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SPECIAL ISSUE

No major impact of new grape varieties on Bordeaux wine typicity: expert assessments in blind and non-blind tastings

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ABSTRACT

Climate change induces major changes in wine typicity due to its impact on berry composition at harvest. This is of great concern for winegrowing regions historically renowned for their terroir and quality potential. Among different levers to adapt to climate change, the modification of grape varieties is considered to be very effective. However, this powerful tool can have repercussions for the protection of the region of origin's wine typicity. In Bordeaux (France), a considerable research effort addresses the physiological traits of new varieties to thrive in a climate becoming increasingly dry and warm. Recently, a study investigating the typicity of 26 red varieties isolated five potential candidates (Fer Servadou, Duras, Manseng noir, Vinhão and Arinarnoa) sharing similar sensorial spaces compared to classical Bordeaux varieties. Varietal mix is strictly regulated by protected denomination of origin (PDO) rules, although these can change over time. If new varieties were to be accepted in the Bordeaux varietal mix, it would most likely be as secondary varieties accounting for a small proportion in the final Bordeaux blend. This study aimed to assess the impact of the five abovementioned varieties when incorporated into a classical Bordeaux blend (*i.e.*, Cabernet-Sauvignon, Merlot, Cabernet franc and Petit Verdot), at a proportion of 10 % and 30 % respectively. Two sensory analysis tests were conducted within a two-month period. The first one, which included 37 professional judges, showed that Bordeaux wine typicity barely changed when these varieties were introduced at 10 % or 30 %, except for Vinhão that underwent a slight typicity decrease. The second sensory analysis test was conducted by 20 highly professional judges with an exceptional degree of expertise (> 15 years of experience), especially in blending. Assessing the wines through both blind and non-blind tastings (indication of the varieties present in the blend), the importance of the information on the typicity judgment was assessed. No significant differences were recorded between non-blind and blind tastings, showing that the perceptual judgement of the highly-experienced professionals was not influenced by the introduction of the new varieties to the classical blend. By means of ranking tests, this sensory analysis also showed that the Bordeaux reference blend was the most typical of the wines. Duras and Arinarnoa at 10 or 30 % had a non-significant effect on the blend's typicity, while a significant decrease of typicity was observed when Fer Servadou (at 10 % or 30 %), Manseng noir (at 30 %) or Vinhão (at 30 %) were introduced to the Bordeaux reference blend. This shift of typicity only occurs, however, on a tight continuum of less to more typical wines.

INTRODUCTION

Blending wine is a very common and historical practice in winemaking. It takes place at different stages of the process: either during fermentation (referred to as the "co-fermenting" practice) or when fermentation is completed before or after ageing. Blended wines can be sourced from different grapevine varieties (as in Bordeaux wines, France), different terroirs (as in the Northern Rhône Valley, France), different vintages (the so-called "soleras" in Jerez, Spain), different colours (as practiced for rosé champagne, France) or different sugar levels (as in Tokaji, Hungary) (Johnson, 2013).

One of the first studies regarding blending wines and its impact on their sensorial profiles, concluded that blended wines always scored better than the lowest scoring wine on its own, indicating that blending may increase the complexity of the final wine (Singleton & Ough, 1962). This increase in complexity, and thus quality (as an increase in complexity is very likely to increase perceived quality (Singleton & Ough, 1962; Charters & Pettigrew, 2007)), is a widely-accepted concept, which acknowledges the benefit of blending in wine production (Hopfer *et al.*, 2012), including co-fermentation (García-Carpintero *et al.*, 2010; Song *et al.*, 2022).

