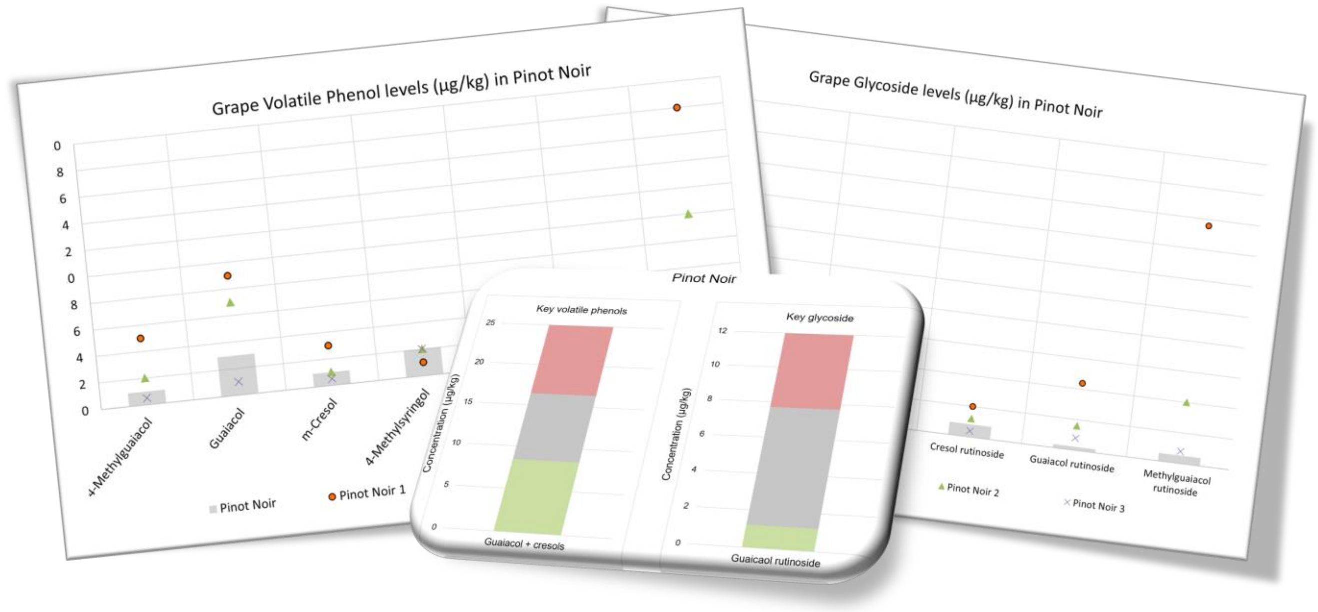
AWRI Australian Wine Research Institute

Fact Sheet

ANALYSIS

Grape smoke panel analysis results and sensory impact



Background

Smoke-exposed grapes can have elevated concentrations of individual volatile phenol and/or phenolic glycoside compounds and this can result in wines with strong, unpleasant smoke and medicinal flavours. These volatile phenols and glycosides can be used as marker compounds ('markers') to assess whether grapes have been exposed to smoke by comparing their concentrations to natural 'background' concentrations found in non-smoke-exposed grapes. If the smoke marker concentrations all fall within the natural background range for the variety, then the interpretation is that there is no evidence of smoke exposure (Coulter et al. 2022). However, it is difficult to predict the degree of smoke flavour that might develop in wines made from grapes that do show evidence of smoke exposure, as the concentration of the various markers can vary according to the variety, choice of wine production techniques and flavour impacts that are matrix dependent. It has been known for some time that various volatile phenol and glycoside compounds contribute to the smoky flavours and aftertaste in smoke-affected wines. However, the link between the concentration of smoke markers in grapes and smoky flavour in wine made from those grapes had not been established. Consequently, research was conducted at the AWRI to evaluate the ability of the current smoke markers to predict smoky flavour in wine. The goal was to develop a model to help industry assess the risk of producing a smoke-affected wine based on the results of analysis of the smoke-exposed fruit.

