Smoke Taint: How Timing of Smoke Exposure in the Vineyard Affects Your Wine

Wines that are made from grapes exposed to wildfire smoke can result in undesirable aromas and flavors which have been described as ashtray, campfire, burnt rubber, smoked fish, disinfectant, and wet ash. Due to the complex chemistry of smoke, there are many factors that influence whether smoke exposure in the vineyard will result in smoke taint in your wine. Some of these factors include timing of smoke exposure, intensity and duration, grape variety, harvesting and winemaking practices. The following overview of current research and our operational experience describes vineyard conditions that are most likely to lead to smoke taint in your wine and what you can do to prevent or remove it.

Some of the compounds responsible for smoke taint are free volatile phenols which result from the burning of lignin in plant material, including guaiacol and 4-methylguaiacol (1). These compounds are used by laboratories as a way to predict the level of smoke taint in grapes, juice or wine. In the juice phase, these compounds are often bound with sugars to form gylcosides (2). As a wine ferments, some of these bound phenols are released to their volatile form and become perceptible in the aroma, flavor, and mouth-feel of the resulting wine. As the wine continues to age, more of these bound phenols are released over time. This process leads to the perception that smoke taint increases or returns over time in impacted wines.

According to a study conducted by the Australian Wine Research Institute (AWRI), wine made from grapes with a single exposure to smoke at 7 days post-verasion resulted in the highest levels of smoke taint when compared to grapes with a single exposure to smoke at other stages of vine development (3). The study determined that exposure to smoke during the shoot development, flowering, fruit set and bunch closure stages has a very low potential for smoke uptake. This potential increases with the onset of verasion, peaks at 7 day post-verasion and decreases slightly toward harvest due to increase in berry size (3,4). The fires in Mendocino County during the 2008 growing season occurred around verasion. Greater density of smoke and duration of exposure are presumed to increase this potential for the emergence of smoke taint in your wine (4). Those of you who experienced the 2008 Mendocino fires can relate to the density and persistence of the resultant smoke exposure.

Smoke in the atmosphere will change composition over time, with the levels of volatile phenols decreasing over time (1). This means the sooner your vineyard is exposed to smoke to the onset of a wildfire, the higher the potential for smoke taint in your wine. Particulate matter in smoke settles on

vines and is thought to be absorbed directly through the grape skins. This is why thinner skinned grape varieties seem to be more susceptible to smoke taint impact than thick-skinned varieties (4). Smoke is also absorbed by the leaves, but the movement of these compounds from the leaves to the fruit is very slow and is thought to have little consequence. No carry-over of smoke taint phenols in the grape vine has been reported from one vintage to the next (3).

What You Can Do if You Suspect Your Grapes Have Been Affected By Smoke Exposure:

Berry Sampling and Analysis: Berry sampling and analysis at harvest can be a good predictor of the potential of smoke taint in your wine. ETS recommends gathering a 200 berry sample as you would for maturity sampling, as close to harvest time as possible. Whole berries are used as the majority of free guaiacols are contained in the grape skins (4). Send your whole berry samples to ETS for free guaiacol/4-methylguaiacol analysis. A result of less than 0.5ppb guaiacol will most likely not result in a wine that expresses smoke taint. A result between 0.5ppb and 2ppb may result in moderate perceptible smoke taint. A result greater than 2ppb is likely to result in smoke taint, with up to 55ppb detected in smoke exposed grapes (2). If your free guaiacol level falls within this range, we recommend taking precautionary steps during the harvesting and winemaking process to minimize this potential for smoke taint in the resulting wine.

