IVES Technical Reviews vine & wine

https://doi.org/10.20870/IVES-TR.2021.4846

A review of the techniques for mitigating the effects of smoke taint in wine production

Sourced from the article "Techniques for Mitigating the Effects of Smoke Taint While Maintaining Quality in Wine Production: A Review" (Molecules, 2021)[1].

>>> Smoke taint has become a prominent issue for the global wine industry as climate change continues to impact the length and extremity of fire seasons around the world. When grapevines are exposed to smoke, their leaves and fruit can adsorb volatile smoke compounds (for example, volatile phenols such as guaiacol, 4-methylguaiacol, *o*-, *m*- and *p*-cresol, and syringol), which can initially be detected in free (aglycone) forms but are rapidly converted to glycoconjugate forms due to glycosylation. During the fermentation process, these glycoconjugates can be broken down, releasing volatile phenols that contribute undesirable sensory characteristics to the resultant wine (i.e. smokey and ashy attributes). Several methods have been evaluated, both viticultural measures and winemaking techniques, for mitigating and/or remediating the negative effects of grapevine smoke exposure. While there is currently no single method that universally solves the problem of smoke taint, this paper outlines the tools available that can help to minimize the negative impacts of smoke taint (Figure 1). <<<

■ Vineyard prevention strategies

Several vineyard practices conducted prior to smoke exposure, or at the time of harvest, have been proposed with the aim of preventing smoke taint. The methods investigated so far include washing grapevines/grapes, partial leaf removal, the application of agricultural sprays, and different harvesting techniques, but have shown little success at eliminating smoke taint compounds and/or the sensory perception of taint in the final wine.

Washing vines or grapes with water, aqueous ethanol, or milk, either during or after smoke exposure does not change the perception of smoke taint in finished wine. Defoliation techniques prevent leaves, which have adsorbed smoke-derived volatile compounds from entering the must, but do not remove the compounds already adsorbed by the grapes. The application of kaolin clay spray to grapevines and their fruit prior to smoke exposure does not appear to reliably minimize taint in grapes and vines treated with this spray[1]. Although a preliminary trial showed a biofilm spray (also applied to the grapes and vines prior to smoke exposure) to be more effective than the kaolin spray, a more recent study has shown that biofilm application could lead to increased concentrations of smoke-related volatile phenols rather than mitigating their uptake[2, 3].

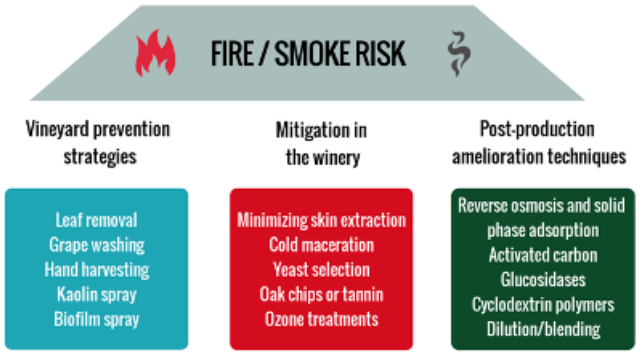

Figure 1. Summary of the strategies tested to reduce the effects of smoke on wine composition and sensory quality.

■ Mitigation in the winery

Several fruit processing methods have been trialed to minimize the negative effects of smoke exposure in wine, including the duration of skin contact during fermentation, temperature control, and yeast strain selection, as well as the addition of oak chips and tannins and post-harvest ozonation of grapes. While some of these methods help minimize the extraction of smoke taint compounds or mask the sensory perception of smoke taint in wine, they do not actually remove smoke taint compounds. These methods are usually only effective for mildly smoke-affected grapes and must therefore be paired with other methods of remediation that can remove smoke taint compounds from wine.

The addition of oak chips or tannins and different winemaking yeast can help enhance desirable organoleptic characteristics and mask smoke attributes. Shorter maceration times, cold maceration, whole bunch pressing, and separation of press fractions can all help to reduce the extraction of smoke taint compounds from grape skins but limit the wine styles that can be made[1]. More recently, the application of ozone gas to smoke-affected grapes (post-harvest and prior to crush and vinification) has been studied. This method shows great potential to minimize the perception of smoke taint, but the timing and duration of ozone treatment needs further optimization before being applied as a commercially viable remedy[4].

■ Post-production amelioration techniques

Many post-production methods have been, and continue to be, studied, due to their promising results.

The set-up and launch of IVES Technical Reviews are supported by the LabEx COTE via its Transfer and valorization call for projects.
The translation of this article into English was offered to you by Moët Hennessy.

Several of these post-production techniques are currently used commercially to treat smoke-tainted wines.

Blending or dilution of smoke-tainted wine with a base (unaffected) wine can help diminish the intensity of smoke taint to levels that are comparable to the base wine alone, but this method is highly dependent on the initial concentration of smoke taint compounds present in the wine.
Two cyclodextrin polymers were evaluated and found to be capable of adsorbing between 45 to 77 % of four volatile phenols that were studied. However, their efficacy for removal of volatile phenol glycosides still needs to be assessed.

Preliminary studies involving addition of glucosidase enzymes to hydrolyze volatile phenol glycoconjugates, enabling the resulting volatile phenols to be more easily removed via other methods of amelioration (e.g., reverse osmosis or activated carbon treatments), offered little evidence of success[1].

