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Impact of Nitrogen Sparging on Chemical and Sensory Characteristics of Verdejo and Sauvignon blanc Wines

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The effect of sparging (gas injection to displace dissolved oxygen – DO) was studied in Verdejo and Sauvignon blanc white wines with different oxygen levels prior to bottling. Sparging did not immediately alter chemical parameters, but it had an influence in their evolution during the bottle aging, especially in Sauvignon blanc, observing that color and F-SO_2 (free SO_2) were better preserved, and a reduction in volatile compounds was observed in some cases. Sensory analysis showed that deoxygenated wines had more fruity notes and fewer oxidized aromas, particularly in the Verdejo samples.

Materials and methods

White wines from the Verdejo and Sauvignon blanc varieties were used to eliminate different concentrations of DO (3, 6, and 8.4 mg/L) through sparging with N_2. The process was carried out in duplicate using 4 L Plexiglas tubes (2 m high and 5 cm wide) at a temperature of 15.5 °C, employing a porous metal diffuser and 99.9 % pure nitrogen from a generator. DO was reduced to <0.3 mg/L by applying a nitrogen flow of 0.03 L/min, following a previously tested methodology with certain modifications[1 2]. Oxygen content was measured using a DP-PSt6 immersion probe connected to a meter (PreSens GmbH, Regensburg, Germany), submerged 10 cm below the wine surface. After DO removal, the wines were stored for 6 months in 0.375 L bottles sealed with synthetic stoppers to minimize oxygen ingress. Bottles were pre-inerted with N_2 and kept under controlled temperature (15.5–16.5 °C) and humidity (72.5–76.5 % RH) conditions to evaluate their evolution. Synthetic stoppers were selected to ensure consistency in oxygen transmission rate (OTR) across all samples, minimizing variability that could arise from the natural heterogeneity of cork. The wines studied were as follows: wines without sparging (W 3: wine with 3 mg/L DO; W 6: wine with 6 mg/L DO; W 8.4: wine with 8.4 mg/L DO); wines with sparging (DEOX 3: wine with 3 mg/L DO deoxygenated; DEOX 6: wine with 6 mg/L DO deoxygenated; DEOX 8.4: wine with 8.4 mg/L DO deoxygenated).

Classical enological parameters were analyzed, including alcohol content, pH, total and volatile acidity, free SO_2 (F-SO_2) and total SO_2(T-SO_2), total phenolic compounds, color, and absorbance spectrum between 330 nm and 700 nm[3]. Minor volatile compounds were determined by GC-MS[4]. Sensory analysis was conducted in a tasting room certified according to UNE-EN ISO 8589 standards, with a panel of 11 expert tasters. Two bottles were analyzed for each condition.

Effect on the absorbance spectrum

After 6 months in the bottle, the wines with sparging showed lower absorbance values between 380 and 500 nm compared to those that were not sparged, especially in Sauvignon blanc (Figure 1). This result could indicate a lower increase in color intensity and a less evolution toward to oxidation, thereby, protecting different polyphenols that are sensitive to oxidative processes.

