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Impact of type of winemaking vessel on the chemical composition of Sauvignon blanc wines

Mariona Gil[1], Cristina Ubeda[1,2], V. Felipe Laurie[3], Álvaro Peña-Neira[4]

1 Universidad Autónoma de Chile, San Miguel, Santiago, Chile
2 Universidad de Sevilla, Spain
3 Universidad de Chile, Santa Rosa, La Pintana, Santiago, Chile
4 Universidad de Talca, Talca, Chile

Recently, the use of alternative vessels to oak barrels during winemaking has become increasingly popular[1, 2, 3], but little is known about their impact on the chemical composition of the final wines. To address this issue, a Sauvignon blanc wine was produced using cylindrical stainless-steel tanks, egg shape concrete vessels, egg shape polyethylene vessels and clay jars. The wines were fermented and aged on their lees for six months and chemically characterised as described hereafter.

Trial

Sauvignon blanc grapes (Leyda Valley, Chile) with a fruit yield of approximately 12 t/ha were hand-harvested, destemmed, crushed and pressed (at approximately 65 % juice yield). Then, the juice was subjected to a 24 h settling period prior to racking in the different types of vessels used for this trial (in triplicate): 150 L stainless steel tanks (CYL INOX), 980 L egg shape polyethylene tanks (OVO PE), 450 L egg shape concrete tanks (uncoated) (OVO CNCR), and 225 L clay jars (uncoated) (JAR CLAY). All the vessels were kept in an underground cellar at a controlled temperature of around 18 °C. Fermentation was monitored daily by measuring the must density and temperature. The juice had 22.1 Brix, 6.75 g/L (tartaric acid equivalents) of titratable acidity, a pH of 3.4 and 174 mg/L of yeast assimilable nitrogen (YAN) and was inoculated with commercial starter yeasts. Once the alcoholic ferntation had finished, the wines were sulfited (200 mg $K_2S_2O_5$/L) and kept in the same vessels for six months of aging on their lees. A single *batonnage* was performed at half aging time; and then the wines were bottled and stored in a dark cellar until analysis (approximately two months later).

TABLE 1. General analyses of wines from each kind of vessel (mean ± SD, different letters in a row indicate statistical differences (p<0.05) among vessels).

Parameter	CYL INOX	OVO PE	OVO CNCR	JAR CLAY
Ethanol % vol.	13.4 ± 0.1	13.3 ± 0.1	13.4 ± 0.2	13.3 ± 0.1
pH	3.32 ± 0.01 a	3.31 ± 0.01 a	3.38 ± 0.01 b	3.28 ± 0.01 a
Titratable acidity (g/L)	7.06 ± 0.25 b	7.20 ± 0.04 b	6.42 ± 0.21 a	6.90 ± 0.06 b
Turbidity (NTU)	3.88 ± 0.87 a	5.58 ± 0.18 b	6.35 ± 0.90 bc	7.48 ± 0.76 c
Low M.W. phenolic compounds (mg/L)	225.8 ± 6.9	228.7 ± 5.0	224.2 ± 1.8	232.7 ± 1.6
Color Intensity (AU)	0.124 ± 0.020	0.124 ± 0.011	0.144 ± 0.014	0.142 ± 0.009
Conductivity (µS/cm⁻¹)	1.77 ± 0.03	1.81 ± 0.05	1.81 ± 0.05	1.80 ± 0.03
Potassium (K) (mg/L)	605 ± 30	598 ± 21	607 ± 19	582 ± 36
Phosphorous (P) (mg/L)	115 ± 2 b	124 ± 3 c	112 ± 2 b	106 ± 5 a
Calcium (Ca) (mg/L)	61 ± 3 b	63 ± 2 b	38 ± 5 a	57 ± 7 b
Silicon (Si) (mg/L)	32 ± 7 a	27 ± 1 a	61 ± 11 b	26 ± 1 a
Sodium (Na) (mg/L)	14.9 ± 2.0 a	17.1 ± 0.8 a	22.4 ± 4.5 b	16.1 ± 0.5 a
Magnesium (Mg) (mg/L)	10.8 ± 1.9 a	8.9 ± 4.0 a	60.6 ± 27.5 b	19.3 ± 9.5 a
Iron (Fe) (mg/L)	0.520 ± 0.061 a	0.433 ± 0.021 a	2.447 ± 0.341 b	0.577 ± 0.110 a
Copper (Cu) (mg/L)	0.107 ± 0.012 a	0.110 ± 0.010 a	0.093 ± 0.015 a	0.170 ± 0.040 b

