Research Article

Sensory Characterization of Wines Obtained by Blending Cencibel Grapes and Minority Grape Varieties Cultivated in La Mancha Region

E. Sánchez-Palomo,¹ P. M. Izquierdo Cañas,^{2,3} J. A. Delgado,¹ and M. A. González Viñas ¹

¹Area of Food Technology, University of Castilla-La Mancha, Camilo José Cela, No. 10, 13071 Ciudad Real, Spain

²Instituto de la Vid y el Vino de Castilla-La Mancha-IRIAF, Ctra. Toledo-Albacete s/n., Tomelloso, 13700 Ciudad Real, Spain

³Parque Científico y Tecnológico de Castilla-La Mancha, Paseo de la Innovación, No. 1, 02006 Albacete, Spain

Correspondence should be addressed to M. A. González Viñas; miguelangel.gonzalez@uclm.es

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The objective of this work was measuring the influence of co-winemaking technique on sensory profile of young red wines made from Rojal, Moravia Dulce, and Tortosí grape varieties cultivated in La Mancha region (Spain) using aroma sensory profile. Sensory aroma profile was evaluated by a panel of 15 experienced wine testers with a previous training. The sensory aroma profiles of monovarietal wines from Rojal, Tortosí, and Moravia Dulce were researched and the effect of blending these grape varieties with Cencibel grapes on sensory characteristics of wines was studied. Co-winemaking wines were elaborated by mixing of (a) Cencibel (50%) + Rojal (50%); (b) Cencibel (50%) + Tortosí (50%); and (c) Cencibel (50%) + Moravia Dulce (50%). The blending of these grape varieties increased the principal aroma attributes of monovarietal wines and, in general, co-winemaking wines exhibited a greater complexity of aroma profile.

1. Introduction

One of the most important attributes that influence the quality of wines is the aroma [1] and it can describe the differences between a lot of wines [2]. The aroma of wine is the result of a biological and technological sequence (grape destemming, crushing, and pressing technology) that is also influenced by the fermentation process [3, 4]. Technological factors will define the complexity of wine aroma but numerous viticulture, enological techniques significantly influence the types and concentrations of volatile compounds [5].

According to Moskowitz, 1983 [6], the first step in the sensory characterization of a food product is the Sensory Descriptive Analysis (SDA). SDA offers us the possibility of defining the characteristic attributes in the sensory description of the wines. The techniques of descriptive sensory analysis allow obtaining an objective description of the wine based on its attributes of aroma and perceived taste and

can be both qualitative and quantitative. The aroma sensory profile of wines of many varieties has been characterized using descriptive sensory analysis, such as, Chardonnay [7], Semillon y Sauvignon Blanc [8], Cabernet Sauvignon [9], Shiraz [10], Airen [11], Touriga Nacional [12], Mencia [13], Tannat [14], Sauvignon blanc [15], Cabernet Sauvignon [16], Albariño [17], Albillo [18], Pinot noir [19], and Cencibel, Bobal and Moravia Agria [20].

The grape variety used in the elaboration is one of the most important factors to determine the sensory profile of wine. The neutral grape varieties can benefit from the presence of grapes during the winemaking process that have a more complex aromatic profile. When the wine is elaborated by blending different grape varieties together in the wine-making process, changes in the sensory profile of these wines in comparison with monovarietal ones are expected. Co-winemaking technique implies comaceration and cofermentation steps. The comaceration and cofermentation of several

TABLE 1: General composition of monovarietal and co-winemaking wines. Mean concentrations and relative standard deviations ($n = 2$).

