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ORIGINAL PAPER

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Geographical differentiation of white wines from three subzones of the designation of origin Valencia

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Abstract The chemical composition of 50 Spanish white wines, 1998 and 1999 vintages, from three subzones of the Designation of Origin Valencia (Alto Turia, Clariano and Valentino), was studied. The 35 components analysed were grouped according to the conventional parameters, alcohols and polyols, and esters. Discriminant analysis was applied to each one of these groups and to each one of the vintages; this did not allow us to correctly classify these wines in their corresponding subzone. To carry out a more exact classification of the studied wines in their corresponding subzone, it was necessary to carry out a discriminant analysis with the 35 parameters and the 50 wines (98% well classified). A stepwise discriminant analysis was used to eliminate the less significant variables. The discriminant analysis was also carried out using only 18 variables and this also led to successful results: 96% of the samples were correctly classified. Using only four parameters, total acidity, ashes (conventional parameters), pentanol (alcohols) and diethyl succinate (esters), we managed to successfully classify 84% of the wines studied into their corresponding subzone.

Keywords Wine characterization · White wines · Geographical differentiation · Discriminant analysis · Volatile compound

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Introduction

In order to characterize wines, it is necessary to know their analytical profile. The appropriate statistical treatment of the analytical data obtained allows the determination of which compounds show similar behaviour in a certain type of wine. Consequently, these compounds are the main discrimination factors, allowing differentiation between different wine styles [1, 2].

All common statistical techniques have already been applied to the characterization and differentiation of wines (discriminant analysis, analysis of main components, canonical analysis, HJ-biplot, multiple regression, artificial neural networks etc.), in terms of the grape varieties used in vinification [3, 4, 5], their different geographical origins [6, 7, 8], the different winemaking techniques [9, 10, 11], or the different characteristics of the harvest [12, 13]. Of them all, discriminant analysis is the most frequently used. It is applied to populations or groups of samples previously identified as such, enabling the classification of each individual later on, so as to verify that it belongs to the established group. The differentiation of the wines can be carried out if a set of wine components is taken into consideration [8, 14, 15], or a certain group of compounds, such as volatile components [16, 17], proteins [18], colour [19, 20], anthocyanins [21, 22], and isotope and trace elements [23, 24].

Therefore, the differentiation of wines from different geographical origins has been approached repeatedly and with success, whether among wines of different varieties and wine regions [15, 25], or when the aim was to differentiate among wines of the same variety, but grown in a different geographical area [26, 27]. However, this differentiation is much more difficult when the aim is to differentiate among wines of the same variety and grown in bordering areas where the climatological component has a dominant role [28].

A similar situation is when the objective is to differentiate white wines with designation of origin Valencia (Spain) in terms of their area of origin. The three sub-areas or subzones included in this Designation of Origin are Alto Turia, Clariano and Valentino. The subzone Alto Turia is located in the northwest of the province. This is the subzone with the smallest area and the highest altitude. The Mediterranean climate is influenced here by the altitude, which causes lower average temperatures and more rainfall. The subzone Valentino, contiguous to Alto Turia, occupies the central part of the province. It comprises the largest area of the three and its climatic characteristics are intermediate. The subzone Clariano occupies the southwest of the province, in the warmest area and with the least rainfall.

The soils of the three sub-areas are calcareous and poor in humus, and occasionally even have drainage problems. Regarding the cultivation and production techniques, there is no apparent differentiating tendency that could be the cause of the different characteristics observed in the wines . The predominant grape variety in the production of these white wines is Merseguera, but in contrast to Alto Turia, whose wines are produced with only one varietal grape, Valentino and Clariano also utilize other minority varieties.

Materials and methods

Material. For this work, 25 white wines from the 1998 harvest and 25 white wines from the 1999 harvest were studied, totalling 50 wines of Designation of Origin Valencia. The selection was as follows: from each year 5 wines of the subzone Alto Turia, produced completely with the variety Merseguera, 6 of the subzone Clariano, produced predominantly with the variety Merseguera, and 14 of the subzone Valentino, in which the dominant variety is Merseguera. Representative samples were taken from the subzone Valentino, and in the case of the Alto Turia and Clariano, all the wines present on the market at the time of the study have been studied.

