

Where There's Fire There's Smoke!

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2015 and the Return of Smoke Flavors in Wine

California's climate has certainly changed perceptibly in the past decade, as drought and increased temperatures year round affect wine growing in the state. Besides potential stress to grape vines, another serious consequence is the increased risk of forest and brush fires. Climate change is predicted to increase the frequency and intensity of forest and brush fires in the future for the west coast. This may eventually cause massive changes to our landscape in terms of types of trees and shrubs that grow. The potential for devastating fires is a grave concern to all living in or near wild land areas.

In the last four drought years, there have been significant forest and brush fires during virtually every month of the year. We no longer have a fire season—rural areas have to be prepared for fire any month of the year if conditions are dry, and there is combustible fuel on the ground. During the growing season of 2015, the entire Pacific Coast was affected by serious drought. Forest fires near wine growing regions in California, Oregon, Washington, and British Columbia had the potential to impart wild fire smoke flavors in wine. This past fall, the Valley Fire burned thousands of acres of Ponderosa pine and associated vegetation in Lake County, primarily on Cobb Mountain down to Middletown, and back up Highway 29 to Hidden Valley. Thousands of structures were destroyed and hundreds of families displaced. It has been ranked as the 5th most expensive fire in California history. This followed two other large fires in the county earlier in the year. Fortunately, most of the smoke blew away from vineyards in the region.

Considering some of the horrific conflagrations that occurred, the impact on wine making across the vast region was surprisingly limited. In most cases, wine makers had the tools and techniques to address any potential problems. Few vineyards were left with unpicked fruit, and fortunately, many of the vineyards that weren't picked were insured to cover losses from fire and smoke. Considering the vast areas burned, the impact on wine was very small for the west coast.

Damage to the Vines

Forest and brush fires have several consequences that are harmful to vineyards, wine grapes and wine. The most catastrophic effect is when vineyards actually catch fire and burn. This mostly happens to small blocks that are surrounded by flammable material. If you are concerned about fires in this situation, it is a good idea to minimize the vegetation on the vineyard floor either by mowing very close early in the growing season to reduce any dry material, or cultivate the vineyard so that the soil is bare. Removing brush, mowing and managing the landscape to risk damaging fires close to the vineyard is advisable. Cal Fire has recommendations to make your area reasonably fire safe that centers on eliminating low growing brush and vegetation to prevent the fire from climbing into the crown of trees if you live in a forested area.

The next most devastating problem is when the edges of the vineyard either burn or are exposed to superheated air from the flames that essentially cook the vascular system of the vines and wilt the fruit. Having originated from riparian areas, wine grapes are not adapted to fire (unlike so

many of our California natives, which depend on fire for propagation and renewal). The bark is very thin, and provides no insulation from heat. The overall mass of the wood in the vine is relatively small, so even internal cells found in the woody xylem are likely to die from heated sap that might actually boil when exposed to hot air accompanying a fire. Vines damaged by fire or heat rarely recover—if the vines are either charred or the leaves are completely desiccated, odds are the vines have been severely damaged and are not going to recover. You may see some buds push, but often the vascular system of the vines is seriously compromised in the woody portions, and there is likely to be irreversible damage. Careful assessment of your vineyard with a knowledgeable viticulturist is advised. Checking the vines by cutting into the cambium, and inspecting the health of the xylem and phloem needs to be checked. Obvious discoloration, loss of turgor pressure in the cells (this requires close inspection with a hand lens or dissecting microscope), cutting into lateral buds to see if they are still green and viable are all part of the inspection procedures that should be made. You can wait and see how the vines push the following growing season, and retrain vines if needed.

The Nature of the Smoke Problem

During forest and brush fires, large volumes of smoke are produced that can travel many miles and settle into valleys and low lying areas. Smoke contains visible airborne byproducts of combustion, made up of water vapor, particulates (including tar, ash, carbon and partially burnt fuel fragments), and many gases (CO₂, CO, N₂O, S₂O, NH₃, CH₄, NO_x, ozone, and other non-methane hydrocarbons.) Smoke makes up about 1.5-2% of the material that has burned.