The research

More than 60 Chardonnay, Pinot Noir and Shiraz wines were produced under controlled conditions from 80–100 kg lots of grapes from the 2020 Australian vintage with various degrees of smoke exposure, ranging from non-smoke-exposed controls to heavily smoke-exposed. The grapes were analysed at the AWRI for seven volatile phenols (guaiacol, 4-ethylguaiacol, syringol, methylsyringol, *o*-cresol, *m*-cresol and *p*-cresol) and six glycosides of volatile phenols (syringol gentiobioside, methylsyringol gentiobioside, phenol rutinoside, cresol rutinosides, guaiacol rutinoside and methylguaiacol rutinoside). Chardonnay grapes were crushed and pressed with minimal skin contact, and standard white winemaking protocols applied. The red wines were all made in full-bodied style with skin contact. Six weeks after bottling, the wines were subjected to sensory assessments and tested for the volatile phenol and glycoside smoke markers listed above. A specifically screened and trained AWRI panel was used for the sensory assessments, which rated the control and smoke-affected wines for the attributes 'smoke aroma' and 'smoke flavour' using an unstructured, 15 cm line scale (0–10). The grape and wine smoke marker analysis results were compared to the results of the sensory assessments to investigate any links between the chemical analysis results and the sensory outcome of smoke exposure.

Key findings

The results of the study conclusively established that the levels of marker compounds in the smoke-exposed grapes were correlated with the sensory perception of 'smoke flavour' in the wines made from those grapes (Parker et al. 2023). However, some markers were more important for modelling 'smoke flavour' than others. For example, while syringol gentiobioside is generally a very good marker for smoke exposure in grapes and un-oaked wines, it did not give the best prediction of 'smoke flavour' in the wines. Guaiacol rutinoside was the glycoside which gave the best prediction of 'smoke flavour'. When all 13 smoke marker compounds were considered, guaiacol and the cresols, along with guaiacol rutinoside and cresol rutinoside, were able to model 'smoke flavour' very well, suggesting these compounds were the main drivers of 'smoke flavour'.

The concentration of guaiacol, the three cresols and guaiacol rutinoside in the grapes were also good predictors of 'smoke flavour', although not quite as good as the concentration of these compounds in the wines. Apart from considering the volatile phenols individually in the grapes, it was found that there was a very good correlation between 'smoke flavour' in the wines and the sum of guaiacol plus cresols (i.e. the sum of the concentrations of guaiacol, *o*-, *m*- and *p*-cresol in μg/kg) in the grapes for each of the three cultivars. Figure 1 shows the correlations between 'smoke flavour' in the Pinot Noir wines and both the sum of guaiacol plus cresols and guaiacol rutinoside in the Pinot Noir wine and grape samples.

Model for assessing the risk of producing a smoke-affected wine

Considering there were good correlations between the sum of guaiacol plus cresols and the concentration of guaiacol rutinoside in the grapes and 'smoke flavour' in the wines, the concentrations of these markers in grapes were used to develop a model for assessing the risk of producing a smoke-affected wine. **However, it must be stressed that the model is only preliminary and specific to the three varieties investigated (Chardonnay, Pinot Noir and Shiraz) and that more data is required for these varieties to increase confidence in the risk assessment.**