These wines were bottled once their vinification was concluded and conserved at 15 °C. Their chemical composition was analysed 3 months later.

Methods. Physical and chemical analysis were conducted on these wines in order to assess those components that can influence flavor and taste. All the analyses were conducted in duplicate in order to work on the average values obtained.

The physical-chemical analyses were carried out according to the Official Methods established by the Official Gazette of the International Organization of the Wine (OIV) [29], so that density, alcohol content, pH, sugars, total and volatile acidity, SO_2 free and total, ashes and alkalinity of the ashes, were determined.

The volatile components were determined by gas chromatography which a Hewlett-Packard 5890 A chromatograph equipped with flame ionization detector and an integrative recorder HP-3390, using nitrogen as gas carrier. The dominant compounds were determined by direct injection, while the minority compounds had been previously extracted by means of liquid-liquid extraction with dichloromethane-pentane.

Acetaldehyde compounds, ethyl acetate, methyl acetate, methanol, 1-propanol, isobutyl alcohol and isoamyl alcohol were determined by direct injection of 1 μl of wine in a Carbowax 1500 filling column on 15% Chromosorb, with 80–100 mesh, 4 m long and l/8 inch diameter, using 4-methyl-2-pentanol as internal standard [30]. Glycerin and 2,3-butanediol were determined by direct injection of 1 μl wine on a Chromosorb 101 packet column, with 60–80 mesh, 2 m long and l/8 inch diameter, using 1,4-butanediol as internal standard.

The analysis of the ethyl propionate, isobutyl acetate, ethyl butyrate, isoamyl acetate, 1-butanol, 1-pentanol, hexil acetate, ethyl lactate, ethyl octanoate, ethyl decanoate, γ-butyrolactone, diethyl succinate, diethyl glutarate, ethyl lauratoe and 2-phenylethanol compounds, was carried out using a continual liquid-liquid extraction with a dichloromethane-pentane mixture in a 2:3 (v/v) proportion , and 1-heptanol was used as internal standard. The extract obtained (1 μl) was injected into a Supelcowax 10 capillary column, 60 m long and of 0.25 mm internal diameter [31].

The quantification of the parameters was carried out using the internal standard method, with standard dissolutions of the studied compounds, and confirmation of the effectiveness of the method was made by mass spectrometry, with a Hewlett-Packard 5979 mass spectrometer coupled to the chromatograph.

Statistical analyses. The initial statistical analyses of the data consisted of the performance of discriminant analyses of variables selected from the 35 compounds studied, grouped as conventional parameters, alcohols and polyols, or esters, for each one of the two harvests studied, as well as a discriminant analysis on all variables with the 50 wines of the two harvests studied together. The stepwise analysis was applied to the set of variables and wines with the objective of reducing the number of variables, so that the maximum classification percentages were obtained with the minimum number of variables, and with the variables selected in this way, new discriminant analyses were performed in order to establish their discriminant force.

Additionally, in order to specify the discrimination associated with each discriminant function, the difference in average values and dispersion was studied for the different groups, in relation to themselves. The analysis of the differences in average values was carried out using a variance analysis of each one of the groups studied, taking as variable response for each wine the value of its discriminant function, and as explanatory variable the group to which it belongs. To study whether the different groups of wines present identical or different dispersions regarding each discriminant function, a new ANOVA was carried out, using as variable response the square of the residuals obtained in the prior analysis of effect on the means.

The normality of the variables has been previously verified. As for the homocedasticity of the data, which is another basic hypothesis in applying the technique of discriminant analysis, the results obtained in this work that indicated the nonexistence of significant differences between the variances of the discriminant functions in the three subzones, validate this hypothesis. Similarly, it was confirmed that the mismatch ratio and the kurtosis were within the acceptable values.

