The Australian Wine Research Institute

Fact Sheet

# Smoke taint – entry into grapes and vineyard risk factors

## Background

The exposure of vineyards and grapes to smoke may result in wines with undesirable sensory characteristics, such as 'smoky', 'burnt', 'bacon', 'medicinal' or 'ash', often described as 'smoke taint'. Consumers have been shown to respond negatively to smoke-affected wines. The compounds in smoke primarily responsible for the smoke characters are the free volatile phenols (e.g. guaiacol, 4-methylguaiacol, *o*-cresol, *p*-cresol, *m*-cresol, etc). These compounds are produced and released into the atmosphere when lignin in wood is burnt. This fact sheet aims to summarise the most recent scientific findings on how smoke taint compounds enter into vines and the viticultural factors that affect smoke uptake.

## How do smoke compounds enter into the grapevine and fruit?

Model studies have demonstrated that the primary mode of entry for smoke-related volatile phenols into the vine, and accumulation in the fruit, is directly via the waxy cuticle on berries. When free volatile phenols enter grape berries, glycoside-'bound' phenols are formed rapidly by biochemical reactions of the berry. While volatile phenols can be also found in leaves, no significant translocation from leaves to berries of volatile phenols or their glycosides has been observed. Importantly, there is no evidence of carry-over of phenols and their glycosides from one season to the next.

## Which factors affect smoke uptake by vines?

The risk of smoke exposure causing a perceptible taint in wine is a function of the stage of grapevine growth and development, the grapevine variety exposed, the smoke concentration, the duration of exposure and the volatile phenol concentration and composition of the actual smoke. Recent

research has been unable to demonstrate any protective effects from applying horticultural barrier products to grapes prior to smoke exposure. Given that most volatile phenols and their glycosides are located in the berry skins, harvesting, juice preparation and winemaking techniques will have a significant impact on how much, if any, smoke character can be perceived in wine following smoke exposure of grapes.

## Grapevine growth stage

The effects of smoke exposure vary depending on stage of grapevine growth and development when smoke exposure occurs. In the past it was believed that early-season smoke exposure posed a lower risk than exposure close to harvest; however, data from Australian smoke events in 2019/20 showed that there is a significant risk of perceptible smoke characters in wine, even when smoke exposure occurs prior to veraison.

*Table 1. Stage of grapevine growth and development and sensitivity of grapes to the uptake of free volatile phenols*

| Grapevine growth stage (E-L stage) | Potential for smoke uptake |
|---|---|
| Shoots 10 cm in length (E-L 12) | Low |
| Flowering (E-L 19-26) | Low |
| Berries pea size (E-L 31) | Variable – high |
| Beginning of bunch closure (E-L 32) | Variable – high |
| Onset of veraison (E-L 34-35) | Variable – high |
| Post-veraison leading up to harvest (E-L 36-38) | High |

## Grape variety

Grapevine varieties seem to differ in their sensitivity to the uptake of smoke compounds. However, these apparent variety effects might also reflect variability of conditions between different smoke events and different phenological stages. Pre-veraison smoke exposure of Pinot Noir, Chardonnay and Shiraz grapes berries in the Adelaide Hills in late 2019 led to perceptible smoke characters in wine in some cases, independent of variety or harvest date. Understanding the relative contribution to smoke taint risk of berry size and exposure conditions compared to variety, clone and viticultural management practices will require further investigation.

## Smoke composition

Smoke is made up of particulate matter, secondary organic aerosols and volatile phenols and other compounds. The exact amount of smoke exposure which will result in a perceptible smoke character in wine is not well known, as the chemical composition of smoke reflects fuel and combustion conditions and changes rapidly in the atmosphere, becoming lower in the concentrations of volatile phenols over time. This means that smoke from recently burnt woody materials will contain higher concentrations of free volatile phenols, and thus have greater potential to cause smoke taint in grapes and wine.

## Smoke exposure

The density of smoke particulate matter can be measured using nephelometry. However, a relationship between measured particulate matter and the risk of smoke taint has not been determined conclusively. Low levels of smoke exposure (i.e. where visibility through smoke haze is >10-15 km or %obscuration/m

is <0.05) is unlikely to result in a perceptible smoke character in grapes or wine. However, the exact level of smoke exposure that will cause smoke characters has not been determined.

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## Further reading

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