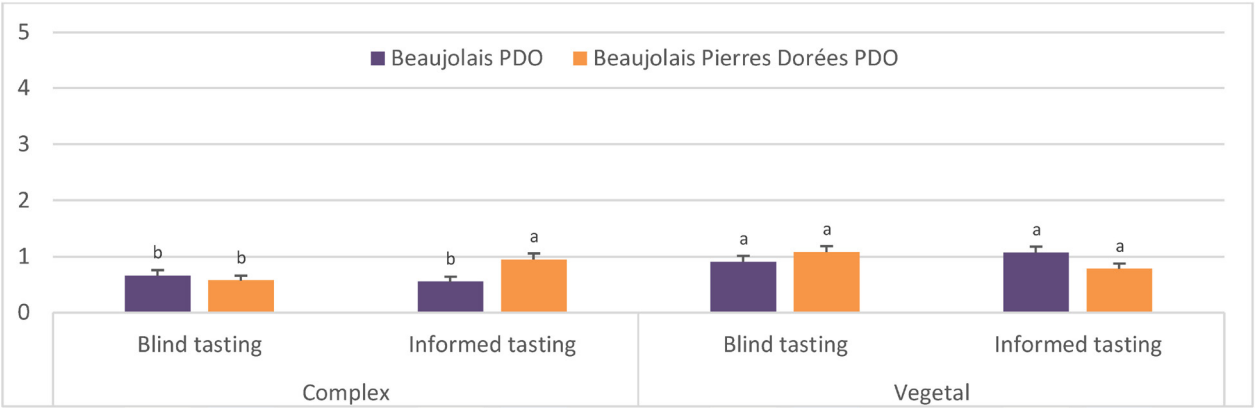


FIGURE 4. Results of the interaction PDO*Condition.

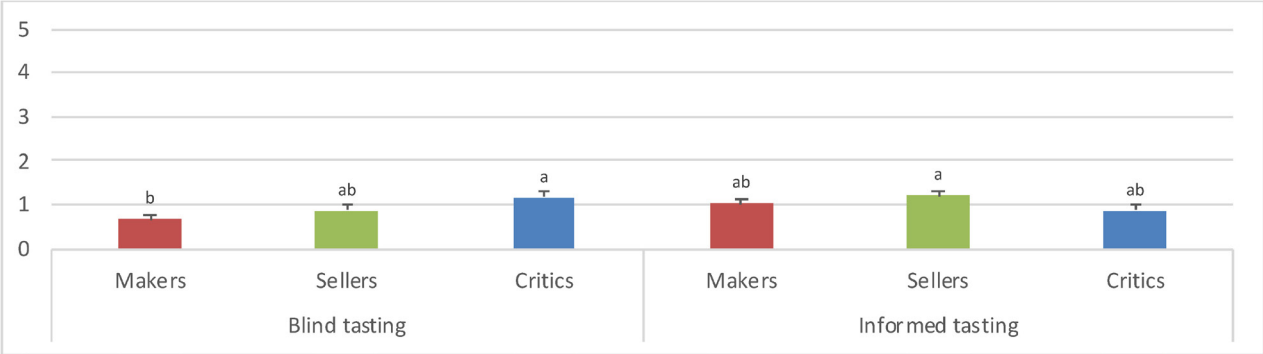


FIGURE 5. Results of the interaction type of experts*Condition for the descriptor Fresh.