In order to validate the discriminant functions, the different wines studied were classified according to them This classification was carried out by the jack-knife method, which consists of the classification of each individual according to the discriminant functions obtained, without taking into consideration that individual for its estimation.

The software packages used were Statgraphic Plus and BMDP.

Results and discussion

Table 1 and Table 2 show the average values and the standard deviations of the 35 compounds determined in the 25 wines studied in each harvest. The first 11 compounds correspond to conventional parameters, the next 10 to the group of alcohols and polyols, and the last 14 to the group of esters. A discriminant analysis was carried out on each one of these three groups, for each one of the harvests studied, thus also establishing the differences between subzones in the average values and dispersion of the discriminant canonical functions obtained for each one of the groups.

Table 1 Average values and standard deviations of the 35 variables studied in the wines of Alto Turia, Clariano and Valentino, in 1998 vintage

Compounds	Subzone		
	Alto turia (*n*=5)	Clariano (*n*=6)	Valentino (*n*=14)
Alcohol content % (v/v)	12.01±0.48	12.40±0.867	12.30±0.664
Density	0.994±0.0009	0.993±0.0008	0.995±0.0014
pH	3.015±0.100	3.152±0.268	2.977±0.191
Sugarg l^{-1}	1.324±0.169	1.168±0.073	1.549±0.594
Total acidity g l^{-1} tataric acid	5.207±0.454	4.374±0.153	5.467±0.618
Volatile acidity g l-1 acetic acid	0.313±0.032	0.391±0.079	0.422±0.099
Free SO_2 mg l^{-1v}	14.65±11.95	17.50±15.55	18.90±10.14
Total SO_2 mg l^{-1}	166.27±39.33	176.20±63.52	181.089±42.23
Ashesg l^{-1}	1.706±0.202	2.038±0.524	2.021±0.439
Ashes alkalinity meg l^{-1}	1.218±0.217	1.184±0.487	1.343±0.339
Acetaldehyde mg l^{-1}	46.73±19.59	53.89±13.66	48.58±19.33
Methanol mg l^{-1}	64.00±7.55	73.80±14.52	92.04±16.05
Propanol mg l^{-1}	26.15±3.01	30.69±8.021	25.99±5.89
Isobutyl alcohol mg l^{-1}	110.98±39.22	179.25±48.66	164.78±41.84
Isoamyl alcohol mg l^{-1}	199.43±33.23	176.58±56.55	193. 015±43.97
Glycerine mg l^{-1}	5879±1165	5867±1527	8103±2784
2,3-Butanediol mg l^{-1}	389.32±57.39	417.08±181.48	427.70±121.33
Butanol mg l^{-1}	1.99±0.68	3.52±1.19	2.949±0.996
1-Pentanol mg l^{-1}	0.031±0.0044	0.039±0.006	0.045±0.009
Cis-3-hexenol mg l^{-1}	0.122±0.056	0.145±0.063	0.122±0.051
2-Phenylethanol mg l^{-1}	38.35±5.07	52.01±12.97	53.97±14.69
Methyl acetate mg l^{-1}	7.45±3.07	7.86±4.88	7.40±15.81
Ethyl acetate mg l^{-1v}	33.32±5.68	47.73±10.29	50.15±16.01
Ethyl propionate mg l^{-1}	0.368±0.181	0.406±0.222	0.188±0.043
Isobutyl acetate mg l^{-1}	0.066±0.033	0.071±0.031	0.032±0.011
Ethyl butyrate mg l^{-1}	0.401±0.159	0.353±0.149	0.224±.079
Isoamyl acetate mg l^{-1}	0.380±0.185	0.783±0.472	0.503±0.231
Hexyl acetate mg l^{-1}	0.198±0.082	0.310±0.197	0.171±0.060
Ethyl lactate mg l^{-1}	45.90±15.14	97.76±49.	46.57±27.02
Ethyl octanoate mg l^{-1}	0.641±0.340	1.342±0.85	1.518±0.410
Ethyl decanoate mg l^{-1}	2.81±1.03	3.75±1.47	2.72±1.00
γ-butyrolactone mg l^{-1}	7.41±2.91	8.59±3.57	12.39±3.10
Diethyl succinate mg l^{-1}	2.71±1.06	5.6±2.81	4.44±2.12
Ethyl glutarate mg l^{-1}	0.034±0.012	0.0±0.0	0.047±0.021
Ethyl laurate mg l^{-1}	0.081±0.056	0.0±0.0	0.041±0.032