	Rojal	Cencibel-Rojal	Tortosí	Cencibel-Tortosí	Moravia Dulce	Cencibel-Moravia Dulce
pH	3.61 ^a (0.23)	3.71 ^a (2.21)	3.81 ^{a,b} (1.15)	3.79 ^{a,b} (0.87)	3.69 ^a (3.10)	3.62 ^a (1.23)
Alcohol (%)	12.52 ^a (0.74)	12.7 ^a (1.34)	12.72 ^a (0.47)	13.05 ^b (4.70)	13.11 ^b (3.91)	12.41 ^a (5.67)
Total acidity g/L (as tartaric acid)	4.63 ^a (0.65)	4.17 ^b (1.01)	3.90 ^b (0.32)	4.16 ^b (3.45)	4.81 ^a (1.48)	4.24 ^b (1.12)
Volatile acidity g/L (as acetic acid)	0.33 ^a (0.06)	0.30 ^a (0.04)	0.36 ^a (0.06)	0.34 ^a (0.08)	0.35 ^a (0.05)	0.33 ^a (0.04)
Free SO ₂ mg/L	16.81 ^a (0.58)	17.32 ^a (2.45)	16.97 ^a (1.23)	16.41 ^a (4.15)	16.89 ^a (2.19)	17.24 ^a (4.16)
Total SO ₂ mg/L	25.50 ^a (2.44)	26.13 ^a (4.21)	30.54 ^b (4.33)	29.24 ^b (3.14)	30.09 ^b (1.44)	29.31 ^b (3.41)

^{a,b} Different superscripts in the same row indicate statistical differences at the 0.05 level according to the Student-Newman-Keuls test; relative standard deviation ($n = 2$) is showed in brackets.

grape varieties could improve the aromatic complexity of the wine due to the presence of volatile compounds of all grape varieties used in the winemaking process. [20–23].

Co-winemaking technique can only be carried out with grape varieties that have similar ripening stages; therefore, this technique is not commonly employed [22, 23].

A previous sensory characterization of wines obtained by co-winemaking technique has been studied by García-Carpintero et al. 2010. In this study the authors showed that the sensory profile of the wine obtained by blending Cencibel, Bobal, and Moravia Agria (33 : 33 : 33) grape varieties, was more complex than the rest of co-winemaking wines, Cencibel-Bobal (50 : 50) and Cencibel-Moravia Agria (50 : 50), and than the monovarietal ones. The panellist identified notes from the all grape varieties used in the elaboration producing a more aromatic complexity in these wines.

The goal of this research was twofold: firstly to identify the sensory key attributes of wines from Rojal, Tortosí, and Moravia Dulce minority grape varieties from La Mancha region. A second objective was to evaluate the effect of the co-winemaking technique with Cencibel variety on the sensory profile of these wines.

2. Materials and Methods

2.1. Winemaking Conditions. Grapes from Tortosí, Rojal, and Moravia Dulce grape varieties cultivated in La Mancha region middle-southeast of Spain, harvested in their optimal ripening stage and in good sanitary conditions, were used for winemaking. Wines were elaborated with the blending of grapes: 100% Rojal, 100% Moravia Dulce, 100% Tortosí, 50% Cencibel + 50% Rojal, 50% Cencibel + 50% Moravia Dulce, and 50% Cencibel + 50% Tortosí. Fermentation conditions involved after stemming and crushing, the addition of 100 mg/L of SO₂, as K₂S₂O₇ [18], inoculation with *Saccharomyces cerevisiae* selected yeasts (UCLM S325, Fould-Springer), and fermentation temperature was 24°C. Manual punching down was done every twelve hours. When the relative density exhibits a constant value the separation of wine from solids was performed. Then, the malolactic fermentation was prompted by inoculation with *Oenococcus oeni* lactic acid bacteria (Lactobacter SPI; Laffort). After

this second fermentation the wines were racked. After one month, the wines were racked again, passed through 1.2 µm membranes (Millipore, Bedford, MA, USA), bottled, and stored in room with a constant temperature between 16 and 18°C. All fermentation was conducted in duplicate.

2.2. Conventional Analysis of Wines. The methods proposed by O.I.V., 2006 [24], were used to analyse total acidity, ethanol, pH, volatile acidity, and total and free SO₂.

2.3. Quantitative Descriptive Sensory Analysis of Wines. Monovarietal wines and wines obtained by blending of studied grape varieties were evaluated in duplicate by a panel of 15 trained judges along eight sessions using a balanced, complete block design. Samples of wines were presented at 15°C (20 mL) in standard wine-tasting glasses [25] covered with a watch-glass to reduce the escape of volatile compounds and coded with random three-digit. The evaluations were made in individual booths under white light in a standard sensory analysis chamber [26].

In order to define the wine sensory attributes physical-chemical standards were used (Noble et al. 1984b; [27]). In order to evaluate the intensity of each sensory attribute a 10 cm unstructured scale was used. The left-hand end of the scale was “attribute not perceptible” and the right-hand end was “attribute strongly perceptible.”