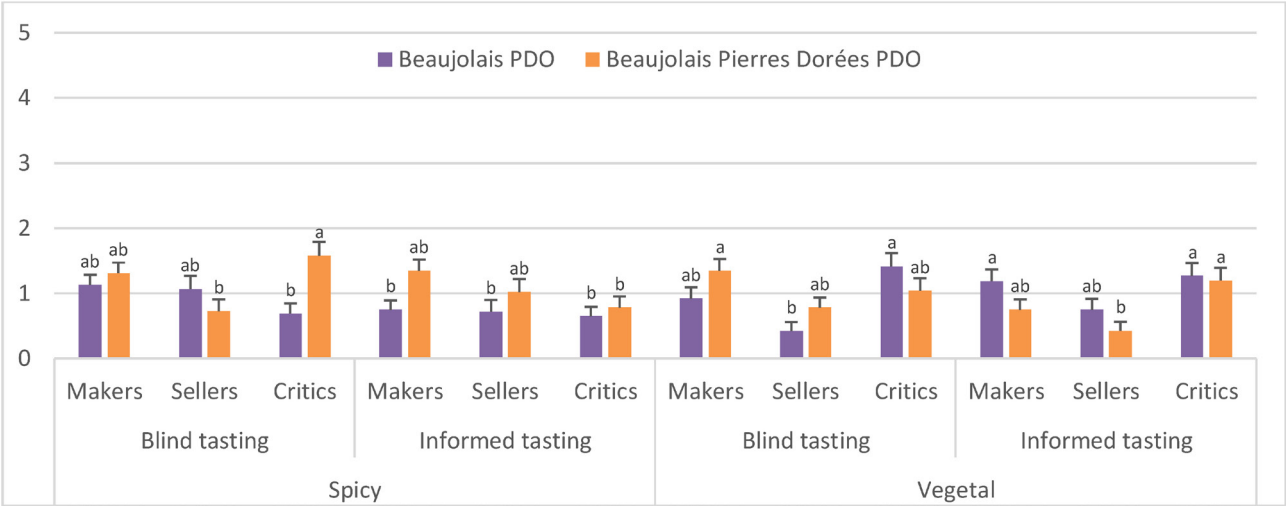


FIGURE 6. Results of the interaction type of experts*condition*PDO.

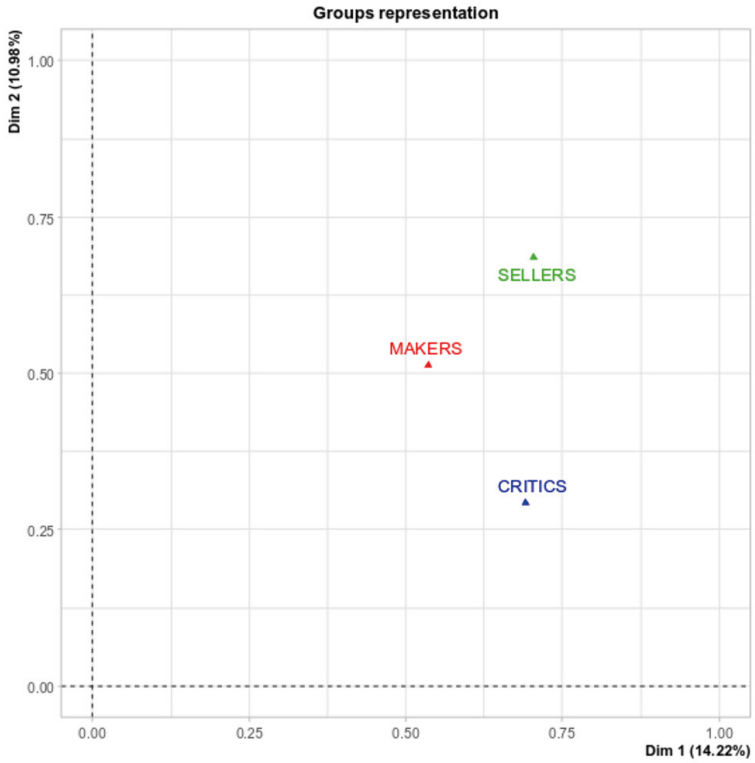


FIGURE 7. Projection of the three types of experts on the first two dimensions of the MFA.

