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Micro-oxygenation of wines produced using toasted vine-shoots (SEGs)

Cristina Cebrián-Tarancón[1]✉, Francisco Fernández-Roldán[2], M. Rosario Salinas[1], Gonzalo L. Alonso[1], Ana M. Martínez-Gil[3], María del Álamo-Sanza[3], Ignacio Nevares[4], Rosario Sánchez-Gómez[1]✉

[1] Grupo de Química Agrícola, E.T.S. de Ingeniería Agronómica y de Montes y Biotecnología, Universidad de Castilla-La Mancha, 02071 Albacete, Spain.
[2] Pago de la Jaraba Winery, Crta, Nacional 310, km 142, 7, Villarrobledo, 02600, Spain.
[3] Departamento de Química Analítica, UVaMOX – Universidad de Valladolid, 34004 Palencia, Spain.
[4] Departamento de Ingeniería Agroforestal, UVaMOX – Universidad de Valladolid, 34004 Palencia, Spain.

This study assessed the quality of Tempranillo wines after 35 days of contact with two different doses of SEGs ("Shoots from vines - Enological - Granule") and two micro-oxygenation levels, analysed at bottling and after six months of aging. Treated wines exhibited a smoother, more harmonious sensory profile, with well-integrated notes of toast, vanilla, nuts, and "SEGs", than the control wine. Phenolic compounds decreased, except for *trans*-resveratrol, which mainly increased with higher SEGs doses. Regarding volatile compounds, the presence of vanillin and guaiacol in the treated wines was particularly notable, especially after six months in the bottle.

Context

Sustainable wine production is increasingly trending in recent years, thus, greater importance is attributed to new methods of producing wine incorporate the reduction of waste and the use of resources. Vine-shoots represent a large annual amount of waste, being 2.5 million tons in Spain. In addition, the wine market is saturated, and winemakers are continually seeking ways to make their wines stand out, prioritising the final quality. Therefore, it is not surprising that notable efforts have been dedicated to valorising vine-shoots due to their oenological potential. Toasted vine-shoots (SEGs, "**S**hoots from vines - **E**nological - **G**ranule") have thus emerged as an innovative oenological tool for enhancing the quality, differentiation and sustainability of wines. Although their use has not yet been approved by the OIV, their ability to modulate the perception of the green character, resulting in rounder and more harmonious wines, has been patented. Several studies have been carried out on the same variety of vine-shoot as the grapes (Airén, Cabernet Sauvignon, Tempranillo, Malbec and Bonarda) used in a traditional vinification process. However, the effects of combining SEGs with other oenological techniques remain underexplored. This study examined the combined effects of Tempranillo SEGs and micro-oxygenation on Tempranillo wines, analysing their sensory profile and chemical composition at bottling and after six months of bottle aging.

Winemaking and wine analysis

Tempranillo grapes were destemmed and crushed, and the winemaking was carried out according to the protocol established by the winery. Tempranillo (TE) vine-shoots were pruned and transformed into oenological additives (SEGs)[1]. The samples were subjected to multiple analytical techniques to evaluate their chemical and sensory profiles. The visible spectra were analysed using ultraviolet-visible (UV-Vis) spectrophotometry, while low molecular weight phenolic compounds were quantified by high-performance liquid chromatography with diode-array detection (HPLC-DAD). Volatile compounds were extracted and analysed using stir bar sorptive extraction coupled with gas chromatography-mass spectrometry (SBSE-GC-MS).
A sensory analysis was also conducted using an adapted tasting evaluation sheet. A novel descriptor, "*SEGs*" (associated with the sensory perception of toasted vine-shoots), was introduced. The sensory descriptors were categorised into four main phases: visual (V), olfactory (O), taste (T), and tannins (astringency/structure).

Effect on chemical composition and sensory profile of wines treated with SEGs-MOX combinations

The results of the sensory analysis are presented in Figure 1, which highlights the descriptors most affected by the SEGs-MOX treatments. Figures 1c and 1d display the significant differences (*) in the treated wines after six months of bottle aging, compared to their own profiles at bottling. Sensory profile of treated wines was significantly modified, mainly at bottling time (Figures 1a and 1b). The wines produced using the SEGs-MOX combination were more aromatic than the control ones in both the olfactory and taste phases. The tasters perceived a greater intensity of "*SEGs*", toasted, and nuts notes in the wines made with the highest SEGs doses[2], although the red fruits note was more intense in the control wine. Regarding tannins, a notable increase in silkiness was observed in all SEGs-treated wines compared to the control.
In terms of bitterness, the TE-12 wines showed no significant differences relative to the control. However, in TE-24 wines, bitterness was significantly reduced, supporting previous findings that this oenological additive can mitigate initial bitterness and dryness in wines.

After six months of bottle aging:



FIGURE 1. Sensory profile descriptors more affected by SEGs-MOX treatments: 12 g/L (a and c) and 24 g/L (b and d).