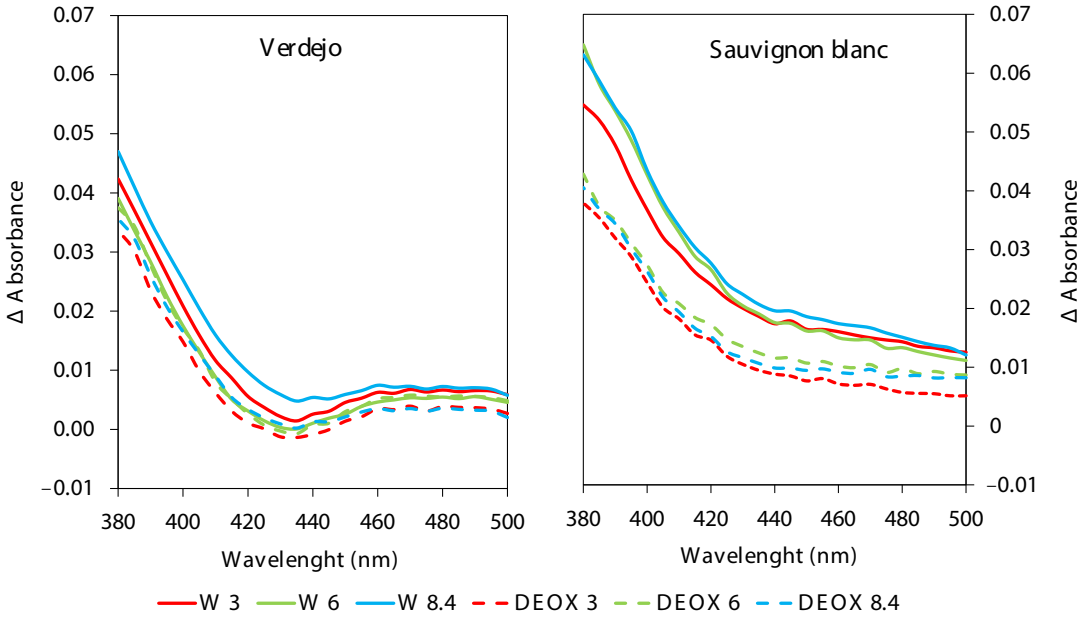


FIGURE 1. Difference in the absorbance spectrum of Verdejo and Sauvignon blanc wines at 6 months of bottle aging and at 0 months.

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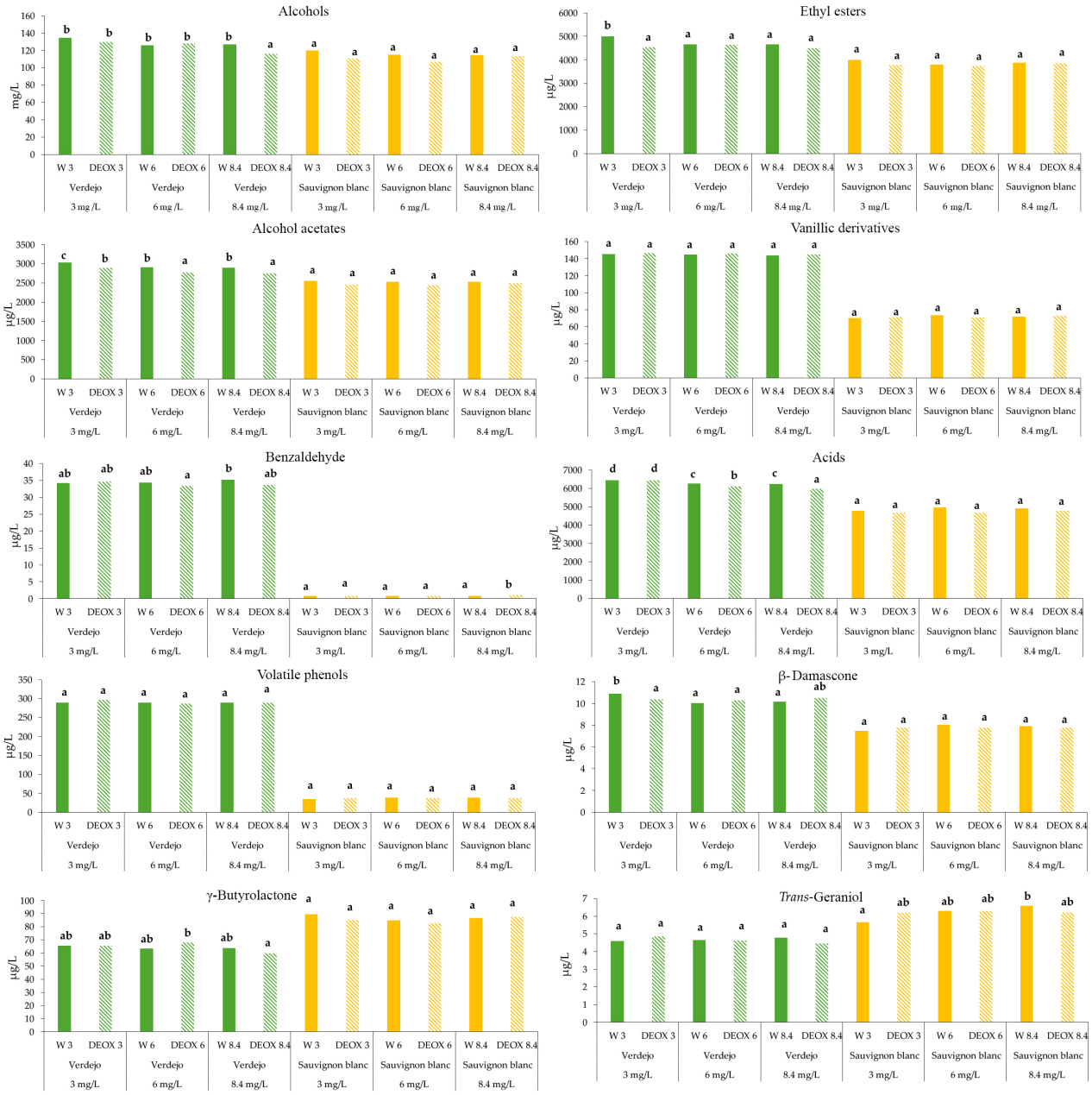


FIGURE 2. Concentration of the different groups of volatile compounds in Verdejo and Sauvignon blanc wines after sparging. Different letters indicate statistically significant differences ($p < 0.05$) between the wines.