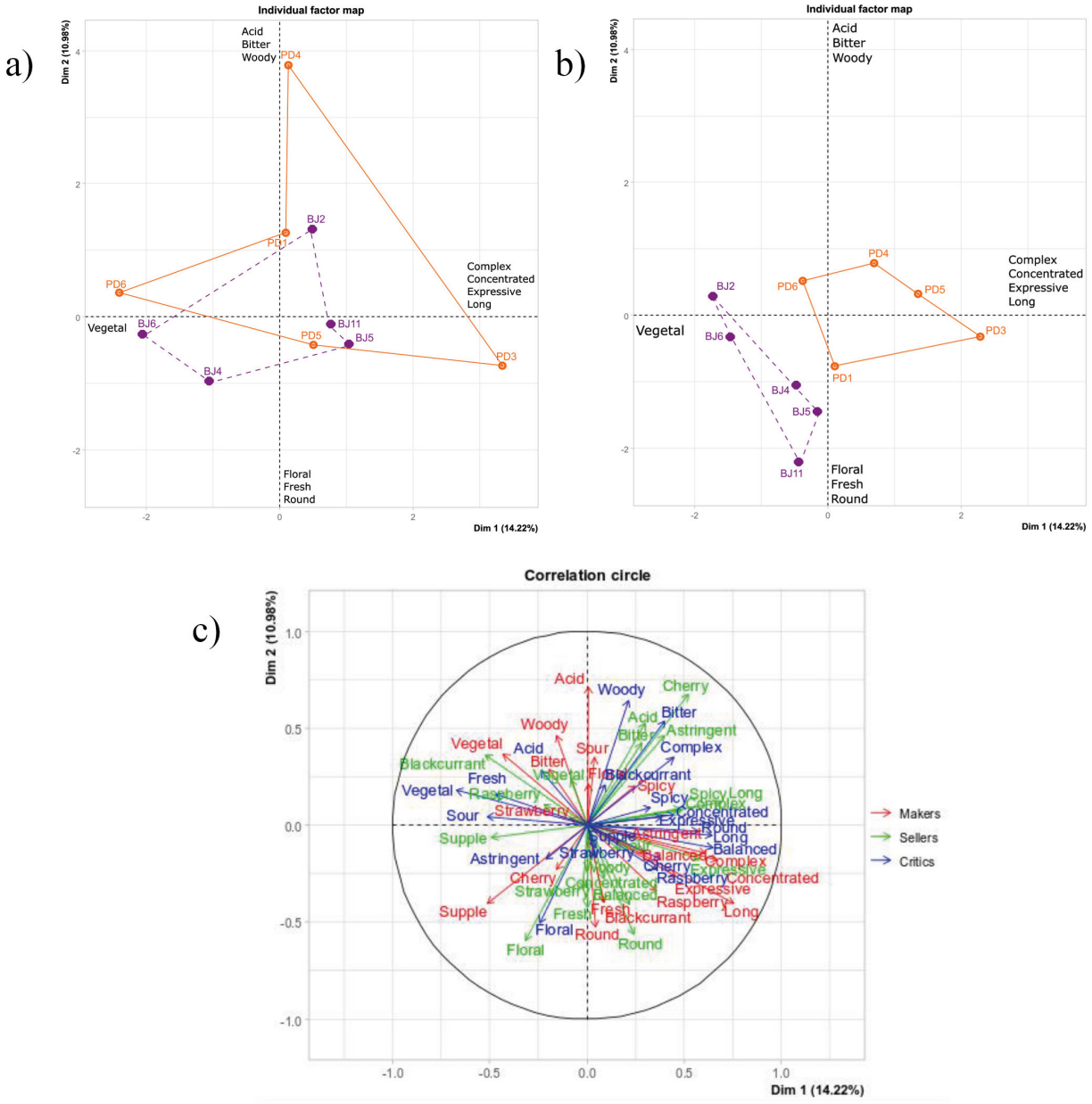


FIGURE 8. Results of the MFA: a) the blind tasting, b) the informed tasting and c) the correlation circle. In the individual factor map, Beaujolais PDO wines were represented by dotted purple lines and Beaujolais Pierres Dorées PDO wines by solid orange lines. The descriptors were added following the correlation circle analysis.

A significant type of expert*condition interaction was observed for the descriptor *fresh* (Figure 5). In the blind tasting condition, the Critics rated the wines fresher than the Makers, but in the informed tasting, no significant difference appeared between the three types of experts.

Finally, a type of expert*condition*PDO interaction was significant for the descriptors *spicy* and *vegetal* (Figure 6). The Critics judged the Beaujolais Pierres Dorées PDO spicier than the Beaujolais PDO in the blind tasting but not in the informed tasting. In addition, the Critics rated the Beaujolais Pierres Dorées spicier than the Sellers did in the blind condition. However, this difference disappeared in the informed tasting. In the blind tasting condition, the Sellers rated the Beaujolais PDO wines as less vegetal than the Critics, but in the informed tasting, this difference was found for the Beaujolais Pierres Dorées PDO.

3. Multiple Factor Analysis of RATA data

Although the first two dimensions explain only 25 % of the total variance, they provide interesting information regarding the variability of the sensory descriptions of the wine samples within each PDO. The remaining dimensions highlighted the same phenomenon but are not shown here. Figure 7 shows that globally the three groups of experts were consensual on the first dimension but less so on the second dimension, with a greater difference between the Sellers and the Critics.

