Sensory analysis of wines made with minority varieties found in Spain

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Abstract. This study evaluates the organoleptic potential of 205 monovarietal wines made with 51 minority varieties found in Spain. The sensory analysis of 90 white, 6 rosé and 109 red wines produced during the 2019, 2020, and 2021 harvests has been carried out by means of an accredited tasting panel (UNE-EN ISO 10725:2017). These wines have been characterized by a total of 67 sensory descriptors (quantitative and qualitative). The goal of the work has been to study the oenological potential for the production of quality wines from varieties with a small area of cultivation, which could be more resistant to drought and certain fungal diseases because they are adapted to each climate zone. These features may be interesting to mitigate the effects of climate change and diversify the wine market that currently exists. The results have made it possible to analyse the sensory descriptors that define the main attributes of each variety, and to check the relationship between the sensory profile and the adaptation of the crop in each wine region.

1 Introduction

The attack of the phylloxera in Europe at the end of the 19th century caused the disappearance of a large number of varieties of *Vitis vinifera* L., that our ancestors cultivated [1]. It is known that the European continent, and specifically Spain, has a great varietal biodiversity [2]. These are vines that in many cases are minoritarian and in danger of disappearing. In the last decades, prospecting and recovery projects started in different wine-growing areas of the world due to the great interest of winegrowers and wineries to recover ancient varieties [3]. In order to value these natural resources, within the framework of the MINORVIN project: "Valorisation of minority grape varieties for their capacity to diversify viticulture and oenology and to minimize the effects of climate change on wine quality", 51 minority varieties recovered in 12 Spanish regions have been studied, analysing aspects such as their phenology, resistance to drought, tolerance to fungal diseases, their oenological and aromatic aptitude, phenolic profile and sensory description.

Sensory analysis is a scientific discipline that allows the characterization of wine and thus determine the perceptible differences between a group of wines, and their relevance in providing information to the final consumer [4]. Consumer acceptance is essential to introduce wines from new grape varieties into the market. Furthermore, terroir tipicity is an important concept for the wine industry because not only delineates geographic areas but also comprises wines with recognisable sensory characters and composition [5]. So, it may be very useful to organoleptically analyse monovarietal wines made with minority varieties in order to describe each one with specific attributes.

Descriptive sensory analysis has been widely applied to wine tasting since it allows both quantitative and qualitative aspects [6]. In this work we present results about organoleptic characteristics obtained from descriptive (quantitative) analysis of monovarietal wines made with ancient grape varieties found in different regions of Spain. The main objective of this study is to characterise and discriminate wine samples according to their sensory descriptors and production origins.

2 Materials and methods

Minority varieties were collected from 12 different regions in Spain. Figure 1 shows the locations where they were found.

Of the 51 varieties studied, 16 white, 2 rosé, and 21 red grape varieties were unique to a single region. However, some of them: Albana, Jarrosuelto, Castellana Blanca, Hebén, Verdejo Serrano, Folgasao, Zurieles (white) and Sanguina, Tortozona Tinta, Cadrete, Tinto Jeromo, Terriza, Morate, Rayada Melonera (red) where cultivated in two or more origins. Moscatel de Grano Menudo and Tempranillo were used as reference varieties for white and red grapes, respectively.

Each variety was harvested with the most appropriate alcoholic strength based on the potential of each one to be studied. For white varieties, the potential alcoholic strength varied from 11 to 12.5 % v/v and for red varieties from 12 to 13.5 % v/v. All microvinifications took place in stainless steel tanks with the same commercial yeast strain: Fermol Super 16 (AEB Group, Spain), in order that the secondary aromas produced by the yeast influence the sensory evaluation in the same way. In the rosé wines, 24 h of maceration with the skins was carried out, and in red wines maceration took place

throughout the entire alcoholic fermentation. Once alcoholic fermentation ended, wines were sulphited, filtered and bottled. Malolactic fermentation was not induced in red wines. So, all wines (white, rosé and red) were elaborated as young wines.

Figure 1. Grape minority varieties and their origin. Green, white wines; pink, rosé wines; red, red wines.

