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High eugenol content of Armagnac hybrid variety Baco Blanc, an asset in combating *Botrytis cinerea*

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Baco Blanc is the grape variety specific to the wine spirit Armagnac. A hybrid vine with good tolerance, particularly to *Botrytis cinerea*, its berries have an atypical chemical composition. Specifically, they have a high concentration of the anti-fungal compound eugenol. This research demonstrates the effectiveness of eugenol concentrations against *B. cinerea* and their relationship to the ripeness of Baco Blanc This study explores the intra-varietal diversity of *B. cinerea* tolerance, a potential source of adaptation to environmental and climate issues.

Baco Blanc, combining tradition and modernity

Baco Blanc is the result of hybridization between Folle Blanche (*Vitis vinifera*) and Noah (*Vitis riparia* × *Vitis labrusca*), developed at the end of the 19th century by Landes schoolteacher François Baco during the phylloxera crisis. Baco's aim was to create a vine variety that was resistant to aphids and fungal diseases, but also capable of replacing the over-sensitive Folle Blanche as the emblematic grape variety of Armagnac. There were numerous regulatory attempts to ban Baco Blanc, mainly due to it being an interspecific hybrid variety. Today, it is authorized in the specifications for the Armagnac appellation and praised by professionals both for its organoleptic qualities and for its recognized tolerance to disease, particularly *Botrytis cinerea*[1]. For the 2022 vintage, Baco Blanc represented approximately 47 % of the surface area (678 ha) and 48 % if the volume of Armagnac production (5,515 hL of pure alcohol)[2]. Recent research has highlighted the high eugenol concentration specific to Baco Blanc (from the grape berry through to distilled spirit)[3]. The atypical presence of this compound, otherwise known to occur in wines and spirits aged in oak, makes it a chemical varietal marker for products made from Baco Blanc, and potentially an additional tolerance factor for vines[4]. Eugenol is a known antifungal agent, and has recently been used in the formulation of anti-*Botrytis* products[5].

We have conducted a study to assess the health impact of this compound on the Baco Blanc variety in Armagnac[4]. The efficacy of eugenol against *B. cinerea* has been demonstrated, illustrating its interest as a resistance factor for the variety against the fungus. Exploration of the diversity of eugenol concentrations in Baco Blanc clones has identified a potentially more interesting clone than the only one currently authorized. This approach has made it possible to establish a link between eugenol and the ripeness of Baco Blanc grapes, and thus to monitor the evolution of the variety's susceptibility to *B. cinerea*.

Efficacy of eugenol against *B. cinerea* (Figure 1)

A Petri dish study showed that eugenol appears to be effective against *B. cinerea*. Furthermore, eugenol showed two distinct effects: the first described as "direct" (direct contact with the fungus) and the second where eugenol was not in direct contact with the isolate (vapor). This fumigation effect could be particularly interesting in the case of post-harvest treatment for table grapes.

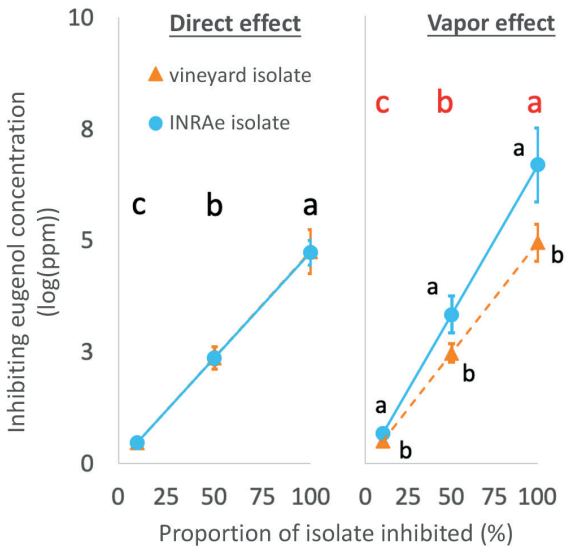


FIGURE 1. Effect of eugenol on *B. cinerea* in a Petri dish by testing the direct effect (left) and the vapor effect (right)

Increasing concentrations were applied to the isolates to determine doses that would inhibit 10 % to 100 % of *B. cinerea* growth. It is noteworthy that the doses of eugenol needed to inhibit 10 % of the fungus isolates are close to the skin concentrations of eugenol in Baco Blanc, which may partly explain the variety's tolerance to *Botrytis*. Finally, the greater sensitivity of the Armagnac isolate to the vapor effect of eugenol suggests that the fungus has not been able to acclimatize to the compound's toxicity (in the 100 years that Baco Blanc has existed), leading to the hope that Baco Blanc may be tolerant to *B. cinerea* in the long term.

