Peer-reviewed research and sector resources

Smoke Taint in BC: What we know so far

Researchers: W. Zandberg, C. Catlett

KEY TAKEAWAYS

- The presence of wildfire smoke does not automatically mean grapes will be smoke-tainted.
- If grapes are smoke-tainted, they may appear unaffected at harvest but develop smoke-like flavours and aromas later during fermentation and wine aging.
- There is currently no single solution for preventing or treating smoke taint. Test fermentations are a key tool for assessing risk and informing harvest and winemaking decisions.
- Smoke taint remains an active area of research, and management currently relies on a combination vineyard and winemaking strategies to reduce its impacts.

Production Type
- Wine grapes

Practice Benefit(s)
- Fruit quality and processing
- Winemaking

Research Location
- Okanagan, BC

Key Terms
- *Wildfire smoke*: Smoke produced by the combustion of forests, grasslands, and other vegetation during and after a wildfire. Its intensity and chemical composition can vary between events, resulting in different levels and characteristics of smoke taint in grapes and wine.
- *Volatile phenols (VPs)*: Chemical compounds released during the burning of wood and other plant materials. These compounds are present in wildfire smoke and can be absorbed by grape berries.

How can this information be used?

This factsheet brings together current information on smoke taint, including what it is, how it occurs, how to detect it, and what options are available to manage its impacts. As smoke taint becomes a growing concern across global wine-producing regions, this factsheet highlights current knowledge gaps and areas of ongoing research.

This document is intended to be informative rather than prescriptive. Every operation is different, and it is best to tailor practices to vineyard and winery conditions where possible.

Much of the information in this document has been sourced and adapted from research conducted in other regions, particularly Australia. Where possible, it has been adapted to BC's context.

What is smoke taint and how does it happen?

Figure 1. Active wildfire in the Okanagan Valley. Photo by Wicked Wine Tours.

As wildfires become more frequent and severe in many wine-growing regions, the potential effects of smoke exposure have become an increasing concern for the grape and wine industry.

Wildfire smoke carries compounds called volatile phenols (VPs), which are released as wood and plant material burn. These compounds can be left on grape clusters by smoke particles and falling ash. When grape berries are exposed to wildfire smoke or falling ash, the compounds can be absorbed through the skins and bind to sugars in the berry. Since these compounds are attached to sugars, grapes can look and taste normal at harvest. Smoke taint often does not become apparent until later in the winemaking process, when yeast breaks down sugar during fermentation and VPs are released. As a result, wine may develop smoky, burnt, or ashy characteristics that consumers find unpleasant. Wines with these characteristics may be harder to sell, resulting in financial losses for growers and wineries and potentially affecting consumer confidence in wines from smoke-affected regions.

Seeing or smelling smoke in the air does not automatically mean grapes will be tainted. Smoke taint risk depends on several factors, including how long the grapes are exposed, smoke intensity, the stage of berry development, and grape variety. One key factor is distance to wildfire smoke. The closer the wildfire is to a vineyard, the more likely grapes are to be tainted, but vineyards that are further away may still be affected. Another important consideration is how wildfire smoke affects grapevine health. Wildfire smoke can interfere with photosynthesis and other plant processes that support berry development, potentially influencing fruit quality. However, compared with smoke taint, relatively little research has examined these effects. Only general trends in how some factors influence smoke taint have been identified. For example, grapes exposed to smoke shortly before or during veraison tend to produce wines with stronger smoke-taint flavours.

Researchers are still working to better understand smoke taint, how different factors affect its presence and perception, and what strategies can help growers and wineries reduce its impacts.

How can smoke taint be detected in grapes?

Laboratory testing and trial fermentations are two of the main tools used to assess smoke taint and estimate its impact on wine quality. Depending on the lab, smoke-related compounds can be analyzed in berry, juice, or fermented wine samples. However, trial fermentations are often the most useful approach for evaluating the intensity of smoke-related aromas and flavors that may develop in wine. The resulting wine can undergo sensory evaluation and laboratory analysis to identify smoky characteristics and assess their severity.

These analyses do not predict how smoke-related characteristics may change during wine aging. In addition, the time required for sampling, test fermentations, laboratory analysis, and reporting may limit their usefulness when rapid harvest decisions are needed.

A lab capable of testing sample for smoke taint is the British Columbia Beverage Technology Access Centre (price list here).

