From a local to an international scale: sensory benchmarking of PDO wines. 'Sauvignon blanc' wines as a case study (France).

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Abstract

The knowledge of how wines are positioned on the local, national or international market from a sensory point of view can be useful to highlight terroir specificities and to develop a collective marketing strategy. We focus on the case of Sauvignon blanc wines and two closely located Loire Valley PDO's (France). Three distinct tastings were organized: firstly, at the local level comparing the 2 PDO's; secondly, at a regional level adding 3 other PDO's and thirdly at an international level comparing these 5 PDO's with Sauvignon Blanc wines coming from South Africa, New Zealand and Chile. A sensory descriptive analysis was performed using an aroma wheel combining with a Check-All-That-Apply methodology. The aim was to facilitate data acquisition in a professional context without common training, to consider the hierarchical relationships among the attributes during the data analysis and to be able to characterize wines with a large range of sensorial variability. We use univariate, multivariate and clustering analyses. Similarities and differences between the 2 PDO and other Sauvignon blanc wines were identified. Specific attributes distinguished the two PDO's and different proximities existed with other local PDO's, while clear differences were observed compared to international wines.

Introduction

In a collective marketing strategy, the Protected Designation of Origin (PDO) can be used as a quality indicator. To highlight terroir specificities, it is useful to know how the wines are positioned on the local, national or international market from a sensory point of view. This is especially true for a comparison of varietal wines (e.g. Sauvignon blanc).

Wine aromatic characterization is a complex task even for well-trained assessors. Quantitative descriptive analysis (QDA) by a trained panel is often considered to be the method of reference for assessing the sensory characteristics associated with a product (Sidel, 2004). However, this method is both time-consuming and expensive due to the amount of training it requires. There is thus an ongoing search for alternative methods of sensory analysis that are easy, fast, and cost-effective (Lesschaeve and Noble, 2022). In recent years, sensory characterization has become increasingly oriented towards consumers (Ares & Varela, 2017) and several methods have been developed for use with non-specialist panels, such as Check-All-That-Apply (CATA) (Meyners et al., 2013; Vidal et al., 2018). To facilitate the training of the assessors and the aromatic characterization, aroma terms are typically arranged in some sort of hierarchical structure, such as aroma wheels. However, information about this structure is lost with existing methods of data acquisition and data treatment.

We performed a sensory descriptive analysis using an aroma wheel allowing to combine a Check-All-That-Apply methodology, often used in sensory benchmarking, with a hierarchical structuration of the attributes. The aim is to facilitate data acquisition in a professional context without common training, to consider the hierarchical relationships among the attributes during the data analysis and to be able to characterize wines with a large range of sensorial variability.

Materials and methods

Data acquisition, samples and assessors

We focus on the case of two closed Loire Valley PDO (France): PDO A and PDO B. Three distinct tastings were organized. Firstly, *tasting 1*, at the local level comparing the 2 PDO (11 and 9 wines, 17 professional assessors); secondly, *tasting 2*, at a regional level adding 3 closed PDO: C, D and E (3 wines per PDO, 16 assessors) and thirdly, *tasting 3*, at an international level comparing these 5 PDO with Sauvignon Blanc wines coming from South Africa, New Zealand and Chile (1 to 3 wines per PDO, 19 assessors). All the wines were from the 2019 vintage and were considered to have a traditional elaboration process without contact with oak. All the assessors are winemakers, producing PDO A and/or PDO B.

A sensory descriptive analysis was performed using an aroma wheel allowing to combine a Check-All-That-Apply methodology. Attributes used for the aromatic description of wines were arranged according to the hierarchical structure presented on Table 1. Our previous studies showed that patterns of semantic categorization of wine aromas did not depend on the level of expertise of the subjects, it can be used for the development of a common lexicon for consumers and professionals (Koenig et al., 2020). These attributes were selected and hierarchically structured according to the results of Koenig et al. (2021). Here, the term 'family' is used for more general attributes (e.g., 'fruity'), 'category' refers to intermediate attributes (e.g., 'red fruit' or 'white/yellow fruit'), and 'terms' are the more specific attributes (e.g., 'blackcurrant', 'cherry', or 'apricot'). The assessors were instructed to select all attributes that corresponded to aromas perceived in the wine. Thus, if an assessor specifically recognized the aroma of 'lemon', s/he could select it. If assessors only perceived a fruity aroma, without a specific identity, they could select the attribute 'fruity'.