Regarding blending finished wines, in particular with different varieties, the findings of Singleton & Ough (1962) have not always been confirmed. Indeed, a number of authors have not found blended wines to be more complex than base wines (with Cabernet-Sauvignon, Merlot and Cabernet franc) (Wang & Spence, 2019), while others have found an increase in wine quality when white Malvasia Istriana was blended with Chardonnay, Sauvignon blanc and Pinot blanc, but not when blended with Muscat (Kovačević Ganić *et al.*, 2003). This is coherent, as blending wines with strong attributes can have an amplifying or suppressing effect on those attributes in the final wine (Dooley *et al.*, 2012; Hopfer *et al.*, 2012), and Muscat is known for its very expressive aroma.

Most research on wine blending has focused on chemical changes in the final wines (Kovačević Ganić *et al.*, 2003; Monagas *et al.*, 2006a; Dooley *et al.*, 2012; Hopfer *et al.*, 2012; Longo *et al.*, 2018; Ling *et al.*, 2021). All these studies have agreed that classical oenological parameters (titratable acidity, organic acids and alcohol content) in the final wine are proportional to their content in the initial wines multiplied by the relative proportion of each wine in the blend (*i.e.*, blending two wines with low and high alcohol content respectively will result in a blend with a medium alcohol content) (Singleton & Ough, 1962; Hopfer *et al.*, 2012).

Regarding colour and most phenolic compounds, a significant blending effect has been found when varieties were added to a base wine (at varying proportions and different ageing times) (Monagas *et al.*, 2006a; Monagas *et al.*, 2006b; Escudero-Gilete *et al.*, 2010; Cáceres-Mella *et al.*, 2014). However, the evolution of phenolic compound concentration from base wine to blended wine is not linear, as chemical reactions can occur between these compounds (Hopfer *et al.*, 2012).

Similarly, the sensory aromatic perception of blended wines is different to that of base wines (Datta & Nakai, 1992; Kovačević Ganić *et al.*, 2003; Hopfer *et al.*, 2012; Hjelmeland *et al.*, 2013). However, the aromatic composition of the final wine is never proportional to that of the base wines. No clear relationship has been established between the aromatic composition of the wines and the sensorial profiles of the wines in the cited studies. For instance, in one study, Cabernet franc was supplemented with Cabernet-Sauvignon with higher levels of 2-isobutyl-3-methoxypyrazine; surprisingly, the blended wine was found to be significantly less "green" than the base wine (Ling *et al.*, 2021).

This very complex topic of blending wines to obtain a target product has been tackled using different machine-learning or computer-aided tools and taking into account aromatic composition or sensory profiles via a neural network (Datta & Nakai, 1992). Because blending wines can also have logistical implications for wineries, a mathematic tool has been created to help winemakers organise their blending sessions (Vismara *et al.*, 2013).

Among the few studies that have analysed the effect of blending wines on the final sensorial wine profile, none have addressed the impact of blending on wine typicity. This is surprising, as typicity is of importance within the wine production sector (Souza Gonzaga *et al.*, 2021), being positively correlated to the consumers' willingness-to-pay (Luomala, 2007).

Our research focused on the impact on wine typicity and wine sensorial profiles of a classical Bordeaux blend (30 % Cabernet-Sauvignon, 30 % Cabernet franc, 30 % Merlot and 10 % Petit Verdot) when blended with five non-autochtonous red varieties that had previously been found to share similar sensorial spaces to classical Bordeaux varieties (Plantevin *et al.*, 2024). By adding 10 % and 30 % of each of the five varieties to the classical blend, 11 blended wines (*i.e.*, the classical blend and the classical blend with 10 % and 30 % of the new varieties) were produced and evaluated through a typicity ranking (with 37 professional judges) and a ranking test (with another panel of 20 highly experienced professionals in wine blending). The first sensory analysis aimed to assess the changes in typicity and wine profiles across the different blends with a usual panel of professionals. To accurately assess the impact of introducing new grape varieties, the second sensory analysis investigated the changes in typicity across the comparison of the different blends with a more highly experienced panel in wine blending of homogeneous expertise. The fact that they carry out similar tasks on a regular basis may make them more sensitive to any minor change to the wines' profiles (Barkat *et al.,* 2012; Solomon, 1990; Spence & Wang, 2019). As exposed by Leriche *et al*. (2020), typicity can be defined both conceptually and sensorially. For wine professionals, the mental representation of the typicity of a region's wines includes some extrinsic factors, such as terroir variables (soil

and climate, in interaction with the different varieties). A dissonance between the conceptual and perceptual definition of typicality among professionals could perhaps modify their acceptability of including new grape varieties in blends. To test this hypothesis, blind and non-blind tasting sessions were also carried out to investigate how information about varieties present in the blend can impact a typicity assessment.