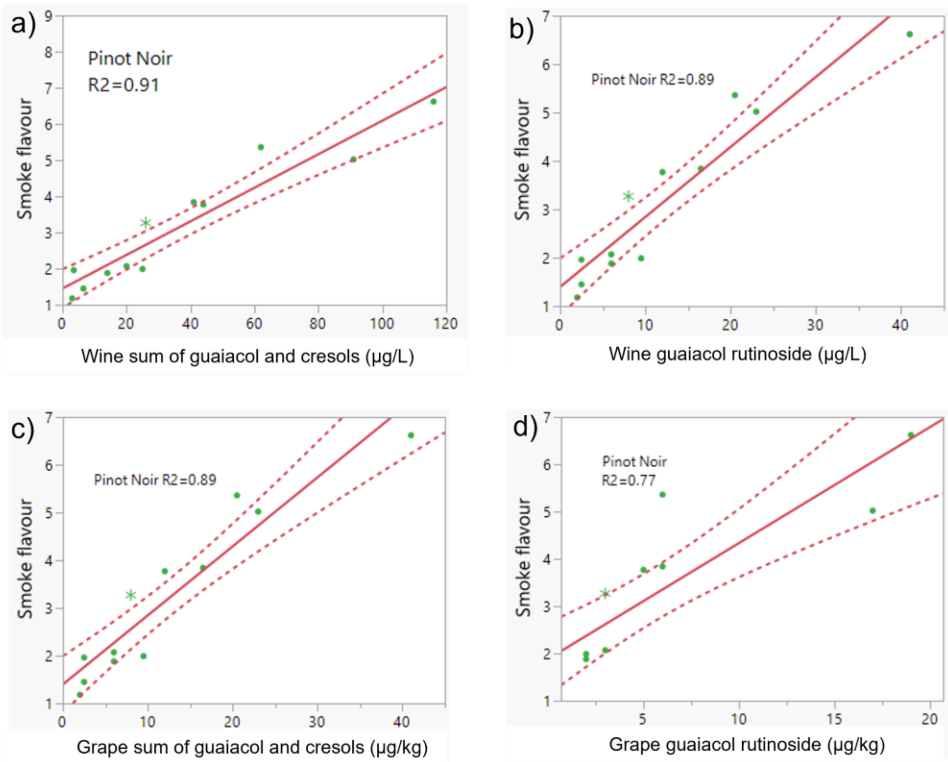


Figure 1. Correlations between the mean values for the attribute smoke flavour obtained from sensory assessments of the Pinot Noir wines and the sum of guaiacol plus cresols (i.e., the sum of the concentrations of guaiacol, o-, m- and p-cresol) and guaiacol rutinoside in the Pinot Noir wine (a, b) and grape (c, d) samples.

The 'zones' model for grape smoke marker concentrations

For the three varieties examined, there were values for the sum of guaiacol plus cresols and guaiacol rutinoside in grapes above which the wines made from the grapes were statistically significantly different ($p<0.05$) to non-smoke-exposed control wines in 'smoke flavour'. Concentrations above these values are designated as being in the 'red zone'. Grape sample analysis results that fall in the 'red zone' are at high risk of producing wine with noticeable 'smoke flavour'

When the sum of guaiacol plus cresols and the guaiacol rutinoside concentrations in grapes are less than or equal to those calculated using, or given by, the 99th percentile values provided in the baseline concentrations of smoke marker compounds database (Coulter et al. 2022), the values are designated as being in the ‘green zone’. Values in the ‘green zone’ do not provide any evidence of smoke exposure, so there is very low risk of producing a wine affected by smoke characters.

For analysis results that fall between the green and red zones, the risk of producing a wine affected by smoke characters is variable. This zone is designated the ‘grey zone’. That is, if the sum of guaiacol plus cresols and/or the guaiacol rutinoside concentrations in grapes fall within the ‘grey zone’ the risk that wine made from those grapes will be affected by smoke is variable. However, it is expected that the risk would become less variable, and in fact be higher, the closer the results are to the ‘red zone’.

Graphs with the three zones related to the key grape smoke marker compound analysis results for Chardonnay, Pinot Noir and Shiraz are shown in Figure 2. Note that the ‘red zone’ in each graph continues upwards from the upper concentration presented in each graph.

Note that smoke taint amelioration techniques during processing, such as avoiding skin contact, carbon fining and/or enzyme treatment, may reduce smoke flavour, particularly for mildly smoke-exposed grape samples whose analysis results fall within the ‘grey zone’.