Figure 8 highlighted that the first dimension (14.22 % of the variance) opposed the less qualitative descriptor *vegetal*

to the more qualitative descriptors *complex*, *concentrated*, *expressive*, and *long*. The second dimension (10.98 % of the variance) opposed the descriptors *floral*, *fresh*, and *round* to the descriptors *acid*, *bitter*, and *woody*. In the blind tasting condition, a large variability can be observed among the wines from the same PDO. Furthermore, the results showed that the two PDOs overlap. Providing information on the wine PDO decreased the difference between wines within each PDO and, thus, allowed a better separation between the two PDOs along the first dimension, with the Beaujolais Pierres Dorées PDO wines described as more *complex*, *concentrated*, *expressive*, and *long,* and the Beaujolais PDO wines described as more *vegetal*.

DISCUSSION

The objective of this second study was to compare the sensory description of Beaujolais PDO and Beaujolais Pierres Dorées PDO. We expected to have sensory characteristics specific to the new Beaujolais Pierres Dorées PDO, different from those of the Beaujolais PDO (H3). The results showed that the descriptions of the two PDOs were not different. The number of descriptors used by the experts to describe the wines was similar, and only two descriptors were different between the two PDOs: *bitter* and *spicy*. These results are reminiscent of the Perrin *et al.* (2008) study, which failed to demonstrate a PDO sensory signature of wines coming from the Loire Valley. Our initial hypothesis could, therefore, not be validated.

Given the experts' experience with Beaujolais Pierres Dorées PDO wines, we expected to observe differences between the descriptions obtained during the two tasting conditions (H4). Our results showed an effect of information on expert descriptions. First, Beaujolais Pierres Dorées PDO wines are described as more *complex*, *concentrated*, *expressive* and *long* and less *vegetal* than Beaujolais PDO wines. Therefore, PDO information has activated in memory descriptors prior to and/or during the tasting of each wine, in accordance with their quality expectation for Beaujolais Pierres Dorées PDO wines as observed in the first study. Second, providing information on the origin of the wines has decreased the variability between wines within the same appellation. This might result from assimilation and contrast phenomena (Tajfel and Wilkes, 1963). In the contrast phenomenon, judgments about the stimuli move away from the value of the anchor stimulus; in the assimilation phenomenon, they move toward that value. In our case, the phenomenon of assimilation has moved the description of the Beaujolais Pierres Dorées PDO towards a more qualitative description than the Beaujolais PDO. The phenomenon of contrast, on the other hand, enhanced the difference between Beaujolais and Beaujolais Pierres Dorées PDOs.

This study also aimed to compare the descriptions provided by the three types of experts. Because we assumed that the Makers were more familiar with the two PDOs than the two other types of experts, we expected them to differentiate Beaujolais better and Beaujolais Pierres Dorées PDO wines than the Sellers and the Critics. Experts' characteristics showed that, indeed, 67 % of the Makers had more than 20 years of tasting experience with Beaujolais wines, while only 33 % of the Sellers and 45 % of the Critics had such an experience. According to Alba and Hutchinson (1987), familiarity increases experts' ability to extract relevant information and generate accurate information. However, our results showed that greater familiarity with Beaujolais wines did not lead to differences in terms of the number of descriptors used and wine descriptions between the three types of experts. Our results diverge from a precedent study conducted with Beaujolais wines (Honoré-Chedozeau *et al.,* 2020). In this study, authors showed that familiarity played a role in the description of wines between experts, familiar consumers, and unfamiliar consumers. The authors concluded that familiarity with wines allowed panellists to describe wines in more precise and specific terms. The difference between the two studies may come from the difference in methodologies. In Honoré-Chedozeau *et al.* (2020), experts had to freely describe the wines, whereas, in the present study, they were constrained by a predefined list of vocabulary.