Sensorial descriptive analysis of 205 wine samples was performed 3-4 months after wines were bottled by an accredited tasting panel (UNE-EN ISO 10725:2017, Official Wine Tasting Panel of Catalonia) composed of 30 trained judges. During 2019, 2020 and 2021 vintages, 21 tasting sessions with 8 judges per session were conducted. In each session among 8 to 11 wine samples were evaluated using standardized wine glass at a serving temperature of 20 ± 2°C, in the same order for all the tasters and identified with random three-digit codes (Fig. 2). In each wine sample, 13 quantitative descriptors and 54 qualitative descriptors were evaluated into three phases: visual, olfactory-gustatory and gustatory. All samples were examined according to the method accredited by the European standard ISO 17025:2017 (ENAC file number 941/LE1830) [7].

Figure 2. Standardized glasses prepared for a tasting session.

The results obtained in each tasting session and for each wine were subjected to Analysis of Variance (ANOVA) to investigate the influences of 'variety', 'region' or 'harvest' on quantitative descriptors and to determine the existence of significant differences ($p < 0.05$). A Discriminant Analysis (DA) was also carried out with the quantitative descriptors in order to identify groups of similar wines based on the variety and the cultivation area. Finally, Principal Component Analysis (PCA) was applied with the aim of discriminating cultivars based on association of the studied descriptor variables. All statistical analysis was carried out using XLSTAT-Pro (Addinsoft NY, USA) statistical software package.

1 Results and Discussion

1.1 Sensory analysis of white wines

Ninety white wines produced with 23 different minority grape varieties found in eleven regions were evaluated by sensory descriptive analysis using 67 descriptors (quantitative and qualitative).

From the results of the Analysis of Variance (ANOVA) on the quantitative descriptive data (intensity scale from 0 to 10) registered in three consecutive vintages (2019, 2020, and 2021), taking 'harvest' as factor, significant differences ($p < 0.05$) were observed in the 2021 harvest. In general, higher scores were obtained in most descriptors in this vintage, mainly in floral, forest herbs, fruity, sourness and structure (Fig. 3).

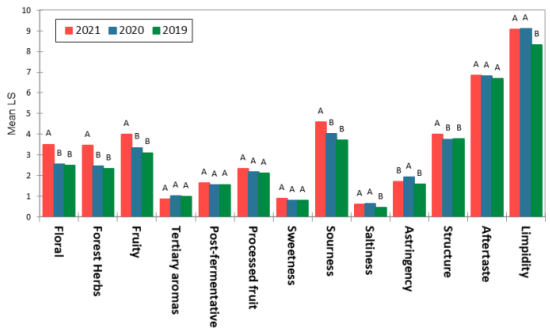

Figure 3. Summary (means) – Harvest. Quantitative descriptors (dependent variables) in white wines.

When the influence of 'variety' was studied, significant differences ($p < 0.05$) were found in 6 quantitative attributes: floral, fruity, tertiary aromas, post-fermentative aromas, sourness and astringency. Table 1 summarizes values of these descriptors (expressed as mean) for each minority grape variety. Wines of Riera 46 from Catalonia stood out for their floral and fruity aromas, while in the gustatory descriptors sourness and astringency, wines made with Marco 1 from Galicia obtained the highest results. Galician varietal wines often stand out for their acidity [8].

Discriminant Analysis (DA) was applied with the quantitative descriptors in order to identify groups of similar white wines based on the region where minority varieties were cultivated. As it can be seen in Figure 4,

samples from Galicia, Extremadura and Andalucía, are separated sensorially from the rest of the wines evaluated. Discriminant function 1 (F1) justified 37.6% of the variance and was mainly defined by sourness and astringency.

Table 1. Mean values of significant sensory descriptors in white wines made with minority varieties from Spain.