Differentiation according to conventional parameters

Discriminant analysis was applied to the conventional parameters analysed in each harvest studied, with the aim of comparing the variability between harvests. Two discriminant functions were obtained for each of the harvests studied. The first one represented 86.2% of the existing variability in the 1998 harvest, and 73.16% in the 1999 harvest. The first discriminant function, mainly associated with the total acidity, total sulphur dioxide, acetaldehyde, and alkalinity of the ashes in both harvests, and to the alcohol content and sugar in the 1999 harvest, differentiated Clariano wines (2), from Valentino (3) and Alto Turia (1). The second discriminant function, mainly related to the volatile acidity, pH and ashes, clearly differentiated Alto Turia wines from those belonging to the other two subzones (Fig. 1). By means of these two discriminant functions, all the wines of the subzones Alto Turia and Clariano were classified correctly; in the case of the subzone Valentino, three wines were classified as Alto Turia in the 1998 harvest, while in 1999, a Valentino wine was classified as Alto Turia and another one as Clariano.

The analysis of the differences in the means for the discriminant functions studied, confirms the results obtained in the discriminant analysis, making it impossible to correctly separate the Valentino wines. The study of dispersion regarding each discriminant function shows that there are no differences among the variances of these functions in the three subzones studied.

The fact that Valentino wines present more difficulties for classification may be due to its being in the intermediate area, between the other two, geographically

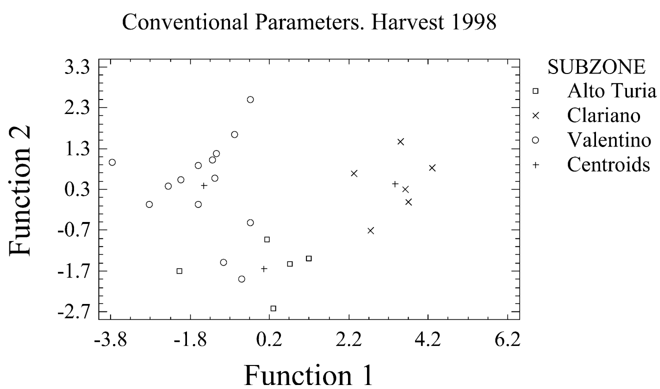

Fig. 1 Sample plot along first and second discriminant functions for the conventional parameters of wines of harvest 1998

Table 2 Average values and standard deviations of the 35 variables studied in the wines of Alto Turia, Clariano and Valentino, in the 1999 vintage