2.4. Statistical Analysis. ANOVA followed by the Student-Newman-Keuls test were used to discriminate among the means of chemical data. Principal component analysis (PCA) was performed on data of aroma descriptions to find the dominant aroma terms of the wines. All statistical analyses were carried out using the SPSS version 17.0 for Windows statistical package.

3. Results and Discussion

3.1. Conventional Parameters of Wines: Effect of Co-Winemaking Technique. Table 1 show the conventional parameters analysed in monovarietal and co-winemaking wines. According to the results, co-winemaking technique does not influence the general composition of studied wines for the analysed parameters because no significant differences were

TABLE 2: Sensory attributes used for described sensory aroma profile of monovarietal and co-winemaking wines.

Attributes generated in training sessions	Attributes selected by consensus identified in wines
Raspberry	
Caramel	
Truffle	
Liquorice	
Fresh	
Clove	Raspberry
Mint	Blackberry
Pepper	Redcurrant
Leather	Blackcurrant
Tobacco	Strawberry
Sweet	Prune
Coffee	Liquorice
Fresh fruit	Fresh
Lychee	Clove
Violet	Pepper
Roses	Coffee
Toffee	Leather
Citric	Tobacco
Blackberry	Sweet
Blackcurrant	Floral
Redcurrant	Fresh fruit
Prune	Lychee
Apricot	Cassis
Sweet fruit	
Cinnamon	
Vanilla	
Floral	
Cassis	

found among monovarietal wines and wines obtained by blending of grape varieties used in this study. Similar results were obtained with Cencibel, Bobal, and Cencibel-Bobal co-winemaking wines by Gómez García-Carpintero [20].

3.2. Training Sessions of Panel. The panellists evaluated commercial monovarietal wines prior to the formal sessions in order to define the sensory attributes that better describe the sensory profile of wines, and also the attributes that can define the major differences among these. In each session, the subjects received three wine samples and individually described their similarities and differences with respect to their aroma. The judges generated a total of 27 olfactory descriptors (Table 2). As a group, the panellists then discussed the terms generated by each individual and, with the supervision of a panel leader, they consensually defined the terms that adequately described the aroma similarities and differences between the evaluated wines. Finally, 18 attributes (Table 2) were used as the best at describing the sensory profile of the wines and the main differences between them in smell terms. Training sessions have a twofold aim: achieving a consensus on the definition of each attribute and using the scales appropriately to quantify the intensity of the attributes. In consensus, the panellists also developed a sensory descriptive ballot for the wines, associating each descriptor with a 10-cm unstructured scale, anchored at its left

and right extremes by the terms “none/weak” and “strong,” respectively. Physical-chemical standards were used to define aroma attributes [11, 19, 20, 28, 29].

3.3. Quantitative Descriptive Sensory Analysis of Wines. In Table 3 are shown the average scores given by the tasters to the intensities of each attribute of the aroma profile and the standard deviation. In order to discriminate among the means of sensory data the Student-Newman-Keuls test was applied. In terms of olfactive profile, La Mancha Cencibel wines presented notes of licorice, fresh, leather, and tobacco but it was the red fruit aroma that presented the greatest intensity [20].

The monovarietal wine made from Moravia Dulce grape variety presented raspberry, blackberry, strawberry, liquorice, and tobacco notes, with greatest intensity of pepper and sweet notes. The olfactory profile from wines obtained by the blending of Cencibel and Moravia Dulce grape varieties presented a higher intensity in the attributes related to the red fruit notes, also showed coffee aromas, contributed by Cencibel grapes, and decreased sweet notes from Moravia Dulce. Cencibel-Moravia Dulce wine showed in general a greater intensity of the main attributes of the sensory profile than monovarietal wines, which increases the complexity of the sensory profile.

The sensory aroma profile of Tortosí wines was defined by raspberry, blackberry, redcurrant, blackcurrant, clove, liquorice, leather, tobacco, coffee, lychee, floral, and cassis notes. Wines obtained by co-winemaking of Cencibel and Tortosí grape varieties presented aroma sensory notes from the two varieties used in the elaboration, like lychee, floral, cassis, and clove odour from Tortosí, also an important contribution from Cencibel was observed due to the enhancement of red fruit attributes, tobacco, and prune aromatic characters.