	Floral	Fruity	Tertiary aromas	Post-ferment.	Sourness	Astringency
Cayetana b.	3,656	4,022	1,256	1,871	3,512	1,462
Evena 1	3,225	3,699	0,719	1,542	3,543	1,740
Riera 46	4,767	5,869	0,190	0,994	4,633	1,566
Albillo del Pozo	3,591	4,090	0,899	1,902	3,926	1,592
Moscatel	4,748	4,659	0,757	1,537	3,797	1,399
Albana	2,857	4,022	0,838	1,678	4,062	1,704
Maquías	2,718	3,570	0,940	1,696	4,461	1,721
Diega 2	2,772	3,185	0,741	1,610	3,761	1,897
Albilla do Avia	4,103	3,866	0,476	1,103	4,825	1,885
Greta	1,887	3,461	1,013	1,767	3,800	1,526
Verdejo serranc	2,642	3,093	1,273	1,950	3,939	1,731
Cagarrizo	1,974	2,590	1,017	1,715	3,981	1,794
Montonera del	2,842	3,049	0,996	1,503	4,401	1,708
Jarrosuelto	2,818	3,546	0,879	1,397	3,859	1,664
Bastardo b.	2,121	2,918	0,931	1,837	4,631	1,681
Castellana b.	2,438	3,080	0,836	1,335	4,387	2,170
Onsella	1,763	3,358	0,523	1,506	3,691	1,888
Zurieles	2,493	3,056	0,985	1,489	3,883	1,650
Marco 1	2,673	3,222	0,752	1,250	5,325	2,273
Ratiño	2,164	2,934	0,773	1,951	4,975	1,875
Indiana	2,430	2,971	1,472	1,444	3,949	1,769
Hebén	2,626	3,028	0,925	1,574	3,800	1,765
Planta nova	2,176	2,702	2,730	1,744	3,378	1,507

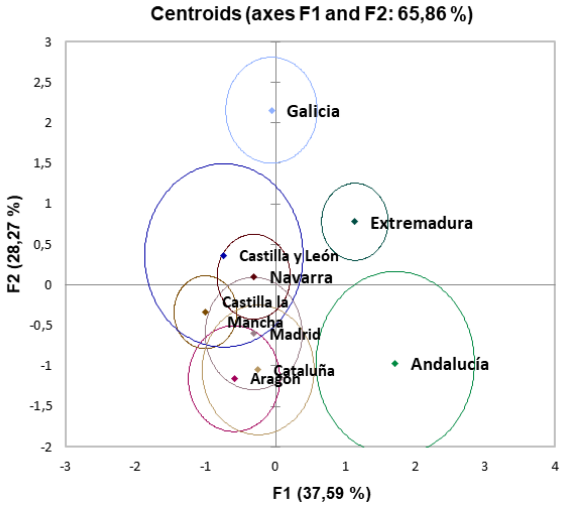

Figure 4. Discriminant Analysis of white wines grouped by region of origin of minority varieties.

Wine characteristics are influenced by many factors related to the specific production area. Among these, grape varieties, and above all, climate and soil play an important role [9]. The northwest region of Galicia has a particular climate and soil conditions. Galician soils are generally shallow, with a sandy or loamy texture, acidic and with abundant organic matter, which gives the topsoil layer its typical dark colour. As a consequence of the rains they suffer a strong washing that causes their acidification and the sourness characteristic in its wines. The southern region of Andalusia has a dry climate and in certain parts a soil with peculiar chemical characteristics called "albarizas". The albarizas are soils rich in calcium carbonate, clay, and silica that influence the astringency and acidity of the vine varieties grown in the area.

To interpret the results in detail, Principal Component Analysis (PCA) was applied. PCA gives a pictorial relationship of the wines based on their sensory composition. In this study, PCA was used to identify the quantitative attributes that discriminated best among wines. As it can be seen in Figure 5, the first two principal components, PC1 and PC2, accounted for 61.29% of total variance (36.64% and 24.65% respectively). The first component (PC1) was characterized by major values of the aromatic descriptors fruity and floral. For the second principal component (PC2), the gustative attributes sourness and astringency showed high and positive values. Riera 46 and Albilla do Avia wines were positioned in positive values for PC1 and PC2 and were described as floral and fruity, with good structure and well balanced in sourness and astringency. The reference white variety used in this study, Moscatel de Grano Menudo (*Muscat à Petit Grains*) were located at positive values for PC1 and negative for PC2, like Cayetana blanca, Albillo del Pozo and Evena 1 wines that were described as wines with long aftertaste, processed fruit linked to mature fruit and sweetness. These descriptions could be related to volatile compounds coming from grapes, mainly mono-terpenes like linalool, geraniol, and nerol as described in Moscatel de Grano Menudo [10].