Compounds	Subzone		
	Alto Turia (*n*=5)	Clariano (*n*=6)	Valentino (*n*=14)
Alcohol content % (v/v)	11.49±0.440	12.55±1.05	12.36±0.924
Density	0.992±0.0019	0.993±0.0017	0.995±0.0018
pH	2.96±0.155	3.20±0.266	3.11±0.126
Sugarg l^{-1}	1.27±0.217	1.20±0.289	1.65±0.572
Total acidity g l^{-1} tataric acid	5.16±0.602	4.54±0.500	5.67±0.729
Volatile acidity g l-1 acetic acid	0.330±0.087	0.497±0.161	0.568±0.168
Free SO_2 mg l^{-1v}	9.32±4.05	10.99±6.14	8.84±5.58
Total SO_2 mg l^{-1}	110.97±23.73	146.06±73.12	179.65±81.01
Ashesg l^{-1}	1.54±0.272	2.54±0.119	2.06±0.479
Ashes alkalinity meg l^{-1}	1.34±0.264	2.19±0.151	1.70±0.415
Acetaldehyde mg l^{-1}	42.82±16.22	61.64±20.86	75.61±28.60
Methanol mg l^{-1}	64.00±7.55	73.80±14.52	92.04±16.05
Propanol mg l^{-1}	26.15±3.01	30.69±8.021	25.99±5.89
Isobutyl alcohol mg l^{-1}	110.98±39.22	179.25±48.66	164.78±41.84
Isoamyl alcohol mg l^{-1}	199.43±33.23	176.58±56.55	193. 015±43.97
Glycerine mg l^{-1}	5879±1165	5867±1527	8103±2784
2,3-Butanediol mg l^{-1}	389.32±57.39	417.08±181.48	427.70±121.33
Butanol mg l^{-1}	1.99±0.681	3.52±1.19	2.949±0.996
1-Pentanol mg l^{-1}	0.031±0.0044	0.039±0.006	0.045±0.009
Cis-3-hexenol mg l^{-1}	0.122±0.056	0.145±0.063	0.122±0.051
2-Phenylethanol mg l^{-1}	38.35±5.07	52.01±12.97	53.97±14.69
Methyl acetate mg l^{-1}	7.71±1.54	16.03±4.39	10.14±4.08
Ethyl acetate mg l^{-1v}	38.65±7.67	53.05±9.24	57.93±13.30
Ethyl propionate mg l^{-1}	0.316±0.155	0.666±0.236	0.457±0.222
Isobutyl acetate mg l^{-1}	0.055±0.019	0.040±0.010	0.059±0.020
Ethyl butyrate mg l^{-1}	0.352±0.040	0.347±0.089	0.447±0.141
Isoamyl acetate mg l^{-1}	0.324±0.058	0.265±0.079	0.366±0.121
Hexyl acetate mg l^{-1}	0.193±0.067	0.172±0.087	0.182±0.064
Ethyl lactate mg l^{-1}	44.88±12.57	59.45±11.26	57.52±21.38
Ethyl octanoate mg l^{-1}	0.798±0.224	0.270±0.061	0.445±0.239
Ethyl decanoate mg l^{-1}	0.711±0.277	4.89±2.47	4.49±2.05
γ-butyrolactone mg l^{-1}	5.37±0.411	8.04±2.42	9.46±2.49
Diethyl succinate mg l^{-1}	3.22±0.593	5.90±2.13	3.73±1.46
Ethyl glutarate mg l^{-1}	0.012±0.004	0.033±0.026	0.045±0.033
Ethyl laurate mg l^{-1}	0.090±0.031	0.077±0.042	0.055±0.040

bordering both. Thus, portions of its wines are produced closer to one area or the other, and the characteristics they present lead to confusion with the wines of the other subzones. In addition, it is the largest and least uniform of the three areas.

Alto Turia wines had the least alcohol content, volatile acidity and content in ashes. Clariano wines had the smallest concentration of sugar and total acidity, while the highest values in these compounds were found in Valentino wines.

The total acidity, an important component in this differentiation, varied considerably from one area to another, depending on the climate and the time of harvesting, as well as alcohol content and the pH, the ashes and the alkalinity, thus relating these variables directly with the climate, geographical situation and moment of harvesting [32, 33], while other variables that also participate in this analysis, such as total sulphur dioxide, volatile acidity and acetaldehyde are more directly related to the conditions of the harvest and the process of fermentation.

Differentiation according to alcohols and polyols

The first discriminant functions obtained with the alcohols and polyols of the 1998 and 1999 harvest represented, respectively, 56.95% and 84.31% of the total variability. The first discriminant function was mainly related to isobutyl alcohol, methanol and pentanol, and the second correlated with isobutyl alcohol in the two harvests, and with glycerin, pentanol and butanol in the 1999 harvest. 2-phenylethanol was correlated with the first discriminant function in the 1998 harvest, and with the second in the 1999 harvest.