MATERIALS AND METHODS

1. Sourcing of the wines

Wines for the study were the same as those used in Plantevin *et al.* (2024), in which vineyard design and vinification processes are fully described. Among the 26 varieties and the five vintages included in Plantevin *et al.* (2024), only the wines of the 2022 vintage were used here because of sample availability and time constraints. Moreover, 2022 was the warmest vintage in the Bordeaux wine region and, as such, it is quite representative of future climatic conditions. Cabernet-Sauvignon, Cabernet franc, Merlot and Petit Verdot served to create the classical Bordeaux blend for the base wine. Duras, Fer Servadou, Manseng noir, Vinhão and Arinarnoa were selected for addition to the classical Bordeaux blend, as they were found to share similar sensorial spaces with the classical Bordeaux blend (Plantevin *et al.*, 2024).

2. Sensory analyses

2.1. Elaboration of the classical Bordeaux base wine and the blends

For the production of a Bordeaux reference wine, to be used as a base wine in the blending, a sensory analysis was conducted by five Bordeaux winemaking experts (each with more than ten years of experience in blending). The tasting took place in the professional tasting room of Château La Tour Carnet, 33112 Saint-Laurent-Médoc, France. The wine glasses were from Chef & Sommelier (62510, Arques, France) and had a diameter of 90 mm and a height of 200 mm ("Young Cabernet" series); such wine glasses are often used in professional wine tasting. After a one-hour blending session, a consensus was reached between the judges on the most typical blend, which was composed of 30 % Cabernet-Sauvignon, 30 % Merlot, 30 % Cabernet franc and 10 % Petit Verdot.

Before each of the two sensory analysis sessions (explained in more detail in Sections 2.2 and 2.3), the eleven blends had been prepared in empty 75 cL glass bottles. For the ten blends other than the Bordeaux reference blend, the proportion of the non-autochthonous varieties (either 10 % or 30 %) was first poured into the empty glass bottles. Then, the bottle was topped up with the classical Bordeaux blend. In this way, 11 wines were prepared for each sensory analysis session: the Bordeaux reference blend, the Bordeaux reference blend supplemented with 10 % or 30 % respectively of each of the five varieties studied (Arinarnoa, Fer Servadou, Duras, Manseng noir and Vinhão).

2.2. Typicity assessment

For the first sensory analysis, the panel included 37 judges (21 females and 16 males), with an average age of 34, ranging from 22 to 61 years old. The judges were all considered as wine professionals as defined by Ballester *et al.* (2008) (*i.e.*, wine researchers, winemakers, wine consultants and wine students with past training in sensory analysis of wines), with sound knowledge of the Bordeaux region and its wines. This panel will be referred to as "prof_panel". The protocol for the tasting was the same as in Plantevin *et al.* (2024). The sample presentation to the tasters was monadic and balanced. The judges first answered two questions using an electronic tablet and Fizz acquisition software (Biosystem SAS, 21560, Couternon, France): 1) "On the nose, do you think this wine is a good example of a Bordeaux wine from the 2022 vintage?", and 2) "On the palate, do you think the taste of this wine is a good example of a Bordeaux wine from the 2022 vintage?". Answers had to be rated using two 10-centimeter unstructured scales, with "good example" written on the right and "bad example" on the left. Following this typicity rating, judges were asked to rate the intensity (on the same 10-centimeter unstructured scales) of 10 descriptors (6 related to the nose and 4 related to the palate). Those 10 descriptors were found to be negatively or positively correlated with the Bordeaux typicity in a previous study (Plantevin *et al.*, 2024). However, no significant differences were found for those 10 descriptors and results are not shown.