Strawberry, fresh, tobacco, and fresh fruit were the attributes that better define the sensory profile of Rojal monovarietal wines. The aromas of co-winemaking wines from Rojal grape variety were more complex than the monovarietal ones, because the raspberry, blackberry, redcurrant, blackcurrant, strawberry, liquorice, fresh fruit, and cassis notes appeared in a greater intensity than in monovarietal wines, and some of these attributed were not found in the, respectively, monovarietal wine but they were identified by the tasters in the co-winemaking wine.

In general the expert tasters found in co-winemaking wines notes from the varieties employed, sometimes producing a synergistic effect and enhancing the aromatic notes in the studied wines; these results are in agreement with García-Carpintero et al. 2010.

3.4. Principal Component Analysis. Table 4 show the correlation coefficients among the attributes. According to the results, very great significant correlation ($p < 0.001$) was established between blackcurrant and redcurrant ($r = 0.911$), prune and redcurrant ($r = 0.941$), and fresh fruit and strawberry ($r = 0.961$) but in this research, these terms were used to describe related aromas and were not used redundantly [30].

TABLE 3: Mean scores and standard deviation ($N = 2$) of each aroma sensory attribute of monovarietal and co-winemaking wines.

Odour attributes	Wines					
	Moravia Dulce	Cencibel-Moravia Dulce	Tortosí	Cencibel-Tortosí	Rojal	Cencibel-Rojal
Raspberry	5.18 ^a (0.47)	6.53 ^b (0.21)	6.83 ^{b,c} (0.89)	7.11 ^c (0.29)	5.13 ^a (0.17)	7.07 ^c (0.22)
Blackberry	5.94 ^a (0.13)	6.21 ^{a,b} (0.11)	6.61 ^c (0.07)	7.44 ^d (0.30)	4.79 ^e (0.06)	6.27 ^b (0.38)
Redcurrant	2.90 ^a (0.16)	3.91 ^b (0.19)	4.60 ^c (0.08)	5.80 ^d (0.10)	2.70 ^a (0.06)	3.49 ^b (0.08)
Blackcurrant	2.32 ^a (0.16)	3.04 ^b (0.06)	4.15 ^c (0.12)	5.10 ^d (0.16)	2.37 ^a (0.06)	3.93 ^c (0.23)
Strawberry	2.75 ^a (0.17)	3.13 ^a (0.15)	0.00	0.00	6.93 ^b (0.36)	4.33 ^c (0.30)
Prune	0.24 ^a (0.09)	0.59 ^a (0.21)	0.00	2.45 ^b (0.97)	0.00	0.00
Liquorice	3.51 ^a (0.21)	5.10 ^b (0.11)	3.52 ^a (0.30)	3.94 ^c (0.42)	0.00	2.03 ^d (0.78)
Fresh	5.02 ^a (0.41)	6.36 ^b (0.05)	5.29 ^a (0.04)	6.02 ^{a,b} (0.42)	7.47 ^c (0.43)	4.96 ^a (0.32)
Clove	3.72 ^a (0.92)	4.09 ^{a,b} (0.28)	4.45 ^b (0.04)	4.83 ^b (0.65)	1.68 ^c (0.64)	4.48 ^b (0.33)
Pepper	4.45 ^a (0.30)	4.39 ^a (0.13)	1.27 ^b (0.14)	1.21 ^b (1.25)	1.56 ^b (0.20)	2.66 ^c (0.30)
Coffee	0.00	2.11 ^a (0.12)	5.11 ^b (1.11)	4.45 ^b (0.41)	0.00	2.19 ^a (0.14)
Leather	2.36 ^a (0.83)	2.39 ^a (0.07)	2.64 ^b (1.05)	2.63 ^b (0.00)	0.00	3.85 ^c (0.14)
Tobacco	3.81 ^a (0.06)	4.12 ^b (0.14)	2.91 ^c (0.06)	3.46 ^d (0.04)	4.62 ^e (0.05)	5.02 ^f (0.12)
Sweet	5.39 ^a (0.08)	3.59 ^b (0.21)	2.79 ^c (0.88)	3.65 ^b (0.27)	3.81 ^b (0.07)	3.46 ^b (0.26)
Floral	0.00	0.00	2.53 ^a (0.05)	1.95 ^b (0.15)	0.00	0.00
Fresh fruit	2.14 ^a (0.05)	2.49 ^a (0.07)	0.00	0.00	4.87 ^b (0.33)	4.59 ^b (0.10)
Lychee	0.00	0.00	3.21 ^a (0.32)	1.30 ^b (1.84)	0.00	0.00
Cassis	0.00	0.00	2.48 ^a (0.46)	1.40 ^b (0.08)	0.00	3.50 ^c (0.06)