As can be seen in Fig. 2, the first function separated Alto Turia wines from the rest of the wines, and the second differentiated Clariano wines. These wines were the only ones classified correctly in the 1998 harvest, because an Alto Turia wine was confused with Clariano and three Valentino wines were classified as belonging to Alto Turia and one to Clariano. In the 1999 harvest, it was possible to correctly differentiate the Clariano and Alto Turia wines.

The analysis of the differences in the means confirmed the results obtained in the discriminant analysis, and the Valentino wines could not be appropriately differentiated.

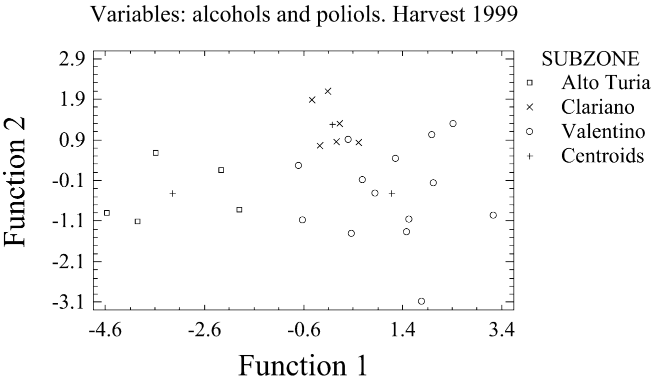

Fig. 2 Sample plot along first and second discriminant functions for the alcohols and polyols of the wines of harvest 1999

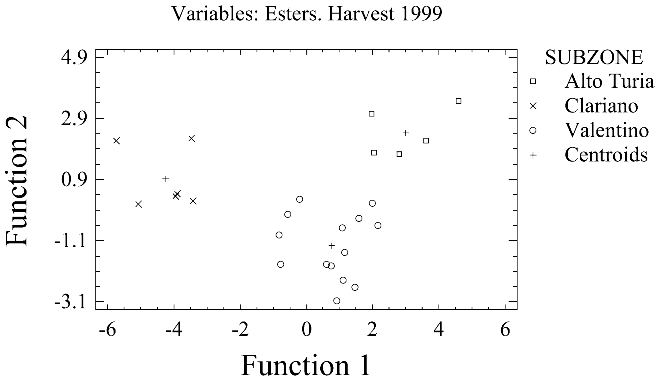

Fig. 3 Sample plot along first and second discriminant functions for the esters of wines of harvest 1999

As for the dispersion analysis, the differences were insignificant.

In the wines studied, the lower values of isobutyl alcohol, 2-phenylethanol, methanol, 2,3-butanediol, pentanol and glycerin corresponded to Alto Turia, and the highest to Valentino, with the exception of isobutyl alcohol and 2.3-butanediol whose higher values were found in Clariano.

The formation of higher alcohols is linked to the metabolism of the amino acids; thus, their concentration depends on the composition of the grape, the yeast stock that performs fermentation and its conditions, such as pH, turbidity of must, temperature, etc. [33, 34]. High concentrations of methanol indicate an excessive contact with the solid parts, maybe due to a defective separation and a fermentation with inadequate temperature control [34], but excess of SO_2 also contributes to an increase in methanol, and in some of the wines studied there were high contents of sulphur. The concentration of glycerin and 2,3-butanediol depends on the initial richness in sugars, pH of the medium and fermentation conditions, therefore, climate, variety and time of harvesting have considerable influence [35, 36]. Isobutyl alcohol has its origin in the glucid metabolism, and some authors have demonstrated that it is a differentiating variable between wines of different origins [37]. The 2-phenylethanol forms parallel to ethanol, and thus is linked in a way to the alcohol content, and therefore to the level of grape ripeness, variety and climate [36].

Differentiation from esters

The first discriminant function calculated for the esters in the 1998 harvest explained 68.16%, and that from 1999, 74.33% of the variability. The first discriminant function was mainly bound to the ethyl lactate, diethyl succinate, ethyl octanoate and ethyl acetate, and it allowed the separation of Clariano from Valentino wines. The second discriminant function, related to ethyl acetate and γ-butyrolactone in the two harvests, and also with isoamyl acetate and ethyl octanoate in the 1999 harvest, allowed the differentiation of the wines of the subzones Alto Turia from the wines of the other two subzones (Fig. 3), thus obtaining a correct differentiation of Alto Turia wines, subzones in which three Valentino wines and one Clariano were also classified.

