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Improvement of Verdejo white wines by contact with oak chips at different winemaking stages

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ABSTRACT

The effect that the addition of wood at different stages of the winemaking process has on the volatile composition and sensory characteristics of Verdejo wines has been studied. Verdejo control wine was made by the traditional winemaking process without oak chips. Oak chips (7 g/L) were added at different stages of the winemaking process: during alcoholic fermentation (OCAF) and in the young wine (OCW). Higher alcohols, ethyl acetate, hexyl acetate, isoamyl acetates and ethyl esters of straight-chain fatty acids were present at higher concentrations in wines that had contact with oak chips during alcoholic fermentation when compared to control wines. The highest concentrations of benzene compounds, oak lactones and furanic compounds were found in both wines in contact with oak chips, particularly in CW samples. Different sensorial profiles were obtained for the wines depending on the stage of the winemaking process at which the chips were added. All wines investigated in this study can provide a viable alternative to traditional Verdejo wines.

1. Introduction

In recent years there has been a change in the concept of the use of wood in wines. Traditionally, wine ageing in oak barrels is employed in wine production as an indispensable step for the elaboration of high quality wines. Nevertheless, ageing wine in barrels requires long periods of contact time. This fact, together with the high price of barrels, their limited lifetime, and the large space and maintenance required, make traditional maturation systems costly and laborious (Garde-Cerdán & Ancín-Azpilicueta, 2006).

Alternatives to oak barrels are being used quality of the wine produced. One of these practices is the use of oak chips, which produce chemical and sensory properties similar to those produced in barrels (Bertrand, Barbe, & Gazeau, 1997; Chassin, 1999; García-Carpintero, Gómez Gallego, Sánchez-Palomo, & González Viñas, 2011; Gómez García-Carpintero, Gómez Gallego; Sánchez-Palomo & González Viñas, 2012; Gómez García-Carpintero, Sánchez-Palomo & González Viñas, 2014; Wilker & Gallander, 1988). The use of short contact times with wood chips provided results similar to those obtained during barrel aging (Wilker & Gallander, 1988). Wines treated with oak chips matured more quickly than wines aged in barrels and a deeper colour and volatile oak extraction were observed (Arapitsas, Antonopoulos, Stefanou, & Dourtoglou, 2004; Del Álamo-Sanza, Nevares-Dominguez, Cárcel-Cárcel & Navas-Gracia, 2004).

In certain countries known as 'New World' winemaking countries, such as South Africa, Australia and Chile, oak wood pieces have been used for many years. However, it was only a few years ago that the European Union (EU) authorised the use of oak wood pieces in winemaking [Council Regulation (EC) No.2165/2005 of 20 December 2005] and regulated the designation and presentation of wines treated with oak wood pieces [Commission Regulation (EC) No. 1507/2006 dated 11 October 2006].

These EU regulations led to major changes in European countries with a long-standing oenological tradition, such as Spain, France and Italy, where winemaking practices tend to be extremely restrictive. Now each European country has to formulate its own legislation in order to apply these EU Regulations and they have to define the labelling process in order to inform consumers about the winemaking process.

Results similar to those obtained during barrel aging are achieved with short contact periods with wood chips (Wilker & Gallander, 1988). The oxidation aromas and colour changes produced during barrel aging of white wines could be avoided by using oak chips and oak notes can be imparted to wines without

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decreasing the fresh and fruity characteristics. The quantity of chips, type of oak wood and treatment and sensory characteristics of the wines obtained must be investigated in order to ensure the production of quality wines with acceptable properties (Guchu, Díaz-Maroto, Pérez-Coello, González-Viñas, & Cabezudo Ibáñez, 2006; Pérez-Coello et al., 2000). Wines treated with oak chips matured more quickly than wines aged in barrels and deeper colours and higher volatile oak extraction were observed (Arapitsas et al., 2004; Del Álamo-Sanza et al., 2004). Fermentations in the presence of oak chips have been compared with cask maturations in another three studies (Gutierrez Afonso, 2002; Gutierrez Afonso, 2003; Pérez-Coello et al., 2000) and compositional and sensory differences were established. Guchu et al. (2006) compared the sensory characteristics of Chardonnay wines treated with American and Hungarian oak chips.

Vitis vinifera cv. Verdejo is an important white grape variety that has recently been cultivated in La Mancha region but is also the basis of the Rueda Denomination of Origin, which produces young white wines with fruity attributes (citrus and tropical characteristics) with nuances of green fruit (Rodríguez-Nogales, Fernández-Fernández, & Vila-Crespo, 2009; Sánchez-Palomo, Alonso-Villegas, & González Viñas, 2015; Sánchez-Palomo, Gómez García-Carpintero, Alonso-Villegas, & González-Viñas, 2010). A range of different winemaking technologies are applied in order to provide diversification in the market and increase the range of products on offer to the consumer. In this respect, the goal of this study was to characterise the volatile composition and sensory profile of Verdejo wines treated with oak chips at two different stages of the winemaking process. It was envisaged that the results would provide a global profile from which the best treatment as an alternative to oak wood barrels could be identified.