Effect on volatile compounds

Sparging with N_2 affected some families of volatile compounds, but depending on the variety (Figure 2).

In Verdejo wines, a slight reduction in acetate esters, volatile fatty acids, and β-damascenone was observed, which could have a sensory impact. In contrast, in the Sauvignon blanc wines, sparging did not show significant effects on most volatile compounds, except for a slight increase in benzaldehyde in DEOX 8.4. During the 6-month bottle storage period, the wines exhibited changes in their volatile composition, with increases mainly in ethyl esters, alcohols, and vanillin derivatives (Figure 3). In Sauvignon blanc, these increases were greater in the wines without sparging than in those with sparging, while in Verdejo no significant differences were found. γ-Butyrolactone, β-damascenone, and benzaldehyde also increased, although to a lesser extent in the wines with sparging. Alcohol acetates decreased in both varieties, although the loss was less pronounced in the wines with sparging. The remaining compounds showed different evolution depending on the variety and the wine analyzed.

Effect on the sensory profile

Sparging did not produce immediate significant differences in the wines, but after 6 months in the bottle, differences were observed, especially in the olfactory phase. In the case of Verdejo, the wines subjected to sparging (DEOX 6 and DEOX 8.4) exhibited more fruity aromas, which are typically produced by ethyl esters and alcohol acetates, than the wines without sparging bottled with 6 and 8.4 mg/L of DO (W 6 and W 8.4). They also showed fewer oxidized notes, which are associated with the formation of oxidation aldehydes such as Strecker aldehydes, and fewer phenolic notes, which are related to the formation of volatile phenols. In Sauvignon blanc wines, initial sensory differences were more related to the oxygen level than to sparging although after aging, the DEOX 8.4 wine displayed more fruity aroma than W 8.4. Therefore, the removal of high concentrations of oxygen in these wines also proved beneficial for preserving or enhancing the olfactory phase.



FIGURE 3. Concentration of the different groups of volatile compounds in Verdejo and Sauvignon blanc wines after 6 months of bottle aging. Different letters indicate statistically significant differences ($p < 0.05$) between the wines.

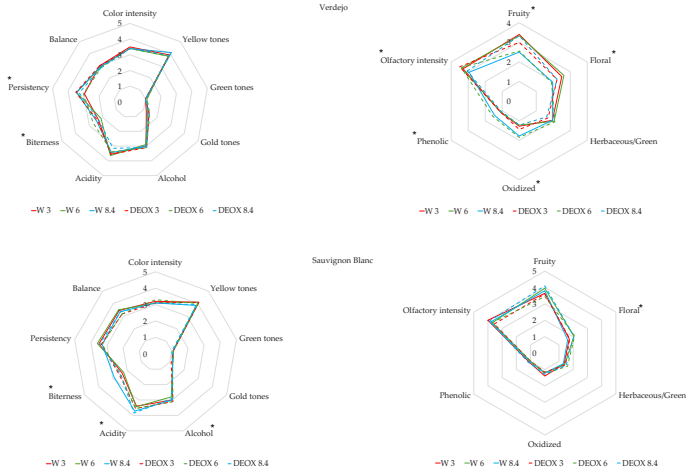


FIGURE 4. Sensory analysis of *Verdejo* and *Sauvignon blanc* wines after 6 months of bottle aging. The asterisk (*) indicates statistically significant differences ($p < 0.05$) between the wines.

Conclusions

Although sparging did not alter the basic chemical parameters in the short term, its application improved color preservation and sensory profile during bottle aging, especially in Sauvignon blanc. The effect on volatile compounds was more noticeable in *Verdejo*, with slight losses of esters and volatile acids. From a sensory perspective, sparging improved aromatic evolution of wines, reducing oxidized notes and enhancing fruit expression, especially after 6 months in wines which had high levels of DO initially and had been removed prior to bottling. ■

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