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Fact Sheet

WINEMAKING

Sensory impact of smoke exposure

Background

When vineyards and grapes are exposed to smoke this can result in wines with undesirable sensory characters, such as ‘smoky’, ‘burnt’, ‘ashy’ or ‘medicinal’, usually described as ‘smoke tainted’. Consumers have been shown to respond negatively to smoke-tainted wines.

The compounds in smoke primarily responsible for the taint are the volatile phenols that are produced when wood is burnt. These can be absorbed directly by grapes and can bind to grape sugars to give glycosides that have no smoky aroma. Often these glycosides are described as smoke taint precursors. During fermentation these glycosides can break apart, releasing the volatile phenols into the must or wine, and allowing the smoky flavour to be perceived. These glycosides can also release the volatile phenols in the mouth during the drinking of wine, which can contribute to the perception of smoke taint.

Updated November 2025

Sensory thresholds of volatile phenols

Compound	Descriptors	Sensory detection threshold in red wine (µg/L)	Sensory detection threshold in water (µg/L)	Sensory detection threshold in 10% ethanol (µg/L)
Guaiacol	Smoky, medicinal	23[a]	0.84[c]	9.5[e]
m-cresol	Tar, medicinal, phenolic	20[a]	15[c]	-
p-cresol	Tar, medicinal, phenolic	64[a]	3.9[c]	-
o-cresol	Tar, medicinal, phenolic	62[a]	-	31[f]
4-Methylguaiacol	Vanilla, clove, smoky	65[b]	21[c]	-
Syringol	Smoky, charcoal	-	-	570[g]
4-Methylsyringol	Smoky, charcoal	-	10,000[d]	

[a]Parker et al. 2012, [b]Boidron et al. 1988, [c]Czerny et al. 2008, [d]Burdock 2002, [e]Ferreira et al. 2000, [f]Lehtonen 1982, [g]Lopez et al. 2002

Guaiacol and *m*-cresol are the most potent volatile phenols and have the lowest sensory detection thresholds. *o*-Cresol and *p*-cresol can also contribute to 'smoky' and 'medicinal' aroma and flavour, as well as a 'tarry' character. Syringol has a much higher sensory threshold, so is less likely to have a direct sensory impact, but it is often a good marker for smoke exposure.

If a wine has any of the volatile phenols present in concentrations above the sensory thresholds, the volatile phenols are likely to be perceptible. The volatile phenols can have a cumulative effect so that when several of these phenols are present below their threshold concentrations, together they can add up and contribute to 'smoky' and 'medicinal' aroma and flavour in the wine. For example, a spike of *o*-, *m*-, and *p*-cresol to a red wine at levels all below their individual threshold concentrations gives a noticeable 'medicinal' flavour (Mayr et al. 2014).

What does a sensory detection threshold number mean?

The most potent odorants in wine can be smelt at very low concentrations, and thus have very low thresholds. The threshold is determined by testing a number of people and then calculating a group threshold from the individual thresholds. **There is always variation in thresholds between individuals, with some tasters more sensitive to volatile phenols than others**. This variation in detection threshold is expected in any group of people, whether they are winemakers or consumers. The threshold indicates that 50% of a group are able to perceive the compound at or below the calculated value, and 50% above, and provides a guide to the potency of each compound.

Sensory impact of glycosides

Glycosides of volatile phenols can accumulate in grapes following smoke exposure (Hayasaka et al. 2010). Of the many different phenolic glycosides that have been found in grapes following smoke exposure, six have been selected as the best markers for smoke exposure: syringol gentiobioside, methylsyringol gentiobioside, phenol rutinoside, cresol rutinoside (includes *o*- *m*-, and *p*-cresol rutinosides), guaiacol rutinoside and methylguaiacol rutinoside. The concentrations of these phenolic glycosides are low in grapes that have not been exposed to smoke. Elevated concentrations of phenolic glycosides are good indicators of smoke exposure in the grapes. Syringol gentiobioside is a particularly sensitive marker of smoke exposure.

Glycosides readily transfer into juice and can persist in smoke-affected wines. During fermentation, the glycosides can breakdown and release volatile phenols (Hayasaka et al. 2010). High glycoside concentrations, together with elevated volatile phenols in grape berries have been shown to predict smoke flavour in the wine made from these grapes (Parker et al. 2023, Parker et al. 2025).

Two specific glycosides (guaiacol glucoside and *m*-cresol glucoside) have been shown to impart 'smoky' and 'medicinal' flavour, by releasing guaiacol and *m*-cresol in-mouth (Parker et al. 2012). The threshold for guaiacol glucoside is 69 µg/L, tasted in water, approximately 10 times the threshold for guaiacol for the same panel (Parker et al. 2019); however, a wide range of individual sensitivities was seen. While the thresholds have not been determined for all the phenolic glycosides, it is reasonable to expect that the rutinosides of guaiacol and the cresols might also impart 'smoky' and 'medicinal' flavour.

Which compounds are responsible for 'smoky' aroma, 'Band-Aid' flavour and 'ashy' aftertaste?