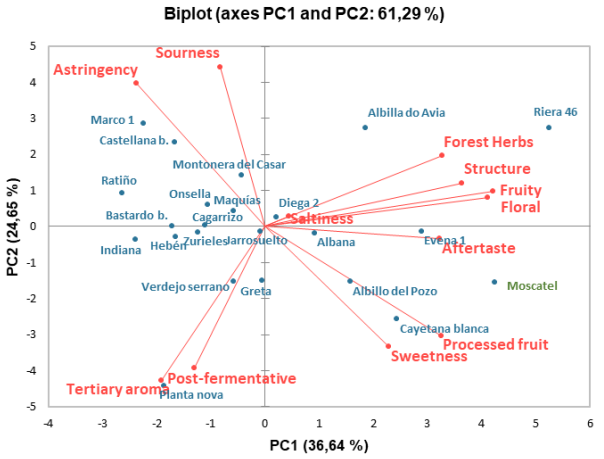

Figure 5. PCA score plot of quantitative sensory attributes (aromatic and gustative) of wines made of white grape varieties.

Marco 1 and Castellana Blanca wines were described by the accredited tasting panel as the most astringent and sourness wines (PC1 negative and PC2 positive). Two of the three wines from white varieties from Galicia (Marco 1 and Ratiño) were placed in this quadrant, standing out for their sourness, as described above. Finally, wines made with Planta nova showed attributes linked to evolution as tertiary and post-fermentative aromas, probably caused by some deviation in the winemaking procedure carried out in the cellar.

1.2 Sensory analysis of red wines

Results were obtained from the sensory analysis of 109 red wines elaborated with 28 red grape minority varieties from nine different wine regions in Spain during 2019-2021 vintages. In this case, traditional red grape Tempranillo was used as reference.

When 'harvest' was fixed as a factor, the 2021 vintage resulted in highest mean values in most of quantitative descriptors, with the exception of limpidity and aftertaste where the 2020 vintage obtained better results. When ANOVA was applied, significant differences ($p < 0.05$) among years were also observed in most attributes. Therefore, in red wines the same trend is followed as in whites, which indicates that the climatic conditions of the vintage are a very important factor in the sensory expression of the minority varieties studied in this work.

Table 2 presents the mean values of quantitative descriptors analysed in red wines setting as a factor the variety with which they have been elaborated. ANOVA found significant effects in 11 aromatic and gustative attributes (shown in Table 2). No significant differences were observed in sweet and salty sensations.

Table 2. Mean values of significant sensory descriptors in red wines made with minority varieties from Spain.