2.3. Typicity ranking

In the second sensory analysis, the panel was made up of 20 judges (9 females and 11 males) with in-depth expertise in Bordeaux wine making, and who were all regularly involved in wine blending (18 years average experience in Bordeaux (ranging from 7 to 35 years)). This panel will be referred to as "exp_panel". The aim was to create tasting conditions similar to professional blending sessions. As such, the sensorial analysis took place in the professional tasting room at the Château La Tour Carnet, 33112 Saint-Laurent-Médoc. Twenty millilitres of wine was poured into covered glasses (the same as described in Section 2.1) at 18 °C. The eleven wines were presented in random order to each of the judges and were identified with random 3-digit numbers. Each judge had to taste the eleven wines twice: once blind and once with knowledge of the blends (non-blind). Nine judges started with the blind tasting followed by the non-blind tasting and 11 judges started with the non-blind tasting followed by the blind tasting. The 3-digit numbers differed between the blind and the non-blind tasting. For the two tastings, a typicity ranking (ISO 8587:2007) was performed and judges were asked to classify the wines from 1 to 11 as a function of their Bordeaux typicity (1 being the most typical wine). Equal ranking was not allowed. Typicity ranking was preferred to typicity scoring, as it is more similar to that used in professional blending.

2.4. Statistics

The analyses were run on R Studio version 2022.12.0 using "Dplyr" package version 1.1.0 for descriptive analysis, "Ggplot" package version 3.3.1 for graphic visualisation,

"Stats" package version 4.2.1 and "FSA" package version 0.9.4 for the Kruskall-wallis test and Dunn test respectively. Statistical differences were assessed through a Tukey test with p-value set at 0.05.

RESULTS AND DISCUSSION

1. Typicity profile

With the exception of Vinhão, the first sensory analysis did not show any significant differences for olfactive typicity (Figure 1.1) or for gustative typicity (Figure 1.2), when blended at 30 % in the classical Bordeaux blend. The latter was perceived as significantly different from most blends, except the base Bordeaux blend and the blends including 30 % Duras and 30 % Arinarnoa.

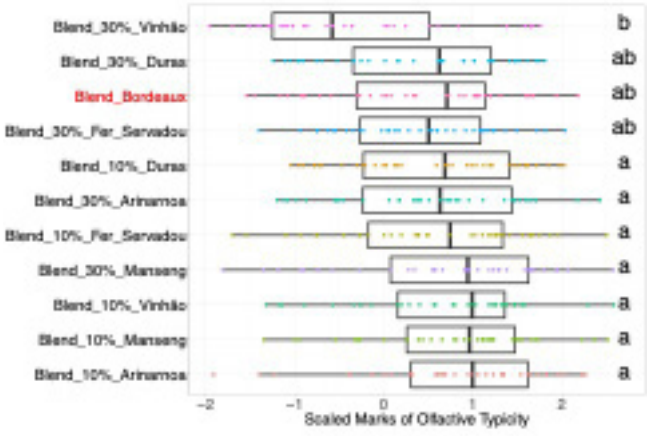


FIGURE 1.1. Olfactive typicity ratings given by judges for a Bordeaux blend and a Bordeaux blend supplemented with 10 or 30 % of Arinarnoa, Duras, Manseng noir, Fer Servadou or Vinhão, presented as box plots. Different letters indicate significant differences as revealed by a Tukey's test.