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➡TE-12 wines (Figure 1c) exhibited increased intensity in the toasted_O, *SEGs_O*, and *SEGs_T* descriptors when the LOTR (low oxygen transfer rate) treatment was applied.

➡No significant changes were observed in the HOTR (high oxygen transfer rate) conditions.

➡In TE-24 wines (Figure 1d), the sensory profile remained stable over time, though tasters noted better integration of vine-shoot-associated descriptors.

For visual descriptors, the evolution of SEGs-MOX wines was consistent with wines aged using other types of wood, such as oak. The garnet descriptor showed significant differences between the control and treated wines, with the treated samples receiving lower scores following SEGs-MOX applications. After six months of bottle aging, garnet intensity decreased slightly across all the samples, regardless of SEGs or MOX dose.

Regarding brown notes, SEGs-MOX treatments resulted in increased values for this descriptor, with TE-24 wines showing significantly higher scores, as expected. These values remained stable during the six months of bottle aging (Figures 1c and 1d).

The chemical composition of wines varied depending on the SEGs-MOX treatment (Figure 2). Vanillin was detected in the treated wines from the bottling time, its levels being higher in TE-24 wines after 6 months of bottle aging and in all cases exceeding its perception threshold. Guaiacol also increased during bottle aging and showed higher concentrations than in the control wine, mainly in TE12-LOTR. Regarding phenolic compounds, all treated wines showed a significant increase in *trans*-resveratrol, with slightly higher concentrations at bottling, reaching up to 2 mg/L compared to 0.90 mg/L in the control wine.

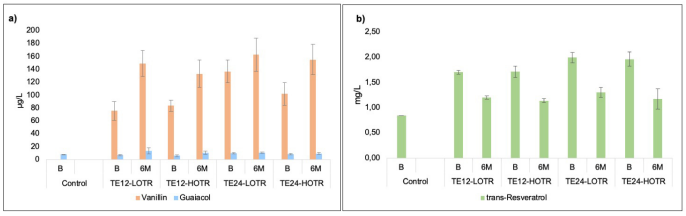


FIGURE 2. Vanillin and guaiacol, in ug/L, (a) and *trans*-resveratrol, in mg/L, (b) concentrations in wines at bottling and after 6 months of bottle aging.

Regarding colour parameters, at bottling time, the control wine retained a significantly higher colour intensity (Figure 3a), with a greater contribution of red tones (Abs520%), and a lower contribution of yellow (Abs420%) and blue ones (Abs620%), than in the SEGs-MOX wines, in which the contribution of blue tones increased significantly. The higher colour intensity in the first month of treatments is consistent with previous studies of other alternative oak products.

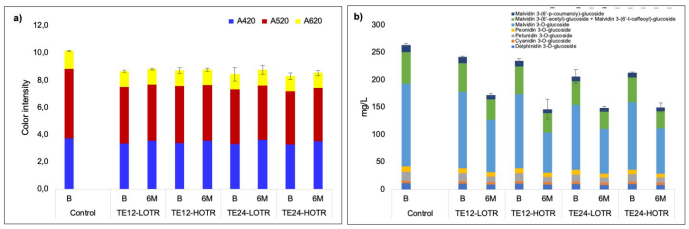


FIGURE 3. Colour intensity and total anthocyanin content (mg/L) in wines at bottling and after 6 months of bottle aging.

In Figure 3b, the control wine also showed a higher anthocyanin content compared to SEGs-MOX wines, with the lowest levels observed in wines treated with 24 g/L of SEGs. This reduction can be attributed to:

➡the surface adsorption of monomeric anthocyanins onto the SEGs, and

➡the formation of new stable pigments, leading to a shift in anthocyanin composition.

Unlike other oenological woods, SEGs lack hydrolysable tannins, which typically help protect anthocyanins. However, condensed tannins present in vine-shoots may contribute to colour stabilisation over time through their interaction with anthocyanins[3].

The decrease in anthocyanins was more pronounced with higher MOX doses (Figure 3b), though the effect varied across different anthocyanin compounds. Both the amount of oxygen and the method of delivery are critical factors. In TE-12 wines, a slight trend was observed: wines treated with LOTR showed less anthocyanin loss, suggesting that HOTR might cause greater oxidative degradation. This anthocyanin loss is also reflected in the reduced absorbance at 520 nm (Figure 3a).

Based on the above, although no clear trend was observed in the chemical composition of the wines, the use of SEGs-MOX combinations effectively reduces the bottle aging time required. While colour loss was significant, this behaviour is exhibited by other woods used in winemaking. This approach results in a more rounded and balanced sensory profile, characterised by integrated notes of toast, vanilla, and "*SEGs*" that enhance and complement the typical attributes of Tempranillo wines.

Finally, the use of SEGs could represent an important means of differentiating wines, since it provides aromas and flavours that are unrelated to other woods, but that are complementary to those provided by the so-called traditional woods. Preparing and using their own SEGs would allow wineries to expand their product range by introducing wines with non-traditional sensory characteristics. ■

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