The two discriminant functions established for the esters in the 1998 harvest did not allow for correct classification of all the wines , since three Valentino wines were classified as Alto Turia. On the other hand, all the wines from the 1999 harvest were classified correctly into their corresponding subzones. It should be noted that, for the three groups of compounds studied, the latter harvest allowed a better differentiation. The results of the variance analysis on the average values of the discriminant analysis canonical functions obtained for the group of esters in the two harvests matched the discriminant analysis, and did not display statistically significant differences in terms of dispersion.

The wines of the subzone Alto Turia had the highest values in ethyl octanoate, and the lowest for the rest of the compounds. Clariano had the lowest values for ethyl octanoate and the highest in ethyl lactate and diethyl succinate, while Valentino had the highest values in ethyl acetate and γ-butyrolactone.

The content and type of esters that appear in the wine depend to a great extent on the type of yeast and the conditions in which fermentation is developed. It is difficult to correlate these esters appropriately with conditions foreign to the process of fermentation, but the fact that these compounds allow the differentiation of wines so similar, with no differentiating characteristics observed in their production, may indicate that other variety or geographical factors can have a direct influence: the type of yeasts present, or in other aspects that condition its formation in the fermentation process.

Overall discriminant analysis for the two harvests

Due to the small number of available samples, it was impossible to carry out a combined discriminant analysis with all the variables in each one of the harvests studied;

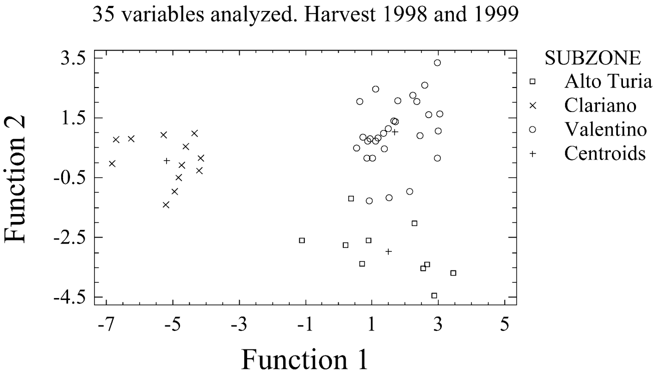

Fig. 4 Sample plot along first and second discriminant functions for the 35 of white wines variables analysed

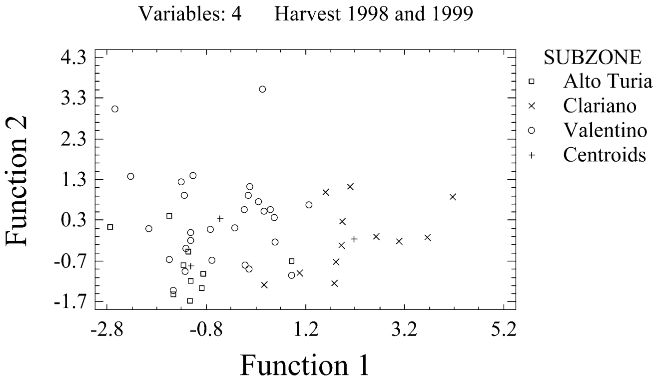

Fig. 5 Sample plot along first and second discriminant functions for the variables total acidity, ashes, isobutylic alcohol and diethyl succinate of wines

thus, the 50 wines from both harvests were used. Two statistically significant discriminant functions were obtained, which explained 75% and 25% respectively, of the existing variability. By means of these two functions we obtained a correct classification of 98% of the wines, since only one Valentino was incorrectly classified as Alto Turia (Fig. 4). The most relevant compounds in this differentiation were practically the same as those that contributed most to the differentiation of the three subzones, when discriminant analysis was applied to the variables separated by groups, a logical consequence due to the similar behaviour observed in the wines from the two harvests studied. As all the variables were included in the same treatment, it facilitated the correct classification of all the wines, since it is this last treatment that obtained the most correct classification, but it required a great number of analytical determinations and the handling of a large amount of data.