Heavily smoke-affected wines tend to have higher concentrations of volatile phenols and glycosides. Aroma descriptors 'Band-Aid' and 'smoky burnt', and palate attributes 'Band-Aid', 'burnt/charred', and 'ashy aftertaste' were highly correlated in research studies with most of the volatile phenols and their glycosides. 'Band-Aid' was particularly related to the concentration of the cresols, and 'ashy' aftertaste was correlated with most of the volatile phenols and the glycosides (Parker et al. 2012; Mayr et al. 2014). A large study of 49 wines made from Chardonnay, Pinot Noir and Shiraz grapes exposed to environmental smoke during the 2019-2020 growing season demonstrated that the concentrations of guaiacol, the cresols and the phenolic glycosides in grapes and wine predict smoke flavour well, and are probably the main drivers of 'smoky', 'ashy' and 'Band-Aid' flavours, with minor contributions from the other volatile phenols, and possibly other unknown components from the smoke (Parker et al. 2023, Parker et al. 2025).

How can you determine if smoke-exposed grapes will produce a wine with smoky flavour?

The AWRI recommends that grapes are analysed for volatile phenols and glycosides to determine if grapes have been exposed to smoke. The results can be compared to the concentrations in grapes that resulted in wine with discernible smoky flavour in the 2020 studies, to indicate risk of producing smoky wine. At the same time, a small-lot fermentation may be useful to help gauge the potential impact in other cultivars and wine styles, or to compare remediation and production methods. This allows both the chemical results and the sensory assessment to be used to make harvest decisions.

What do consumers think about smoke-affected wines?

Several studies have shown that on average, consumers dislike heavily smoke-affected wines with strong smoke flavour (Bilogrevic et al. 2023), whether they are tasting unoaked Chardonnay, Pinot Noir rosé or Shiraz. However, not all consumers are the same. In each consumer group, there were three main clusters: one group disliked a low level of smoke flavour and appeared to be as sensitive as the AWRI trained panel or winemaker panels; one group disliked the wines with strong smoky flavours; and one group's liking of the wines was not related to the smoke flavour (Bilogrevic et al. 2023). More information on this consumer study can be found in the AWRI fact sheet 'Consumer acceptance of smoke-affected wines'.

Acknowledgement

This work was supported by Wine Australia, with levies from Australia's grapegrowers and winemakers and matching funds from the Australian Government. The AWRI is a member of the Wine Innovation Cluster in Adelaide, SA.

References and further reading

Bilogrevic, E., Jiang, W., Culbert, J., Francis, I.L., Herderich, M.J., Parker, M. 2023. Consumer response to wine made from smoke-affected grapes. *Oeno One* 57(2): 417-430

Boidron, J.N., Chatonnet, P., Pons, M. 1988. Effects of wood on aroma compounds of wine. *Conn. Vigne Vin* 22: 275–294.

Burdock, G.A. 2002. *Fenaroli's Handbook of Flavor Ingredients*. 4th ed.; CRC Press: Boca Raton, FL.

Czerny, M., Christlbauer, M., Christlbauer, M., Fischer, A., Granvogl, M., Hammer, M., Hartl, C., Hernandez, N.M., Schieberle, P. 2008. Re-investigation on odour thresholds of key food aroma compounds and development of an aroma language based on odour qualities of defined aqueous odorant solutions. *Eur. Food Res. Technol.* 228: 265-273.

Ferreira, V., Lopez, R., Cacho, J. F. 2000. Quantitative determination of the odorants of young red wines from different grape varieties. *J. Sci. Food Agric.* 80: 1659-1667.

Hayasaka, Y., Baldock, G. A., Parker, M., Pardon, K. H., Black, C. A., Herderich, M. J., Jeffery, D. W. 2010. Glycosylation of smoke-derived volatile phenols in grapes as a consequence of grapevine exposure to bushfire smoke. *J. Agric. Food. Chem.* 58: 10989-10998.

Lehtonen, M. 1982 Phenols in Whisky. *Chromatographia* 16: 201-203.

Lopez, R., Aznar, M., Cacho, J. Ferreira, V. 2002. Determination of minor and trace volatile compounds in wine by solid-phase extraction and gas chromatography with mass spectrometric detection. *J Chromatogr A*, 966(1-2): 167-77.

Mayr, C.M., Parker, M., Baldock, G.A., Black, C.A., Pardon, K.H., Williamson, P.O., Herderich, M.J., Francis, I.L. 2014. Determination of the importance of in-mouth release of volatile phenol glycoconjugates to the flavor of smoke-tainted wines. *J. Agric. Food. Chem.* 62: 2327-2336.

Parker, M., Onetto, C., Hixson, J., Bilogrevic, E., Schueth, L., Pisaniello, L., Borneman, A., Herderich, M., de Barros Lopes, M., Francis, I.L. 2019. Factors contributing to interindividual variation in retronasal odor perception from aroma glycosides: the role of odorant sensory detection threshold, oral microbiota, and hydrolysis in saliva. *J. Agric. Food. Chem.* 68: 10299–10309.

Parker, M., Osidacz, P., Baldock, G.A., Hayasaka, Y., Black, C. A., Pardon, K.H., Jeffery, D.W., Geue, J.P., Herderich, M.J., Francis, I.L. 2012. Contribution of several volatile phenols and their glycoconjugates to smoke-related sensory properties of red wine. *J. Agric. Food. Chem.* 60: 2629-2637.

Parker, M., Bilogrevic, E., Jiang, W., Wilkes, E., Francis, I.L. Herderich, M.J. 2025. Bottle Aging of Smoke-Affected Wines: Changes in Smoke Flavor and Chemical Composition. *J Agric Food Chem*, 73(3): 2114-2123.

Parker, M., Jiang, W., Bilogrevic, E., Likos, D., Gledhill, J., Coulter, A.D., Cowey, G.D., Simos, C.A., Francis, I.L., Herderich, M.J. 2023 *Aust. J. Grape Wine Res.* 2023: 4964850.

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