	Floral	Forest Herbs	Fruity	Tertiary aromas	Post-ferment.	Processed fruit	Sourness	Astringency	Structure	Aftertaste	Limpidity
Benedicto	2,0395	3,5703	4,0780	1,6760	1,7416	2,7364	3,8908	4,1762	4,5614	7,3823	8,4130
Cenicienta	2,5066	2,6451	4,0171	1,1423	1,7070	2,2352	3,9244	4,1001	4,4433	7,3374	9,0521
Riera 2	2,4292	3,0237	3,6951	1,3149	1,3463	2,3799	4,7643	3,7394	4,4962	7,3433	9,8277
Gorgollassa	2,1697	3,9299	3,0138	1,7491	2,0793	2,0049	4,3908	3,5942	4,4906	7,4058	9,8798
Hondarrabi b.	2,4411	3,0094	3,4897	1,6214	1,7820	2,1924	3,8060	3,1567	4,3486	7,7183	8,8003
Negrella	2,4411	3,0094	3,4897	1,6214	1,7820	2,1924	3,8060	3,1567	4,3486	7,7183	8,8003
Planta mula	2,4411	3,0094	3,4897	1,6214	1,7820	2,1924	3,8060	3,1567	4,3486	7,7183	8,8003
Trobat	2,4411	3,0094	3,4897	1,6214	1,7820	2,1924	3,8060	3,1567	4,3486	7,7183	8,8003
Zamarrica	2,4411	3,0094	3,4897	1,6214	1,7820	2,1924	3,8060	3,1567	4,3486	7,7183	8,8003
Tinta Oubiña	2,4179	3,0267	3,6933	1,5238	1,1832	2,1662	3,9768	3,3263	4,0528	7,1886	9,2854
Tinto Fragoso	2,2604	3,2246	3,7965	1,3726	1,6049	2,6381	4,1270	3,7967	4,4836	6,6299	8,1547
Forcallat	2,7120	3,1469	3,6397	1,3839	1,7112	1,7341	3,7810	3,3442	4,6903	7,8433	8,5420
Tinto Jeromo	1,9155	3,3136	3,5005	1,4923	1,4659	2,4245	3,9608	4,0561	4,0593	6,1112	8,8985
Arcos	2,5828	3,1552	3,4814	0,8131	1,7029	1,3591	3,9810	3,3317	4,2153	7,4892	8,8545
Tempranillo	2,2680	2,8568	3,4781	1,3935	1,7256	2,5987	3,6099	3,8976	4,2703	6,9796	8,4444
Gajo Arroba	2,5530	2,9886	4,1582	1,0744	1,5969	2,3311	3,8649	3,4710	3,6575	6,6410	8,6229
Sanguina	1,9834	2,9017	3,3546	1,5042	1,4195	2,4299	4,0893	3,9001	4,0212	6,2838	8,8194
Corchera	2,1453	2,8233	3,3948	1,0621	1,7317	2,5172	3,5986	3,6416	4,1195	7,3805	7,9196
Estaladiña	2,0352	2,3213	3,6975	0,8804	1,6058	2,0472	4,7090	4,0180	4,3808	6,2541	9,0449
Cadrete	2,1587	2,2771	3,0371	1,6036	1,7878	1,8353	3,3111	2,8693	3,6963	7,3207	8,8697
Tortozona t.	2,1837	2,6042	3,3303	1,1182	1,5539	2,1980	4,0357	3,0596	3,8915	6,0725	8,5450
Rejano Tinta	2,0493	2,7918	3,5010	0,7892	1,0998	2,2906	3,9363	3,8729	3,8495	5,1730	7,9583
Mandregue	1,8804	2,4924	2,7206	0,6556	1,3881	1,5681	4,9148	3,9392	3,8385	6,2906	8,5722
Marco 2	2,2155	1,7719	3,1362	1,3006	1,4213	2,1073	4,1673	2,2638	3,4391	7,0338	7,7176
Terriza	1,7709	2,5970	3,1462	1,0355	1,4274	2,2441	3,7020	3,4741	3,7364	5,5717	8,9224
Morate	2,0291	2,5110	3,2453	1,7460	1,8657	2,0739	3,6982	3,1386	3,5706	6,8914	8,3784
Melonera	2,1423	2,6292	3,4252	1,1371	1,6460	2,0553	3,2706	2,8939	3,7308	6,4817	8,4505
Garró	1,7306	2,7028	2,5175	1,3544	1,5221	1,9107	3,7854	3,5106	3,4757	5,6385	8,5081
Diega 1	1,5719	1,8854	2,4050	1,0764	1,3672	1,5695	3,5084	3,3895	3,3798	5,2344	8,4665

A group of wines of 3 varieties stood out for their complexity in olfactory and gustatory descriptors. Benedicto from Castilla La Mancha obtained good scores in forest herbs, fruity, specifically processed or mature fruit, and astringency and structure in mouthfeel. Gorgollassa from Mallorca (Balearic Islands) received good values in forest herbs, fruit, tertiary and post-fermentative aromas and the visual descriptor limpidity. Forcallat from Valencia stood out for their floral aroma and structure and aftertaste in gustative attributes. Furthermore, Gajo Arroba from Castilla y León received the best score in fruit aroma and red wines of Mandregue from Madrid and Riera 2 from Cataluña were the most acidic.

As in white wines, a DA was carried out with the values of sensorial descriptors of red wines of minority varieties, with the purpose of looking for distances or similarities by regions of the sensory characteristics of the wines (Fig. 6).

The plot shows that, mainly, red wines from Valencia, Aragón and Galicia are distributed differently at sensory level from the rest of the samples analysed. Wines from Valencia and Aragón were basically characterized for their sourness and tertiary aromas, and Galicia samples for their astringency. Red wines from regions with positive F1 and negative F2 values were defined as the most complex, in which fruit, floral and forest herbs aromas and good structure and long aftertaste in mouth were mainly perceived by the tasting panel.