^{a,b,c,d} Different superscripts in the same row indicate statistical differences at the 0.05 level according to the Student-Newman-Keuls test.

The first two principal components accounted for 85.2% of the total explained variance between the samples. Table 5 shows the rotated principal component loadings for aroma terms. Loading values (i.e., correlation coefficients) > 0.700 were marked throughout in boldface type. Based on these results, tobacco, fresh fruit, strawberry, floral, prune, lychee, redcurrant, sweet, blackcurrant, raspberry, and pepper were considered the more differentiating aroma characters of sample wines.

The results of the principal component analysis (PCA) on sensory aroma attributes from monovarietal wines and for co-winemaking wines are represented in Figure 1, which showed the simultaneous projection of the 12 wines and the 18 aroma descriptors with absolute correlation coefficient values greater than 0.700. Wine samples are written in bold; the axis “ x ” represents dimension 1 and the axis “ y ” represents dimension 2.

The wines investigated were separated in the space defined by the two principal components. Co-winemaking wines are situated on the positive “ y ” axis along the two principal component according to the intensity of raspberry, blackcurrant, coffee, redcurrant, prune, floral, clove, lychee, liquorice, leather, cassis, fresh fruit, and tobacco. Monovarietal wines, situated on the negative “ y ” axis are separated from the co-winemaking wines in relation to the intensity of fresh fruit, strawberry, pepper, and sweet aromas. Dimension 1 was separated clearly between the Tortosí, Moravia Dulce, and wines obtained by blending of Cencibel and Tortosí grape varieties, situated on the positive x -axis, and monovarietal

Rojal wines and Cencibel-Rojal and Cencibel-Moravia Dulce co-winemaking wines.

Mean intensities of attributes more correlated with PC 1 and 2 of monovarietal and co-winemaking wines show, respectively, in Figures 2 and 3. Each monovarietal wine had its own sensory profile; Rojal wine showed strawberry, fresh fruit, tobacco, and sweet and raspberry notes; Moravia Dulce presented similar profile to that of Rojal wine with lower intensity in strawberry and fresh fruit aromas, but Moravia Dulce wine showed a higher intensity in sweet character. The sensory profile of Tortosí wine was characterized by raspberry, blackcurrant, sweet, tobacco, and floral and lychee aromas. On the other hand in co-winemaking, wines showed an important Cencibel character modified by each of the minority grape varieties employed in the co-winemaking process.

4. Conclusions

Moravia Dulce monovarietal wine presented pronounced pepper and sweet notes with aromas of raspberry, blackberry, strawberry, liquorice, and tobacco. Tortosí wines were characterized by red fruit, clove, liquorice, leather, tobacco, coffee, lychee, and floral and cassis notes. Rojal monovarietal wines showed a different sensory profile with strawberry, fresh, tobacco, and fresh fruit notes. The wines obtained by the blending of each minority grape variety with Cencibel grapes presented more aroma complexity than the monovarietal wines. These wines presented sensory characteristics of the

TABLE 4: Correlation matrix between the aroma sensory attributes of monovarietal and co-winemaking wines.