Chemical composition of the resulting wines

The vessels used for winemaking did not impact the alcohol, colour intensity or phenolic content of the wines (Table 1). The lack of differences in colour intensity and phenolic content was somewhat surprising, given that oxygen has been shown to permeate through polyethylene, concrete and clay, but not through stainless steel. Instead, the use of uncoated concrete or clay vessels showed a higher concentration of iron and copper in the resulting wines which could contribute to future wine oxidation.
The results for the different types of Vessels clearly showed impacts on titratable acidity and pH of the resulting wines (Table 1), with egg shape concrete vessels having the lowest titratable acidity and the highest pH. Such results could be explained by the release of inorganic compounds from concrete, such as silicon, sodium and magnesium. Moreover, it seems that concrete vessels favour the precipitation of calcium salts during winemaking, since the concrete vessel wines had the lowest calcium content.

The profiles of the volatile compounds are summarised in Figure 1, in which no differences for terpenes and alcohols can be observed. In contrast, wines from clay jars had lower ester and acid content compared to wines from stainless steel and concrete vessels. Even though wines from clay jars showed the lowest content of volatile compounds, they had lower C6 compounds content (related to herbaceous scents) and a higher amount of ethyl heptanoate (an ester related to primary aromas from grapes, a result of yeasts not synthesising compounds containing backbones with an odd number of carbon atoms). Thus, it can be hypothesised that wines from clay jars are perceived as being fruitier, although, due to their lower ester content, they could also be less aromatically intense. These results seem to indicate that vessels can modulate the aromatic profile of wines, either by affecting yeast metabolism during alcoholic fermentation or by modifying the evolution of volatile compounds during ageing. This is an interesting possibility, since these kind of vessels could be used as alternatives to oak barrels - thus avoiding the aromatic shift resulting from contact with the wood - and widen the range of blending options.

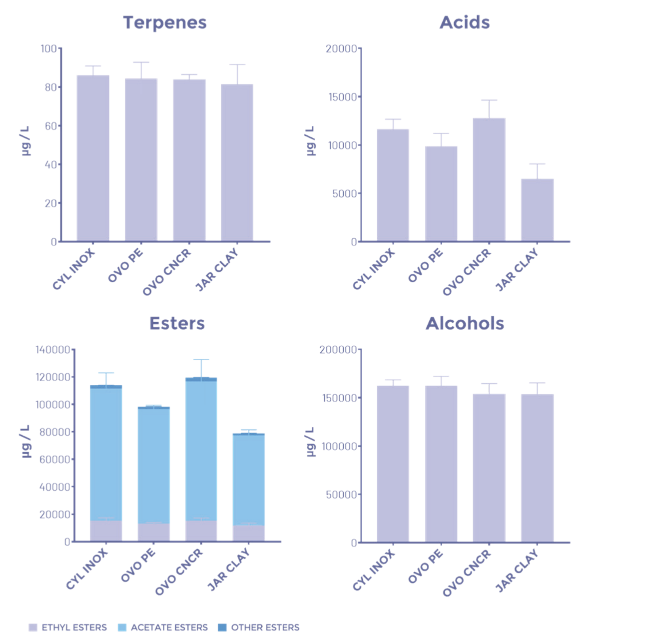

FIGURE 1. Main classes of volatile compounds from wines fermented in different kinds of vessels.