Reduction of the number of discriminant variables

In order to simplify the method, and to establish those variables essential for the differentiation of these three subzones, the number of variables was limited to those with the most relevance for the differentiation, by means of a stepwise analysis (BMDP), which allowed a reduction of the 35 initial variables to 18 statistically significant variables (density, pH, sugar, total and volatile, acidity, ashes, methanol, glycerine, 2,3-butanediol, butanol, isobutyl alcohol, 2-phenylthanol, ethyl acetate, isobutyl acetate, octanoate and ethyl decanoate, γ-butyrolactone and diethyl succinate). A new discriminant analysis with these 18 variables showed that the compounds with the highest relevance for this differentiation [sugar, ashes and total acidity (general components), methanol and butanol and isobutyl alcohol (alcohols), and ethyl acetate, ethyl octanoate, ethyl succinate and butyrolactone (esters)], also contributed, mainly to the differentiation of the wines when this was carried out by groups of compounds. The discriminant analysis carried out with these 18 variables led to the correct classification of 96% of the wines, since 48 of the 50 wines analysed were classified correctly (only 2 Valentino wines were classified as Alto Turia). The classification was therefore fully satisfactory, since with 17 compounds fewer, we were unable to classify appropriately with the previous treatment only one wine that was not only from the most conflicting area, but was also not correctly classified systematically when the statistical procedures were made by groups of related or chemically similar compounds. This demonstrates that is possible to reduce the number of variables, considering only the most significant, although inclusion of variables from differents groups is required.

When we continued reducing the number of variables by means of the discriminant technique "step by step" starting from the 18 variables selected in the previous analysis, we observed that with four of them (total acidity, ashes, isobutyl alcohol and diethyl succinate) 84% of the wines were classified correctly, the subzone Valentino being, as in the previous cases, the subzone where the classification failed (Fig. 5). When we applied the analysis of the variance to the three types of wines and the two discriminant functions obtained, it was confirmed that some Valentino wines were overlapped from both sides with Alto Turia and Clariano wines. The analysis of the dispersion did not show significant differences between the wines of these three subzones.

Three of the four variables implicated, total acidity, ashes and isobutyl alcohol, have proven their discriminant force in all those treatments where they were used, allowing us to put down their differentiating character to their direct relationships with the different soils and climatological conditions of the studied sub-areas. On the other hand, it is difficult to find a geographical origin to ethyl succinate—an unfavorable compound for the aging sensation that it contributes—since it is more closely related to the yeasts that carry out the fermentation and to the conditions in which this is carried out, but the high values observed in the Clariano wines contributed to a great extent to the differentiation of this subzone.

In view of the different treatments performed, we have established that Alto Turia and Clariano wines can be differentiated correctly according to their analysed composition, regardless of the group of compounds considered, with all the variables combined, or with a reduced number of them. Valentino wines can be differentiated for the most part, but a minimum percentage of them are classified incorrectly, due to their larger geographical dispersion and their proximity with the other areas.

In the three subzones of Designation of Origin Valencia there is a predominant variety and yet it is possible to differentiate the wines, since there is a marked influence of environmental conditions during the maturation of the grape and the moment of the harvest, as well as the composition of the soils and the minority varieties that are used for mixtures. The geographical situation also determines the type of yeasts and its proportionality in grape, and the wine making process can contribute differences that mask those due to the variety and cultivation area. In addition, the type of technology used in the cellars may also condition the type of wine produced.

So, in spite of the great number of variables that result in the final characteristics of white wines, some characteristic of the cultivation area, and others independent, which vary from one cellar to another, it is possible to differentiate the wines of the three subzones of origin studied.

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