	Raspberry	Blackberry	Redcurrant	Blackcurrant	Strawberry	Prune	Liquorice	Fresh	Clove	Pepper	Coffee	Leather	Tobacco	Sweet	Floral	Fresh fruit	Lychee	Cassis
Raspberry	1.000																	
Blackberry	0.753*	1.000																
Redcurrant	0.756*	0.885**	1.000															
Blackcurrant	0.851**	0.843**	0.911***	1.000														
Strawberry	-0.638	-0.867**	-0.819**	-0.695	1.000													
Prune	0.537	0.818**	0.941***	0.803**	-0.780*	1.000												
Liquorice	0.435	0.656	0.540	0.335	-0.732*	0.454	1.000											
Fresh	-0.374	-0.515	-0.139	-0.279	0.510	-0.035	-0.359	1.000										
Clove	0.713*	0.895**	0.663	0.701*	-0.758*	0.543	0.657	-0.742*	1.000									
Pepper	-0.355	-0.196	-0.471	-0.554	0.175	-0.492	0.415	-0.214	0.006	1.000								
Coffee	0.880**	0.791*	0.885**	0.884**	-0.794*	0.740	0.442	-2.84	0.679	-0.533	1.000							
Leather	0.685	0.663	0.380	0.510	-0.510	0.193	0.525	-0.763*	0.762*	0.163	0.414	1.000						
Tobacco	-0.344	-0.551	-0.618	-0.387	0.855**	-0.660	-0.532	0.225	-0.389	0.249	-0.639	-0.075	1.000					
Sweet	-0.709*	-0.220	-0.454	-0.583	0.070	-0.262	0.016	-0.264	-0.161	0.529	-0.603	-0.146	-0.048	1.000				
Floral	0.649	0.663	0.805**	0.744	-0.811**	0.787*	0.288	-0.192	0.472	-0.665	0.884**	0.182	-0.834**	-0.383	1.000			
Fresh fruit	-0.505	-0.770*	-0.798**	-0.597	0.961***	-0.819**	-0.676	0.315	-0.606	0.227	-0.743*	-0.274	0.846**	0.031	-0.846	1.000		
Lychee	0.527	0.495	0.577	0.517	-0.666	0.531	0.185	-0.274	0.420	-0.633	0.785*	0.135	-0.758*	-0.306	0.882**	-0.694	1.000	
Cassis	0.747*	0.441	0.335	0.651	-0.282	0.136	-0.063	-0.565	0.533	-0.420	0.562	0.686	0.034	-0.530	0.393	-0.078	0.382	1.000

, Significant at $p < 0.05$, $p < 0.01$ and $p < 0.001$, respectively.

TABLE 5: Rotated principal component loadings for aroma sensory terms.

Aroma term	Component	
	1	2
Tobacco	−0,970	0,089
Fresh fruit	−0,962	−0,093
Strawberry	−0,871	−0,159
Floral	0,861	0,376
Prune	0,789	0,476
Lychee	0,768	0,184
Redcurrant	0,720	0,630
Coffee	0,680	0,618
Blackberry	0,636	0,426
Sweet	0,031	−0,910
Blackcurrant	0,492	0,757
Raspberry	0,347	0,754
Pepper	−0,350	−0,732
Fresh	−0,190	0,221
Leather	0,054	0,259
Clove	0,443	0,287
Cassis	−0,034	0,535
Liquorice	0,509	0,045
% variance explained by PC	43.59	38.89
Cumulative % of variance	43.59	82.48

Loading values > 0.700 are marked throughout in boldface type.

FIGURE 1: Principal component analysis (PCA) biplot of the monovarietal wines, co-winemaking wines and aroma sensory attributes (MD: Moravia Dulce; TOR: Tortosí; RO: Rojal; CEN-MD: Cencibel-Moravia Dulce; CEN-TOR: Cencibel-Tortosí; CEN-RO: Cencibel-Rojal).

FIGURE 2: Olfactory sensory profile monovarietal wines: only the attributes more correlated (>0.75) with the two principal components have been included.

FIGURE 3: Olfactory sensory profile of co-winemaking wines: only the attributes more correlated (>0.75) with the two principal components have been included.

grape varieties used in the elaboration and in general, an increase in the aromatic intensity and therefore a greater complexity of the sensory aroma profile.

Additional Points

Practical Applications. Some grape varieties could benefit in the existence of other grape varieties that have an excess of volatiles compounds. In this research, the wines were elaborated by mixing different grape varieties together; this process involves comaceration and cofermentation steps. Co-winemaking technique could benefit from other compounds provided by the other grape varieties, resulting in a more

complex development than in monovarietal wines. This technique can be considered a good alternative to conventional winemaking process to increase the aromatic complexity and improve the sensory quality of wines.

Conflicts of Interest

There are no conflicts of interest related to this paper.

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