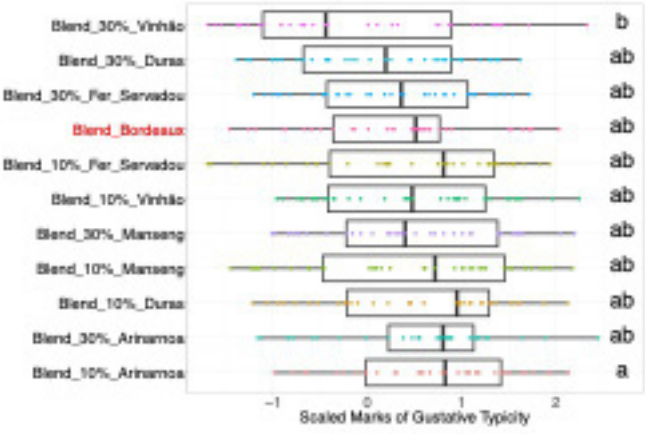


FIGURE 1.2. Gustative typicity ratings given by judges for a Bordeaux blend and a Bordeaux blend supplemented with 10 or 30% of Arinarnoa, Duras, Manseng noir, Fer Servadou or Vinhão, presented as box plots. Different letters indicate significant differences as revealed by a Tukey's test.

In a previous study, the five varieties used for supplementing the classical Bordeaux blend had been found to be either very typical of Bordeaux wines (especially the Manseng noir) or sensorially close to the varieties used in Bordeaux (Plantevin *et al*., 2024). This may explain why the studied varieties did not significantly impact the Bordeaux typicity when blended at 30 % maximum (except Vinhão at 30 %, but which is not significantly different from the Bordeaux blend of reference). This result allows their legal introduction to the Bordeaux varietal mix to be considered.

2. Typicity ranking

A second sensory analysis was conducted with highly-experienced judges in wine blending (exp_panel). Expert judges had to rank the 11 wines from least typical to most typical. To assess a possible psychological effect of knowing whether the new varieties were present in the blend or not (and, if so, which variety was present at which percentage), each judge had to taste the wines twice: blind and non-blind.

Typicity rankings were performed on the eleven wines in the blind and the non-blind tasting, and are shown through the sum of the ranking scores for each wine in blind tasting and in non-blind tasting (Figure 2.1). The higher the sum of scores, the less typical the wine was found to be. Interestingly, no significant differences were found between the two tastings (using a Friedman rank sum test with a p-value set at 0.05), showing that wine professionals do not seem to be significantly influenced by knowing the varieties in their typicity ranking (Figure 2.1).

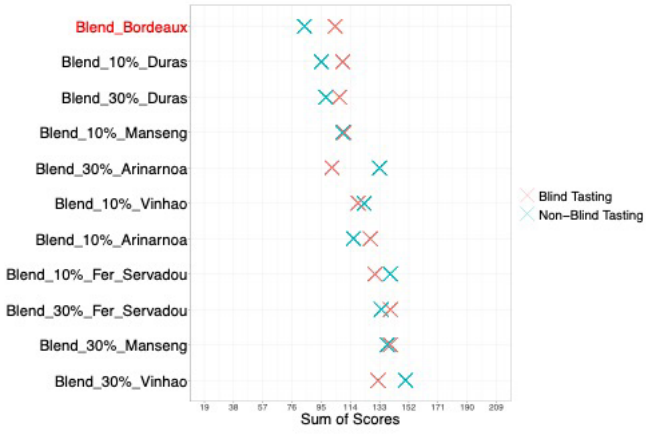


FIGURE 2.1. Sum of scores from a typicity ranking of a Bordeaux blend and a Bordeaux blend supplemented with 10 % or 30 % of Arinarnoa, Duras, Manseng noir, Fer Servadou or Vinhão. Blue stars represent the results of the non-blind tasting and red stars the results of the blind tasting. The higher the rank, the less typical the wines. Results of a Friedman rank sum test for each wine between the ranking of blind tasting and non-blind tasting showed no significant differences.