CONCLUSION

The main objective of these studies was to understand if the evolution of the PDO system has led to an evolution in wine sensory characteristics. Our results indicate that none of the expert groups developed a specific sensory concept of the Beaujolais Pierres Dorées PDO. The blind tasting also failed to reveal a specific sensory profile of the Beaujolais Pierres Dorées PDO. The similar grape variety and winemaking methods involved in Beaujolais and Beaujolais Pierres Dorées PDOs production could explain these results. However, the effect of the information demonstrated the presence of an expectation phenomenon related to the Beaujolais Pierres Dorées PDO. This phenomenon could come from the communication made around this new mention presenting it as a higher quality appellation in the process of upmarket. However, currently, no effect has been observed except in terms of experts' expectations. A methodology specifically based on quality evaluation could be used in future work to evaluate this aspect better. Our study showed that the definition of a specific geographical area alone was not sufficient to obtain a specific sensory description of an appellation. Some modifications of viticultural techniques, such as yield or production methods and maturation, could be implemented to differentiate the Beaujolais and Beaujolais Pierres Dorées PDO wines.

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REFERENCES

Alba, J. W., & Hutchinson, J. W. (1987). Dimensions of Consumer Expertise. *Journal of Consumer Research*, 13(4), 411-454. https://doi.org/10.1086/209080

Antalick, G., Perello, M.-C., & de Revel, G. (2014). Esters in Wines: New Insight through the Establishment of a Database of French Wines. *American Journal of Enology and Viticulture*, 65(3), 293-304. https://doi.org/10.5344/ajev.2014.13133

Ares, G., Bruzzone, F., Vidal, L., Cadena, R. S., Giménez, A., Pineau, B., Hunter, D. C., Paisley, A. G., & Jaeger, S. R. (2014). Evaluation of a rating-based variant of check-all-that-apply questions: Rate-all-that-apply (RATA). *Food Quality and Preference*, 36, 87-95. https://doi.org/10.1016/j.foodqual.2014.03.006

Brochet, F., & Dubourdieu, D. (2001). Wine Descriptive Language Supports Cognitive Specificity of Chemical Senses. *Brain and Language*, 77(2), 187-196. https://doi.org/10.1006/brln.2000.2428

Cadot, Y., Caillé, S., Thiollet-Scholtus, M., Samson, A., Barbeau, G., & Cheynier, V. (2012). Characterisation of typicality for wines related to terroir by conceptual and by perceptual representations. An application to red wines from the Loire Valley. *Food Quality and Preference*, 24(1), 48-58. https://doi.org/10.1016/j.foodqual.2011.08.012

Commission Delegated Regulation (EU) 2019/33 (2018). Supplementing Regulation (EU) No 1308/2013 of the European Parliament and of the Council as regards applications for protection of designations of origin, geographical indications and traditional terms in the wine sector, the objection procedure, restrictions of use, amendments to product specifications, cancellation of protection, and labelling and presentation, 009 OJ L (2018). http://data.europa.eu/eli/reg_del/2019/33/oj/eng

Geffroy, O., Buissière, C., Lempereur, V., & Chatelet, B. (2016). A sensory, chemical and consumer study of the peppery typicality of French gamay wines from cool-climate vineyards. *OENO One*, 50(1), 35-47. https://doi.org/10.20870/oeno-one.2016.50.1.53

Hinnewinkel, J.-C. (2004). Les Terroirs Viticoles : Origines et Devenirs. Féret.

Honoré-Chedozeau, C., Chollet, S., Lelièvre-Desmas, M., Ballester, J., & Valentin, D. (2020). From perceptual to conceptual categorization of wines: What is the effect of expertise? *Food Quality and Preference*, 80, 103806. https://doi.org/10.1016/j.foodqual.2019.103806

Hughson, A. L., & Boakes, R. A. (2002). The knowing nose: The role of knowledge in wine expertise. *Food Quality and Preference*, 13(7-8), 463-472. https://doi.org/10.1016/S0950-3293(02)00051-4

Johnson, T. E., Hasted, A., Ristic, R., & Bastian, S. E. P. (2013). Multidimensional scaling (MDS), cluster and descriptive analyses provide preliminary insights into Australian Shiraz wine regional characteristics. *Food Quality and Preference*, 29(2), 174-185. https://doi.org/10.1016/j.foodqual.2013.03.010

Jose-Coutinho, A., Avila, P., & Ricardo-Da-Silva, J. M. (2015). Sensory Profile of Portuguese White Wines Using Long-Term Memory: A Novel Nationwide Approach. *Journal of Sensory Studies*, 30(5), 381-394. https://doi.org/10.1111/joss.12165