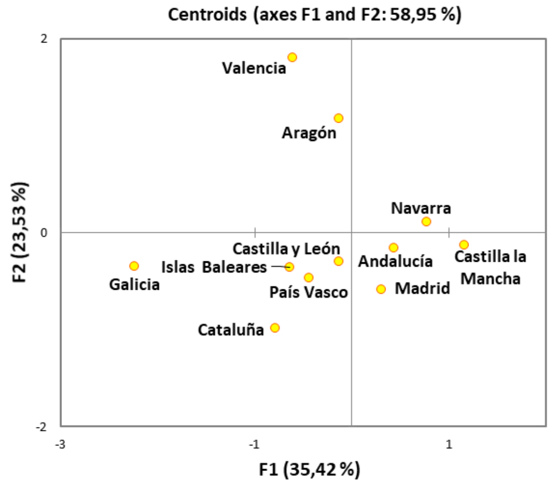

Figure 6. Discriminant analysis of red wines grouped by region of origin of minority varieties.

To relate each red wine from minority varieties with the sensory attributes that best define it, a PCA analysis was performed (Fig. 7).

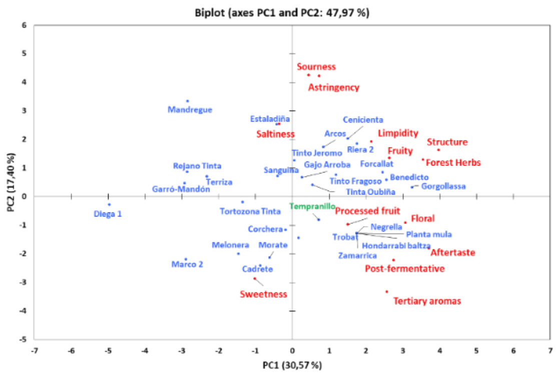

Figure 7. PCA score plot of quantitative sensory attributes (aromatic and gustative) of wines made of red grape varieties.

The first two principal components, PC1 and PC2, accounted for 48% of total variance (30.6% and 17.4% respectively). PC1 was linked in positive values to forest herbs and fruit aroma and also to structure and limpidity of the wines. Red grape varieties of diverse origins: Cenicienta, Riera 2, Forcallat, Benedicto and Gorgollassa, were related to these attributes. Second component, PC2, was associated with elevated levels of astringency and acidity. The Tempranillo reference wines along with five other wines (Negrella, Planta Mula, Hondarrabi Baltza, Zamarrica and Trobat) were related

mainly with processed fruit (mature fruit) and floral notes.

Apart from the results obtained with the quantitative sensory descriptors, the tasters of the accredited panel described all the wines of this study (white and red) with 54 qualitative descriptors (data not shown). The global results have helped to define the main attributes that characterize the quality of the wines made with these minority grape varieties.

4 Conclusions

In Spain exists minority vine varieties that have been preserved for years in centuries-old vineyards. There is an increasing interest shown in the properties of minority cultivars that may have potential uses as complementary varieties. The importance of recovering these formerly cultivated varieties that are in danger of disappearing can lead to obtaining wines with differentiated sensory attributes, which could provide great added value to the final product and favour market diversification without losing tradition and the use of its own varietal heritage.

In this work, we have analysed the sensory descriptors that define the main sensory attributes of the wines made with them, and the relationship with the adaptation of the crop in each region has been verified. The results show that the edaphoclimatic conditions of each territory seems to prevail over the characteristics of the minority varieties, although some of them have peculiar characteristics. Moreover, an important effect of the harvest (vintage) is observed.

Acknowledgments

This research has been funded by the project MINORVIN "Valorisation of minority grape varieties for their capacity to diversify viticulture and oenology and to minimize the effects of climate change on wine quality", RTI2018-101085-R-C33 (MICINN/AEI/ERDF, EU).

The authors would like to thank the 30 tasters of the accredited panel who participated in the different tasting sessions and the group of researchers and winemakers of the MINORVIN project who produced the wines.

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