Intra-varietal variability of Baco Blanc (Figure 2)

While there is only one authorized clone of Baco Blanc to date (no. 1086), several others are being studied in an experimental plot in the Landes department, with the aim of identifying a clone that may be more interesting from an agronomic point of view. Rigorous observations of 6 clones, including no. 1086, were carried out on this plot to study intra-varietal variability in the variety's susceptibility to *B. cinerea*.

The translation of this article into English was offered to you by Moët Hennessy.

Analyses of skin eugenol in two forms (free and the glycosylated precursor) revealed significant differences between clones. This variability in composition is correlated with differences in susceptibility to *B. cinerea*, making eugenol a marker of ontogenic resistance in Baco Blanc. This is a preliminary step towards identifying a potential Baco Blanc clone with greater tolerance to the pathogen than clone no. 1086.

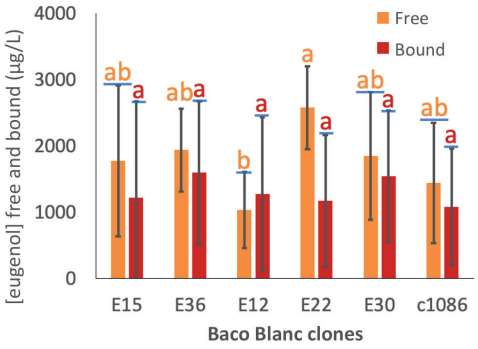


FIGURE 2. Variation of eugenol concentration (free and bound) in Baco Blanc clones.

Link between eugenol and ripeness (Figure 3)

Three plots of Baco Blanc (clone no. 1086) in production were monitored for 2 years (2021 and 2022), at several phenological stages (bunch closure, veraison, harvest and late harvest) and according to several parameters (total acidity, sugar concentration, skin eugenol). This comprehensive monitoring program revealed an important physiological trait of the variety. In fact, the skin eugenol concentration is inversely correlated with the Technological Maturity Index (sugar/acid ratio). In other words, the riper the grapes become, the lower the skin eugenol concentration and the greater the susceptibility to *B. cinerea*.

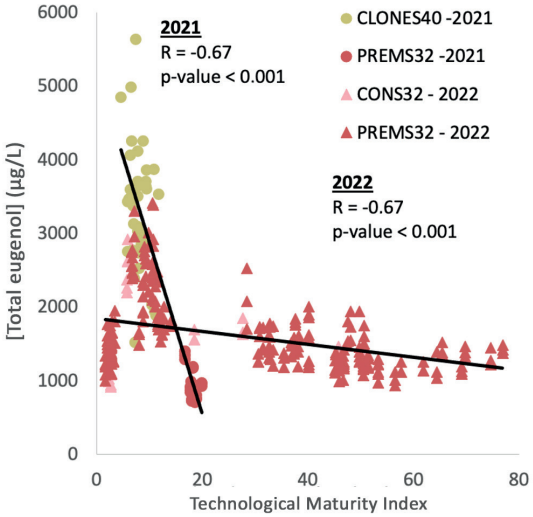


FIGURE 3. Relationship between ripeness of Baco Blanc berries and their eugenol concentration, 2-year overview (2021: 72 measurement points; 2022: 288 measurement points) over 3 plots.

Conclusions

This study confirms that eugenol does indeed provide protection to bunches of the Baco Blanc variety and is of interest in combating *B. cinerea*. This research has highlighted the dual action of eugenol, already mentioned in the scientific literature[6]. Furthermore, it appears that the *B. cinerea* isolate from the vineyard is sensitive to the vapor effect of eugenol, demonstrating the value of growing a variety with a high eugenol concentration such as Baco Blanc. Observation of the clones of this variety show variability in the concentration of eugenol. The differences observed are phenotypic variations worth exploring. These intra-varietal differences may be useful in the context of climate change and viticultural adaptability. However, as Baco Blanc is a relatively recent innovation (just over a century of vegetative propagation), the very status of these clones is an issue to be addressed using genetic tools. Lastly, multi-year monitoring of several plots of Baco Blanc confirmed an inverse correlation between skin eugenol concentration and grape berry ripeness. This relationship makes it possible to propose eugenol as a new marker of the ontogenic resistance of Baco Blanc to *B. cinerea* and to open up new possibilities for use of the variety in winemaking. ■

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