2. Material and methods

2.1. Wine samples

Vitis Vinifera cv. Verdejo white grapes were obtained from the vineyards of La Mancha in the mid-southeast of Spain and they were harvested manually in their optimal ripening stage (20 °Brix) in good sanitary conditions. Verdejo control wine was elaborated by following the traditional white winemaking process without the addition of oak chips. The rest of the Verdejo wines were elaborated with the addition of oak chips at a dose rate of 7 g/L at the beginning of alcoholic fermentation, during alcoholic fermentation (OCAF) and at the end of alcoholic fermentation, during wine maturation over one week (OCW). In order to avoid an excessive impact of the wood character in wines, which could have a negative effect on taste, the amount of chips used in this study was selected according to the results of previous research (Guchu et al., 2006; Pérez-Coello et al., 2000). The oak chips (as a powder whithout sap-wood or bark and with clear brown satin as colour) were obtained from a mix of American (*Quercus alba*) and French oak (*Quercus petraea*) with medium toast (Nobile Original Blend, Laffort), qualified for the elaboration of products for direct human consumption, in accordance with the current International Œnological Codex and the Australian Food Standards code. Three batches of grapes (25 Kg each one) were destemmed and crushed in a bladder press. The must was homogenized and was then distributed into six vessels of 10 L. All musts were submitted to SO_2 addition (100 mg/L, as $K_2S_2O_7$) to avoid possible must oxidation. The fermentations were carried out in duplicate. *Saccharomyces cerevisiae* yeasts (CECT 10835) were selected to carry out the alcoholic fermentation. The fermentation was controlled by monitoring the density and by enzymatic methods for residual sugar (Boehring Mannheim, Germany). All fermentations were conducted with the temperature adjusted to 18 °C. The wines were decanted, filtered through 0.45 μm membranes (Millipore, Bedford, MA, USA), bottled and stored in a conditioned room at 10 °C prior to chemical analysis and sensory evaluation.

2.2. Reagents and standards

Dichloromethane and methanol were purchased from Merck (Darmstadt, Germany). Ammonium sulfate and anhydrous sodium sulfate were obtained from Panreac (Barcelona, Spain). Pure water was obtained from a Milli-Q purification system (Millipore, US). LiChrolut EN resins were purchased from Merck (Darmstadt, Germany). The chemical standards were supplied by Sigma (St. Louis, MO, USA), Aldrich (Gillingham, UK), Firmenich (Geneva, Switzerland), Panreac (Barcelona, Spain), Merck (Darmstadt, Germany), Fluka (Buchs, Switzerland) and Lancaster (Strasbourg, France).

2.3. Instrument

An Agilent Gas Chromatograph model 6890 N coupled to a Mass Selective Detector model 5973 inert equipped with a BP-21, Polyethylene glycol TPA treated, capillary column (60 m × 0.25 mm i. d.; 0.25 μm film thickness) was used to perform Gas Chromatography Mass Spectrometry (GC-MS) analysis.

2.4. Standard chemical analysis of wines

O.I.V. International Oenological Codex, 2006, was employed for the analysis of Total Acitidity, °Brix and pH in musts, as well as total and volatile acidity, alcoholic strength (% v/v), pH, and total and free SO_2 in Verdejo wines.

2.5. Analysis of major volatile compounds

Major volatile compounds were analysed by direct injection into an HP-5890 gas chromatograph with an FID detector and a CP-Wax-57 capillary column (50 m × 0.25 mm i. d.; 0.25 μm film thickness). The samples (1 μL) were injected in split mode with a split ratio of 1:15. The carrier gas was He (0.7 mL/min). The oven temperature programme was: 40 °C (5 min) − 4 °C/min − 120 °C. The injector and detector temperatures were 250 and 280 °C, respectively (Sánchez-Palomo, Pérez-Coello, Díaz-Maroto, González-Viñas, & Cabezudo, 2006).

2.6. Extraction of minor volatile compounds

The wine samples (100 mL) were passed through preconditioned styrene-divinylbenzene cartridges (LiChrolut EN, Merck, 0.5 g of phase) at a flow rate of 1 mL/min according to the method proposed by Sánchez-Palomo et al., 2006. The column was rinsed with pure water (50 mL) to remove sugars and other low molecular weight polar compounds. The volatile compounds were eluted with dichloromethane (10 mL) and the extract was concentrated to a final volume of 200 μL under a nitrogen stream.

2.7. Chromatographic conditions

The oven was programmed at an initial temperature of 70 °C for 5 min and this was then increased at a rate of 1 °C/min to 95 °C, maintained at 95 °C for 10 min and then increased up to 200 °C at a rate of 2 °C/min. The temperature was maintained at 200 °C for 40 min. The carrier gas was helium at a flow rate of 1 mL/min. The sample (1 μL) was injected in splitless mode. Mass spectrometry detection was performed by electronic impact ionisation (70 eV):