Reverse osmosis and solid phase adsorption reduced the concentration of smoke-derived volatile phenols in wine, but volatile phenol glycoconjugates were not removed and might still impart perceivable taint characters. Thus, this approach may not salvage more heavily smoke-tainted wine[5].

Activated carbon can remove smoke-derived volatile phenols from wine, with preliminary evidence suggesting that certain activated carbons might also remove volatile phenol glycoconjugates. This appears effective for treating mildly smoke-tainted wines, but cannot remedy severely tainted wines, and without removal of glycoconjugates, taint might still be perceived (via in-mouth hydrolysis). Some activated carbons also strip wine color and/or desirable volatile compounds (aroma and flavors) from wine[6, 7].

■ Conclusions

Among the commercially available methods of remediation, activated carbon fining and reverse osmosis remain the best options for amelioration of smoke-tainted wines, although the success of these methods has been largely restricted to grapes and/or wines which exhibit low to moderate levels of smoke taint. For grapes that have been subjected to marginal smoke exposure and/or exposure at a low-risk stage of the growing cycle (pre-veraison, for example), cold maceration or limiting the duration of skin contact, together with careful yeast selection and/or aging with oak may enhance desirable organoleptic characteristics, and therefore yield a wine of acceptable quality. These approaches may, however, limit the style of wine that can be made, and therefore the economic returns (e.g., production of rosé wines rather than red wines, with less aging potential).

Agricultural sprays such as biofilm have shown promising results as vineyard-based preventative measures, but further research is needed to determine their efficacy (and safety) when applied before a fire event. For more severely tainted grapes, it is difficult, if not impossible, to produce quality wine with the methods described in this paper. Prevention of severely smoke tainted grapes (and wine) might depend on external policies, such as improved forestry and fire management; alternatively, grape and wine producers might need to consider investing in crop insurance where coverage for smoke taint is available. Alternative uses for smoke-tainted grapes, including the production of spirits via distillation, biofuels or even sanitization materials, could offer a pathway for grapes that cannot be used for winemaking. This provides an alternate revenue stream for producers (albeit at a reduced income) when wine cannot be produced, and therefore a possible solution for smoke-tainted grapes. ■

Ysadora A. Mirabelli-Montan[1], Matteo Marangon[1], Antonio Graça[2], Christine M. Mayr Marangon[2], Kerry L. Wilkinson[3,4]
1 Department of Agronomy, Food, Natural Resources, Animals and Environment (DAFNAE), University of Padova, Viale dell'Università 16, 35020 Padova, Italy.
2 Sogrape Vinhos S.A., Aldeia Nova, 4430-809 Avintes, Portugal.
3 Department of Wine Science and Waite Research Institute, The University of Adelaide, PMB 1, Glen Osmond, SA 5064, Australia.
4 The Australian Research Council Training Centre for Innovative Wine Production, PMB 1, Glen Osmond, SA 5064, Australia.

1 Mirabelli-Montan, Y.A.; Marangon, M.; Graça, A.; Mayr Marangon, C.M.; Wilkinson, K.L. Techniques for Mitigating the Effects of Smoke Taint While Maintaining Quality in Wine Production: A Review. *Molecules*. 2021, 26, 1672. https://doi.org/10.3390/molecules26061672
2 Favell, J.W.; Noestheden, M.; Lyons, S.-M.; Zandberg, W.F. Development and evaluation of a vineyard-based strategy to mitigate smoke-taint in wine grapes. *J. Agric. Food Chem.* 2019, 67, 14137–14142. https://doi.10.1021/acs.jafc.9b05859
3 Favell, J.W.; Fordwour, O.B.; Morgan, S.C.; Zigg, I.; Zandberg, W.F. Large-Scale Reassessment of In-Vineyard Smoke-Taint Grapevine Protection Strategies and the Development of Predictive Off-Vine Models. *Molecules*. 2021, 26, 4311. https://doi.org/10.3390/molecules.26144311
4 Modesti, M.; Szeto, C.; Ristic, R.; Jiang, W.; Culbert, J.; Bindon, K.; Catelli, C.; Mencarelli, F.; Tonutti, P.; Wilkinson, K. Potential Mitigation of Smoke Taint in Wines by Post-Harvest Ozone Treatment of Grapes. *Molecules* 2021, 26, 1798. https://doi.org/10.3390/molecules26061798
5 Fudge, A.; Ristic, R.; Wollan, D.; Wilkinson, K. Amelioration of smoke taint in wine by reverse osmosis and solid phase adsorption. *Aust. J. Grape Wine Res.* 2011, 17, S41–S48. https://doi.org/10.1111/j.1755-0238.2011.00148
6 Fudge, A.; Schiettecatte, M.; Wilkinson, K.; Ristic, R.; Hayasaka, Y. Amelioration of smoke taint in wine by treatment with commercial fining agents. *Aust. J. Grape Wine Res.* 2012, 18, 302–307. https://doi.org/10.1111/j.1755-0238.2012.00200
7 AWRI Helpdesk. Treating Smoke-Affected Juice or Wine with Activated Carbon. Available online: https://www.awri.com.au/wp-content/uploads/2021/02/Treating-smoke-affected-grape-juice-with-activated-carbon.pdf