Steps to Take During the Winemaking Process:

1. Hand harvest grapes and handle gently to prevent damage to the skins. Since the majority of guaiacols are in the skins, this will help to prevent the compounds from entering the juice and eventually your wine. Avoid leaf material which can also be contaminated and release smoke taint into your wine (3). Washing the grapes will not reduce the potential for smoke taint (4).
2. For whites and rosé, leave clusters intact and use a gentle press cycle. Keep press fractions separate. Free run juice is observed to exhibit lower levels than press fractions from the same lot of grapes.
3. For red wine, minimize skin contact time as much as possible. Handle ferments as gently as possible. Keep fermentation temperatures low to minimize extraction. Keep free run and press wine separate.
4. Flash Détente treatment of smoke exposed grapes followed by liquid phase fermentation can reduce the level of free guaiacols measured in the resulting wine, but has limited effect on the bound forms (5). Contact us for more nformation on the use of this pre-fermentation technology on smoke-impacted grapes.
5. Do not use oak or oak products. Toasted oak contains guaiacols and will not mask the smoke taint, and will affect the ability to determine whether guaiacol levels in your wine are a result of smoke exposure (2).

6. Send a sample of your wine post malolactic fermentation for guaiacol/ 4-methylguaiacol analysis. In white wines, guaiacol levels >4ppb usually resulted with smoke taint character, in red wines, >6ppb resulted in smoke taint character. The exception is syrah wines which have naturally occurring guaiacols at levels of 20-40ppb even without the use of oak [(2)].
7. Smoke taint generally becomes perceptible 6-8 weeks after the conclusion of malolactic fermentation. We recommend delaying treatment until after that point, as our operational experience has shown that sensory confirmation is critical to ensure the effectiveness of smoke taint removal methods.

Current methods for smoke taint removal can successfully remove the free volatile phenols from wine using a combination of reverse osmosis and carbon filters. However, this method will only remove the free volatile form. As wine ages and more volatiles are released from their bound form, a subsequent cycle if treatment may be required. Winesecrets is beginning trials to address this issue. Our goal at Winesecrets is to remove both the free and bound smoke taint molecules using a method of treatments that will preserve the desirable components of your wine, while only removing the compounds associated with smoke exposure.

Contact Winesecrets to Develop a Smoke Taint Removal Plan: Our Targeted Filtration TestTrack System will allow you to evaluate the effectiveness of our smoke taint removal process on two to five gallons of wine before committing to a full-scale treatment. You will receive samples of your wine at different levels of treatment for sensory and analytical evaluation.

Our Current Smoke Taint Removal Method: Winesecrets uses reverse osmosis technology followed by carbon block filters. This method is proven to be effective in reducing the free fraction of guaiacols. However, it is not effective against the glycosylated or “bound” fraction. Over time as a wine ages this bound fraction may be released and is thought to be responsible for the re-emergence of smoke taint character post-treatment.

Our New Method Development Goal: Winesecrets is working to develop a treatment method that targets these bound forms of guaiacols to resolve this problem. Fortunately, Enartis has developed an analytical method which measures total (free+bound) guaiacols. This allows us to evaluate the effectiveness of our new method.

The Experiment Plan: We are experimenting with a variety of filtration membranes with different specificities to isolate the molecules we wish to remove from the wine into a permeate stream. This will allow us to preserve the desireable components of the wine, such as pigments and aromas, and to avoid “stripping” the wine. We will then treat this permeate with one or a combination of methods to remove the bound guaiacols:

1. **Molecularly Imprinted Polymer (MIP):** this material is imprinted using a technique that leaves a cavity that has an affinity for a chosen "template" molecule. This polymer will bind the template molecules, in this case the bound guaiacols, and remove them from the permeate solution. The permeate is then treated with carbon blocks and recombined with the retentate.
2. **Enzymes**: an enzyme cocktail is used to cleave the bonds in the glycosylated guaiacol molecules in permeate, freeing them from the sugars they are bound to. Once they are in the free form they are removed using carbon blocks. We will experiment with heating the enzyme treated permeate to accelerate this process.

Citations:

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(5) Lasky, Michael S. (2018) Flash Détente as a Mitigation Technique for Smoke Exposed Grapes, Wine Business Monthly, September 2018 XXV No. 9: 28-32.