Table 1. Attributes used for the olfactory description of wines were arranged according to a hierarchical structure (according to Koenig et al., 2020)

CATA attributes		
FAMILY	Category	*Term*
FRUITY	Red fruit	blackcurrant – cherry – strawberry – raspberry - ripe red fruit - black fruit – redcurrant – blackberry – blueberry - red grape
	White/yellow fruit	apricot - stone fruit - white fruit - yellow fruit - melon - peach - pear - apple - quince
	Citrus	lemon - lime - orange - grapefruit
	Tropical fruit	pineapple - passion fruit - lychee - mango
	Amylic	
FLORAL	Floral	acacia - orange blossom - jasmine - lilac – rose – violette - chamomile
SPICY	Mentholated	licorice - anise - mint
	Spice	clove - pepper
VEGETAL	Aromatic plant	laurel - tea - thyme
	Vegetal	grass - cut grass - green pepper – green - asparagus
ROASTED	Lactic	butter - yeast
	Dried grass	hay - tobacco
	Burned	smoke - broiled - toasted bread – toasted brioche
MINERAL	Mineral	flint – flintstone
CHEMICAL	Chemical	alcohol - rubber - nail polish remover - oil - sulfur - vinegar
UNDERGROWTH	Animal	sweat - leather
	Woody	oak - cork - pine
	Earthy	mushroom - cork - musty - undergrowth - truffle - dust
SWEET	Sweet	caramel – honey – vanilla – lactic - butter
	Dried fruit	dried apricot – almond – hazelnut - walnut

At the local scale, a complementary task was performed: for each samples the assessors had to say whether it was the PDO A, PDO B or 'unidentified', in order to evaluate if a typicity of the PDO was identified.
Color and flavor attributes were also rated by the assessors, using quantitative scales, but these data are not presented here. All data were collected using FIZZ software (Biosystèmes®, 1990). Families and categories were presented as tabs and the attributes belonging to each family (or category) were listed in a corresponding tab. In addition, the full hierarchical structure of the attributes was presented to the subjects on a paper sheet so they could have an overall view of the attributes and their structuration.

Data treatment

Compared to conventional CATA data, our Hierarchical Check-All-That-Apply (HCATA) dataset was composed of a larger number of attributes (122, comprising 83 terms, 20 categories, and 9 families), of which only a few were likely to be selected. Consequently, our HCATA dataset contained a much larger proportion of non-evaluated data than what is usually encountered with CATA. Nevertheless, sample discrimination can be similar for short and long CATA list (Jaeger et al., 2015). To address this, an initial coding step was performed and the statistical techniques usually applied to CATA data (Meyners et al., 2013) were adapted to this specific data configuration.
HCATA data were collected in a *product x attribute* data table for each subject. At this stage, the data array included all the attributes selected, regardless of their nature, i.e. without considering the hierarchical structure. In a first step, to incorporate the hierarchical structure of the attributes, a coding step was used to aggregate information from the lower hierarchical levels to the higher ones. The hierarchical structure of the data was accounted for using the following rules: (1) If an assessor checks a category or a term, then the check provided to the category is imputed to the family to which it belongs. (2) If an assessor checks a term, then the check provided to the term is imputed to both the category and the family to which it belongs. In this way, a *product x attribute* data table was computed for each assessor that represented the hierarchical structure of the aroma terms used in the evaluation.
In a second step, using Cochran's Q test, it was established if the assessors had detected significant differences between samples for each attribute. The significant attributes were selected considering a P-value lower than 0.20 and only attributes used by at least 5 assessors for a wine were taking into account. For *tasting 1*, a Fisher's exact test was performed on average citation frequencies for each PDO to evaluate the attributes that can differentiate the two PDOs.
In a third step, CATATIS method was used to avoid the impact of atypical assessor (Liobell et al., 2019). A consensus configuration that reflects at best the different assessors is formed and is projected on different axes by a Factorial Correspondance Analysis (FCA). A Hierarchical Ascendant Classification (HAC) was performed on the factors of the FCA to evaluate the proximity between the wines.

Results and discussion

We choose here not to present all the results in an exhaustive way but to focus on some.

Local scale: aromatic resemblances and differences are identified between the two closed Loire Valley PDO.

The 8 most cited attributes do not discriminate the two PDOs (Fisher's exact test, p-values <0.05): FRUITY, White/yellow fruit, SWEET, Citrus, Dried fruit, Floral, *Acacia*, ROASTED. They allow us to identify a family resemblance. The differences in citation frequency are significant for 24 attributes. Among these 24 attributes, we can count: 2 families (CHEMICAL PDO A > PDO B, UNDERGROWTH PDO A < B), 4 categories (Tropical fruit PDO A < PDO B, Roasted PDO A < PDO B, Sweet PDO A < PDO B and Woody PDO A < PDO B) and 18 terms (the 5 most cited being: *grapefruit* PDO A > PDO B, *almond* PDO A > PDO B, *orange blossom* PDO A > PDO B, *dried apricot* PDO A > PDO B and *jasmine* PDO A < PDO B). It appears that some of the terms are significant but not often cited, however it is interesting to have a large enough list to have precise differentiating attributes.
Concerning the question of typicity, the assessors recognized in a significant way (Khi2 test, p-value <0.05) the PDO A (119 'right PDO'; 54 'wrong PDO', 14 'unidentified') unlike the other PDO B (60 'right PDO'; 75 'wrong PDO', 18 'unidentified'). Even if, the panel of assessors was mainly composed by winemakers producing the two PDO, it was easier for them to identify the wines of the PDO A. As in Coulon-Leroy et al. (2018), it would have been interesting to identify the descriptors linked to the typicity and leading the tasters not to make mistakes in the identification of the PDO, the dataset which was not built for this purpose does not allow this analysis.