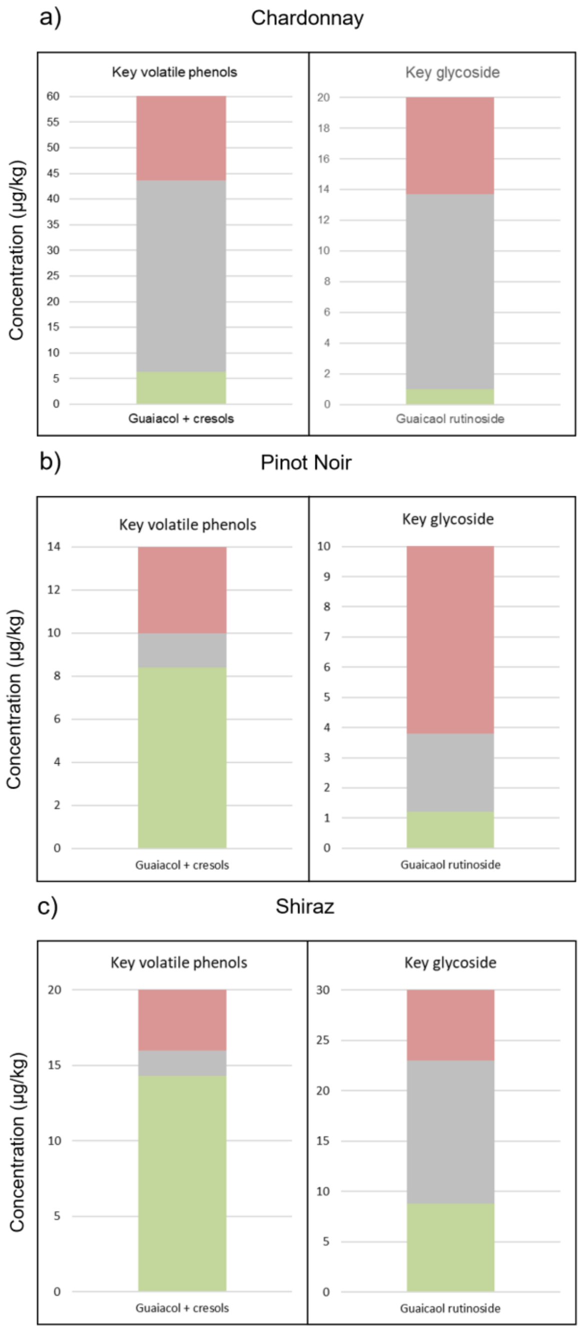


Figure 2. Graphs showing the three zones related to the key grape smoke marker compounds for a) Chardonnay, b) Pinot Noir and c) Shiraz. The zones provide an indication of the likely risk that wine made from grapes might be affected by smoke characters, with green indicating very low risk, grey indicating variable risk and red indicating high risk.

Provisos

The method described in this fact sheet for predicting smoke flavour in wine based on the levels of marker compounds in grapes is in its infancy, and more data is required from multiple fire events over multiple vintages to decrease the width of the 'grey zone' for each variety. Anecdotally, some smoke-affected wines have been observed to become smokier over time, and this phenomenon is currently being investigated. In addition, the upper limit of the grey zone appears to be dependent on the variety, so data equivalent to that presented here would be required for other varieties in order to determine the 'grey zone' upper limits for those varieties.

Finally, concentrations of the marker compounds guaiacol, *o*-, *m*- and *p*-cresol and guaiacol rutinoside (analysed by direct measurement) must be known in order to use the graphs shown in Figure 2 to assess the risk of producing a smoke-affected wine from smoke-exposed grapes. Knowledge of only the volatile phenol compound concentrations is not sufficient to assess this risk using the graphs in Figure 2.

Note: The findings and conclusions generated in this fact sheet are based on results from the analytical methods offered by Affinity Labs. Drawing direct conclusions using third-party data is not recommended due to the inherent differences in analytical techniques. Please contact the AWRI helpdesk for further advice.

Acknowledgement

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References and further reading

AWRI resources on smoke taint:
https://www.awri.com.au/industry_support/winemaking_resources/smoke-taint/

Coulter, A., Baldock, G., Parker, M., Hayasaka, Y., Francis, I. L., Herderich, M. 2022. Concentration of smoke marker compounds in non-smoke-exposed grapes and wine in Australia. *Aust. J. Grape Wine Res*. 28(3): 459-474.

Parker, M., Jiang, M., Bilogrevic, E., Likos, D., Gledhill, J., Coulter, A. D., Cowey, G.D., Simos, C. A., Francis, I, L., Herderich, M. J. 2023. Modelling smoke flavour in wine from chemical composition of smoke-exposed grapes and wine. *Aust. J. Grape Wine Res*. 2023: 4964850.

Wine Australia resources on smoke taint: https://www.wineaustralia.com/growing-making/vineyard-management/assess-and-manage-smoke-impact

Contact

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Website https://www.awri.com.au/industry_support/winemaking_resources/smoke-taint/

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