Kustos, M., Gambetta, J. M., Jeffery, D. W., Heymann, H., Goodman, S., & Bastian, S. E. P. (2020). A matter of place: Sensory and chemical characterisation of fine Australian Chardonnay and Shiraz wines of provenance. *Food Research International*, 130, 108903. https://doi.org/10.1016/j.foodres.2019.108903

Lawrence, G., Symoneaux, R., Maitre, I., Brossaud, F., Maestrojuan, M., & Mehinagic, E. (2013). Using the free comments method for sensory characterisation of Cabernet Franc wines: Comparison with classical profiling in a professional context. *Food Quality and Preference*, 30(2), 145-155. https://doi.org/10.1016/j.foodqual.2013.04.005

Lê, S., Josse, J., & Husson, F. (2008). FactoMineR: An R Package for Multivariate Analysis. *Journal of Statistical Software*, 25, 1-18. https://doi.org/10.18637/jss.v025.i01

Legouy, F., & Dallot, S. (2019). Les AOC en France des débuts à nos jours : La complexité d'une construction dans l'espace et dans le temps. Mappemonde. *Revue trimestrielle sur l'image géographique et les formes du territoire*, 125, Article 125. https://doi.org/10.4000/mappemonde.805

Leriche, C., Molinier, C., Caillé, S., Razungles, A., Symoneaux, R., & Coulon-Leroy, C. (2020). Development of a methodology to study typicity of PDO wines with professionals of the wine sector. *Journal of the Science of Food and Agriculture*, 100(10), 3866-3877. https://doi.org/10.1002/jsfa.10428

Otheguy, M., Honoré-Chedozeau, C., & Valentin, D. (2021). Do wine experts share the same mental representation? A drawing elicitation study with wine makers, sellers, and critics. *Food Quality and Preference*, 94, 104302. https://doi.org/10.1016/j.foodqual.2021.104302

Perrin, L., Symoneaux, R., Maître, I., Asselin, C., Jourjon, F., & Pagès, J. (2008). Comparison of three sensory methods for use with the Napping® procedure: Case of ten wines from Loire valley. *Food Quality and Preference*, 19(1), 1-11. https://doi.org/10.1016/j.foodqual.2007.06.005

Quijada-Morín, N., Williams, P., Rivas-Gonzalo, J. C., Doco, T., & Escribano-Bailón, M. T. (2014). Polyphenolic, polysaccharide and oligosaccharide composition of Tempranillo red wines and their relationship with the perceived astringency. *Food Chemistry*, 154, 44-51. https://doi.org/10.1016/j.foodchem.2013.12.101

Ríos-Reina, R., Callejón, R. M., Savorani, F., Amigo, J. M., & Cocchi, M. (2019). Data fusion approaches in spectroscopic characterization and classification of PDO wine vinegars. *Talanta*, 198, 560-572. https://doi.org/10.1016/j.talanta.2019.01.100

Solomon, G. E. A. (1997). Conceptual Change and Wine Expertise. *Journal of the Learning Sciences*, 6(1), 41-60. https://doi.org/10.1207/s15327809jls0601_3

Souza-Gonzaga, L., Capone, D. L., Bastian, S. E. P., Danner, L., & Jeffery, D. W. (2019). Using Content Analysis to Characterise the Sensory Typicity and Quality Judgements of Australian Cabernet Sauvignon Wines. *Foods*, 8(12), 691. https://doi.org/10.3390/foods8120691

Tajfel, H., & Wilkes, A. L. (1963). Classification and quantitative judgment. *British Journal of Psychology*, 54(2), 101-114. https://doi.org/10.1111/j.2044-8295.1963.tb00865.x

Thiollet-Scholtus, M., Caillé, S., Samson, A., Lambert, J.-J., & Morlat, R. (2014). Use of Production Practices and Sensory Attributes to Characterize Loire Valley Red Wines. *American Journal of Enology and Viticulture*, 65(1), 50-58. https://doi.org/10.5344/ajev.2013.12141

Urdapilleta, I., & Manetta, C. (2011). Le monde des odeurs : De la perception à la représentation. (L'HARMATAN, Éd.). L'Harmattan.

Valentin, D., Parr, W. V., Peyron, D., Grose, C., & Ballester, J. (2016). Colour as a driver of Pinot noir wine quality judgments: An investigation involving French and New Zealand wine professionals. *Food Quality and Preference*, 48, 251-261. https://doi.org/10.1016/j.foodqual.2015.10.003.