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The soluble polysaccharide content of wines from different vessels are shown in Figure 2. The method used for analysing the soluble polysaccharides of wines allows them to be separated according to their molecular mass (which is based on the size of the molecule). As a result, four different fractions of polysaccharides were obtained: the largest polysaccharides (F I), intermediate-sized polysaccharides (F II), small-sized polysaccharides (F III), and oligosaccharides (comprising a few molecules of carbohydrates) (F IV). The sum of these four fractions represents the total amount of polysaccharides. Wines from CYL INOX and OVO CNCR vessels showed lower polysaccharide content than those from JAR CLAY. Moreover, wines from CYL INOX vessels showed the lowest content of oligosaccharides (F IV; accounting for polysaccharides of 2 to 5 KDa in molecular mass). In contrast, wines form JAR CLAY vessels showed the highest content of high molecular mass polysaccharides (F I; 50 to 700 KDa) and oligosaccharides (F IV). The results therefore show that clay jar wines contain more polysaccharides than CYL INOX wines, as well as OVO CNCR wines. Three out of four vessels used in this trial were egg shape. The wider end of OVO PE and OVO CNCR is at the bottom, while it is at the top of JAR CLAY. One of the reasons put forward for using egg shape vessels is that their shape favour the formation of convection currents inside the liquid, thus preventing suspended solids from settling at the bottom of the vessel and causing the release of yeast-derived polymeric carbohydrates into the wine. This hypothesis is supported by theoretical data[4], but whether the alleged convection currents effectively increase the colloidal content of wines is not easy to prove. Alternatively, the extent of the surface contact between the settled solids and wine in the round-bottomed tanks may help explain the rise in polymeric carbohydrates[1]. In terms of the shape of the vessels used during this trial, it is possible to assume that, compared to egg shape vessels, the inner walls of the jars have a larger surface area on which solids can settle (as showed in the diagram of Figure 2), and that this surface can be estimated. The proportion of settled solids surface contact with respect to the volume of wine is about 44.6 cm^2/L for clay jars (corresponding to 224 L/m^2) and about 34.0 cm^2/L for concrete egg shape vessels (corresponding to 295 L/m^2). Thus, it seems reasonable to have found a higher enrichment of wine polysaccharides in clay jars than in concrete egg shape vessels.

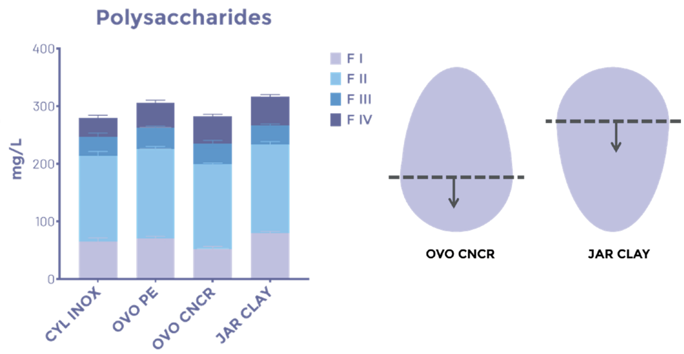

FIGURE 2. Polysaccharide content of wines from each kind of vessel (left) and diagram of ovoid vessels (right).

Conclusions

The results regarding volatile compounds suggest that selecting the right kind of vessel may help enhance or mitigate certain aromatic features of the resulting wines and be a good tool for upgrading typicality. Moreover, the results of this trial seem to indicate that vessel material has greater impact on the chemical composition of the resulting wines than vessel shape. Although the overall chemical differences between the wines were small, the changes produced by different kinds of vessels may offer winemakers a wider range of wine blending options, as well as a tool for upgrading typicality. However, the magnitude of the differences reported suggests that the use of different kinds of vessels could help winemakers modulate some final attributes of wine to a limited extent, the main attributes of the resulting wines depending much more on the raw grapes and winemaking practices than the type of vessel employed. ■

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