Figure 2. Grapes being collected for test fermentations. Photo by Wines of British Columbia.

The two main trial fermentation methods are: **micro-fermentation and nano-fermentation.** These methods were developed by the Australian Wine Research Institute and adapted for use in western North America by the **West Coast Smoke Exposure Task Force.**

Micro-fermentation or 'bucket ferments'

Micro-fermentation involves collecting a large, representative grape sample and fermenting it for a week under conditions similar to standard commercial winemaking. It is recommended to run a micro-fermentation about three weeks before harvest to allow enough time to collect the grapes, ferment them, send samples to a lab if desired, and receive results. Doing this process so close to harvest can provide results that closely reflect what wine will be like, making it a reliable tool available for evaluating smoke taint and supporting decision-making.

The micro-fermentation protocol can be accessed here: **Micro-Fermentation Protocol.**

Nano-fermentation

Nano-scale fermentation is a rapid, small-volume alternative to micro-fermentation. It requires less fruit, space, and equipment, and fermentations can be completed in as little as 36 hours. This quick turnaround is useful when decisions need to be made quickly, such as during tight harvest windows or when lab and winery capacity is limited after a big wildfire. This method is best used as a screening tool to identify risk and guide next steps, rather than a replacement for micro-fermentation when higher confidence is needed.

The micro-fermentation protocol can be accessed here: **Nano-Fermentation Protocol.**

It is not recommended to submit samples from fermentations made of mixed grape varieties. Different varieties respond differently to smoke exposure, and mixing them can make test results difficult to interpret. **On-farm test fermentations can add extra costs from purchasing supplies (e.g., solvents) and equipment. Carefully review what the fermentation protocols require beforehand to determine the best option for you.**

Table 1. This table summarizes some of the most common smoke-taint markers and the flavours and aromas they may contribute to red and white wine. Since some of these compounds can occur naturally in non-smoke-affected grapes and wines, results should be interpreted alongside background levels whenever possible.

Volatile phenol (name of it's bound form)	Associated flavor and/or aroma
Guaiacol (Guaiacol rutinoside)	burnt, woody
4-Methylguaiacol (Methylguaiacol rutinoside)	spicy, woody, smoky
Syringol (Syringol gentiobioside)	charred wood, smoked bacon
Phenol	pungent sweet, tar, medicinal, burnt
4-Methylsyringol (Methylsyringol gentiobioside)	smoky, woody
o-Cresol (Cresol rutinoside)	Ashtray/animal/pig
m-Cresol (Phenol rutinoside)	
p-Cresol	Ashtray/animal/pig; potential health risk

How can smoke-taint be managed?

A range of vineyard techniques can be used to help reduce smoke-like flavours and aromas that show up during winemaking. Current research suggests that these approaches are generally more effective when used together. **However, even when applied together, they may not completely remove smoke taint and may increase production costs due to additional processing requirements.**

Keep detailed records of any efforts made to salvage smoke-exposed grapes, along with any rejection letters from wineries or purchasers. This may be helpful in supporting a production insurance claim. **See this document for more information on business risk management for smoke-exposed grapes.**

Table 2. This table summarizes several techniques currently being explored by wine researchers. The effectiveness of these methods varies depending on smoke exposure conditions and vineyard management practices.

Method		Explanation
In the field	Hand harvesting	Machine harvesting is more likely to break or rupture grape skins that contain VPs. By hand harvesting, grapes are more carefully handled and damaged less.
	Excluding leaf material	Some studies have found that grape leaves can contain higher levels of volatile phenols (VPs) than grape skins. Excluding leaf material during processing can help reduce smoky flavours and aromas.
	Washing ash off grapes	Washing grapes in the vineyard can remove ash, but its effectiveness on smoke taint varies. How thoroughly grape clusters can be cleaned and whether ash remains on nearby leaves or other vineyard surfaces can influence results. See more information about falling ash here: **FAQs Smoke Impacts**.
In the winery	Keep fruit cool	Some studies have found fruit processed at 10 °C to have fewer smoke-related compounds than fruit processed at 25 °C.
	Whole bunch press	Pressing grapes with the stem intact has been shown to reduce the extraction of smoke-related compounds, especially in white wines.
	Minimize fermentation time on skins	Fermentation that reduces skin contact time can reduce smoke aromas and flavours.
	Using activated carbon as a fining agent	Activated carbon can adsorb VPs from juice to reduce harsh flavors prior to fermentation. However, it can also adsorb compounds that give wine good characteristics (e.g., tannins). Certain types of activated carbon can remove up to 60% of VPs present in wine. Find out more here: **Activated Carbon.**
	Avoid oak barrels	Smoke-tainted wines may not be well suited to aging in oak barrels because oak can contribute additional smoky aromas and flavours, potentially enhancing the perception of smoke taint.
	Reverse osmosis	Reverse osmosis is a filtration process used to remove some smoke-related compounds from wine. Its effectiveness in reducing some of these smoke taint compounds has produced mixed results.