Regional scale: focusing on aromatic perception, the PDO are not clearly distinguishable

Only 6 attributes are cited at least 5 times for a wine and allow to discriminate the wines: *white fruit*, Tropical fruit, Sweet, *mint*, ROASTED, Lactic. All wines are mostly quoted as fruity. With only 3 wines per PDO, it appears that the variability between the wines of a given PDO can be as strong as that between the PDOs.

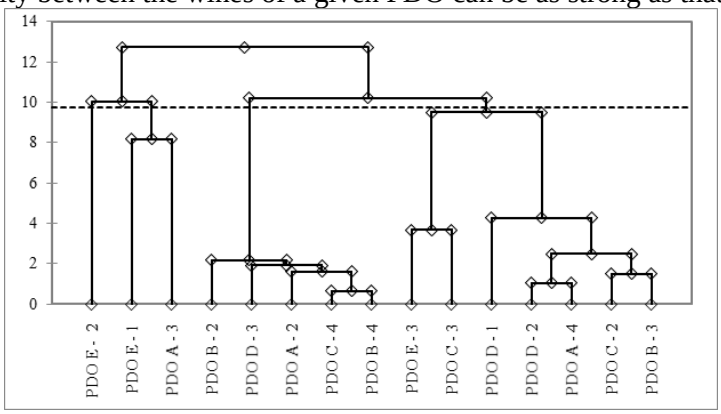

Figure 1. Hierarchical Ascendant Classification on factors (5 dimensions) of the Correspondance Analysis (according to CATATIS methodology (Llobell et al., 2019))

International scale: The Sauvignon blanc wines of the Loire and those of other countries are significantly different

Two clusters are easily identifiable on Figure 2, the Sauvignon blanc wines of the Loire valley are less 'vegetal' and 'roasted' and more 'fruity' (with white and yellow fruit aromas). Fruity and green characters are reported as salient to Sauvignon blanc's aromatic profile due to thiol and methoxypyrazine compounds (Green at al., 2011). Various studies have shown that aromatic profiles of Sauvignon blanc are influenced by wine source-of-origin (e.g. Green et al., 2011; Parr et al., 2013). It appears that the aromatic compounds are different depending on the practices and viticultural conditions (e.g. Parr et al., 2013) but no study had been done on the PDO considered in this study at the local level. In addition to scientific knowledge, a better definition of the identity of the wines of each PDO and a better knowledge of those of other terroirs all over the world can allow the producers of PDO to better promote the specificities of their wines.

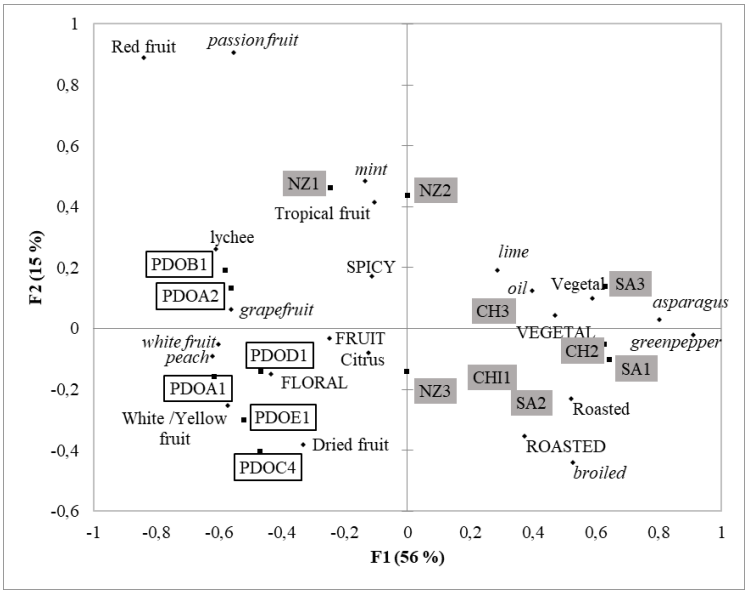

Figure 2. Factorial Correspondance Analysis (CATA) of the wines samples and sensory attributes at the international scale (NZ: New-zealand, CH: Chile, SA: South Africa)

Conclusion

Our study contributes to propose and discuss a method to do a wine sensory benchmarking highlighting sensory specificities linked to origin. When the work is carried out with professionals, the number of wines had to be reduced to limit the duration of the tastings. It would be relevant to cross-check the results with an expert panel, the complementarity of the two panels has already been confirmed (e.g. Coulon-Leroy et al., 2018). Thanks to this work we confirm the relevance of using nested scales for the sensory characterization and considering the hierarchical relationships among the attributes. Similarities and differences between the 2 PDO wines and other Sauvignon blanc wines were identified. Specific attributes can distinguish the two PDO and different proximities exist with other local PDO, while clear differences were observed compared to international wines.

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