As no significant differences were found between the two tastings, the ranks for the blind tasting and the non-blind tasting were averaged for each judge; the results are

displayed in Figure 2.2. Statistical significance of typicity scoring between the wines were calculated by means of a Dunn test with a p-value set at 0.05.

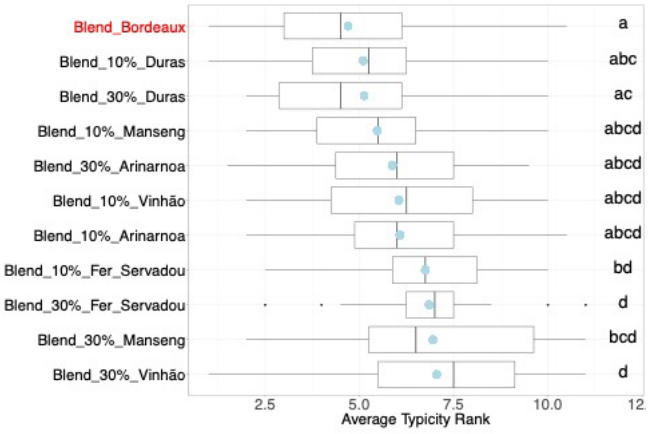


FIGURE 2.2 Average typicity rankings for the eleven wines presented as box plots. The higher the value, the less typical the wine. Letters represent significant groups through a Dunn test with p-value set at 0.05. Blue points represent the mean values.

The Bordeaux reference blend was found to be the most typical of the eleven wines (Figure 2.2).When added at 10 % or 30 % to the classical Bordeaux blend, Duras did not significantly impact the typicity of the wines (Figure 2.2). Conversely, when added at either 10% or 30%, Fer Servadou negatively impacted the Bordeaux typicity as it was perceived to be significantly different to the classical Bordeaux blend (Figure 2.2). Regarding Manseng noir and Vinhão, the blends were judged as typical for Bordeaux when incorporated at 10%, while at 30% Bordeaux typicity of the blend significantly decreased.

Both panels agreed on the negative impact of Vinhão at 30 % on typicity (Figures 1.1, 1.2 and 2.2). However, only the highly-experienced panel found the Fer Servadou at 10% and 30% and the Manseng noir at 30 % to significantly decreased the typicity of the classical Bordeaux blend (Figure 2.2).

Although significant differences are shown in Figure 2.2, all of the eleven wines were on the same tight continuum of typicity: from less to more typical. No dramatic changes to the typicity were observed for any of the blends.

CONCLUSION

The main aim of this research was to assess the impact on Bordeaux typicity of five non-autochtonous varieties when blended in a classical Bordeaux blend: Fer Servadou, Duras, Manseng noir, Vinhão and Arinarnoa. We also investigated whether the typicity assessments of blending experts could be influenced by knowing the varieties incorporated into the blends. Those five varieties were previously found to be part of the sensorial space of classical Bordeaux varieties. Two sensory analysis sessions were conducted: one that assessed the Bordeaux typicity of the wines with a classical professional panel, and another that classified the typicity of the wines with highly experienced professionals in wine blending. From the first analysis, only one of the five varieties was found to slightly decrease the typicity of the blend when added at 30 %: Vinhão. But this decrease in typicity did not result in a significant difference with respect to the reference Bordeaux blend. From the second sensory analysis session, a decrease in typicity was also found when Manseng noir (at 30 %), Fer Servadou (at 10 % and 30 %) and Vinhão (at 30 %) were added to the blend. However, in both cases, the decrease in typicity took place within a tight continuum of more typical to less typical wines, and Bordeaux typicity was never drastically affected. It was also shown that an expert blending panel is not influenced in their typicity ratings when they have knowledge of the varieties present in the blend. This study is a step towards the potential introduction of the studied five non-autochthonous varieties to the classical Bordeaux blend. It needs to be completed with further studies to assess the typicity of the different blends after barrel and bottle ageing, as well as with different vintages.

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