What's next?

Smoke taint is a significant challenge for the global wine industry. Researchers are investigating both vineyard and winery-based strategies to reduce or prevent smoke-like flavors and aromas in wine. Potential approaches include the use of protective coatings or sprays on grapes, as well as specialized processing and filtration technologies. Many of these solutions require further refinement before they can be adopted on a commercial scale. In the meantime, there is ongoing discussion about whether some smoke-affected wines could be marketed differently. This may be through price adjustments or by highlighting smoky sensory characteristics that are valued in other foods and beverages, such as smoked salmon or whiskey.

About this factsheet

This brief was prepared by Nisa Chavez from the BC Food Web team, with the help of Carien Catlett and Wesley Zandberg, and is based on the following scientific journal articles and resources:

- 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.
- Collins, T. (2024). Nano-scale fermentation Protocol. Washington State University. https://www.washingtonwine.org/wp-content/uploads/2021/08/Nano-Fermentation-Protocol_7.21.pdf.
- Favell, J. W., Fordwour, O. B., Morgan, S. C., Zigg, I., & Zandberg, W. F. (2021). Large-scale reassessment of in-vineyard smoke-taint grapevine protection strategies and the development of predictive off-vine models. Molecules, 26(14), 4311. https://doi.org/10.3390/molecules26144311.
- Jacobson, A., and Hansen, M. (2024). Micro-fermentation (Bucket) Protocol. West coast smoke exposure task force. https://www.wcsetf.org/files/Nano-Scale-Fermentation-Protocol_July-2024.pdf.
- Krstic, M. P., Johnson, D. L., & Herderich, M. J. (2015). Review of smoke taint in wine: Smoke-derived volatile phenols and their glycosidic metabolites in grapes and vines as biomarkers for smoke exposure and their role in the sensory perception of smoke taint. Australian Journal of Grape and Wine Research, 21(S1), 537-553. https://doi.org/10.1111/ajgw.12183.
- Mirabelli-Montan, Y. A., Marangon, M., Graça, A., Mayr Marangon, C. M., & Wilkinson, K. L. (2021). Techniques for mitigating the effects of smoke taint while maintaining quality in wine production: A review. Molecules, 26(6), 1672. https://doi.org/10.3390/molecules26061672.
- Smoke taint – practical management options for grape growers and winemakers. (2025). Australian Wine Research Institute. https://www.bwga.net/files/AWRI-Smoke-Taint-Practical-Management-Options.pdf.
- Oberholster, A., Wen, Y., Dominguez Suarez, S., Erdmann, J., Cauduro Girardello, R., Rumbaugh, A., Neupane, B., Brenneman, C., Cantu, A., & Heymann, H. (2022). Investigation of different winemaking protocols to mitigate smoke taint character in wine. Molecules, 27(5), 1732. https://doi.org/10.3390/molecules27051732.

Want to learn more?

- For any questions regarding this research, contact Carien Catlett at carien.catlett@ubc.ca.

For more research briefs like this one, visit bcfoodweb.ca/research-briefs

Funding for this research was provided by The University of British Columbia (Okanagan Campus) Eminence Program and supported by the Natural Sciences and Engineering Research Council of Canada (NSERC). This research was conducted by The University of British Columbia (Okanagan Campus) with grape and field donations from three participating vineyards in the midst of growing/harvest season.

NSERC CRSNG

THE UNIVERSITY OF BRITISH COLUMBIA

Funding for this factsheet is provided by the Government of British Columbia through programs and initiatives delivered by the Investment Agriculture Foundation of BC.

IAF

BRITISH COLUMBIA