Lignin in wood is the primary source of phenolic compounds that cause smoke flavors in wine. Wood is composed of about 20-30% lignin, which gives wood strength and lines water conductive tissues. Phenolic compounds associated with smoke include guaiacol and 4-methylguaiacol. Both are chemicals that we can taste in smoked food flavoring. These compounds can be found in oak barrels during the toasting process. On their own, these two chemicals have flavor profiles described as “bacon, burnt bacon, smoky, leather, spicy, phenolic, and spicy, salami, and smoked salmon” which doesn’t sound so bad. The problem is that there are more than 70 other compounds in forest fire smoke that also produce very undesirable flavors and odors that are described as, “like licking an ash tray, burnt garbage, a burnt potato, a campfire that has been drenched with water.”

The phenolic forming compounds from smoke concentrate in the skins of the fruit, more than in the pulp and the juice. If you can minimize skin contact to the juice during harvest, you will also minimize the smoke tastes. This works fine for white varieties, but since skin contact is essential to make red wine, there is an inherent problem when red grapes become smoke affected. Both guaiacol and 4-methylguaiacol can be detected in the fruit by gas chromatography, so it is possible to sample fruit before harvest to make picking decisions. While these compounds aren’t necessarily the sole cause of smoke flavors, they are highly correlated to many other compounds that cause the wine to taste bad, and are easily detected in the lab. There are protocols in place to test fruit before picking, and anything found to have more than 0.5 parts per billion (ppb) guaiacol is considered likely to have smoke flavor problems. Sampling whole berries is recommended, as the skins of the berries have the highest concentration of guaiacol and 4-

methylguaiacol compared to juice. Whole berry test results indicate that levels between 0.5 ppb to 2.0 ppb are moderately affected, and will require special handling and treatment in the winery. Levels above that are almost certainly going to have major problems, and may be cause for rejection by the winery, especially for red fruit.

Where Does The Smoke Go?

Research in Australia has shown that smoke uptake is most serious during the post-veraison period, but smoke damage can occur at other times when fruit is growing, as well. In the 2008 North Coast Lightning Complex, dense smoke occurred from June 21- early August in many areas when fruit was developing, and smoke flavored fruit was widespread. No doubt the intensity and duration of smoke plays a factor. We noted locally that not all vineyards were equally affected, and why this occurred, and the pattern of smoke affected vineyards remains a mystery.

If your vineyard is close to a large fire and is inundated with intense smoke for a relatively short period of time, it is likely that the fruit will be affected by smoke. In Australian research, ash settling on fruit was not found to contain very much guaiacol. Researchers were unable to remove guaiacol from the fruit by washing or rinsing with any solvents. However, removing the leaves from around the fruit, high volume and high pressure washing with water before harvest did seem to help reduce smoke flavors in the wine.

By contrast, if you are in a confined valley, and smoke settles as an inversion layer for a day or two from a distant fire, it is less likely that you will have issues with off flavored fruit. If that smoke lasts for weeks, you may very well have smoke problems with your fruit.

Varieties also differ as to how much smoke that they will absorb and the extent of off flavors that result. Experiences in California, Canada and Australia suggest that the most affected varieties in decreasing order are Sangiovese> Pinot noir> Cabernet sauvignon> Chardonnay > Sauvignon blanc> Syrah >Merlot> Petite Sirah.

Processing White vs. Red Fruit Affected by Smoke

Experience has shown that smoke affected white fruit can be avoided and cleaned up by following these practices:

- Harvest when the fruit is cool
- Hand harvest into smaller containers to avoid breaking skins as much as possible
- Separate the press fraction from the free run juice and wine extracted at low pressure pressing at the winery, which is less likely to have any smoke flavors
- The press fraction will have to be treated, most likely with ultrafiltration which removes phenolic compounds and discoloration. Carbon fining may also be useful. Treat until the wine can be blended back with the free run juice, or not used if there are concerns about diminishing the quality of the final product.

For red wine making, the most confounding aspect of the smoke flavors is the tendency of the problem to increase as fermentation proceeds. The release during primary fermentation of the

smoke flavor compounds from the skins is anticipated. The problem is that after removal from the skins (either free run or pressed wine), the flavors increase as the wine goes through malolactic fermentation. This suggests that there is conjugation of the smoke flavor causing compounds, and enzyme hydrolysis of smoke affected grape juice occurs, intensifying the smoke flavor. Following processing and fermentation, guaiacol levels can increase three fold in white wine. In fermented red fruit, the levels may increase by 5 to 10 times higher than detected in unfermented red fruit. Tasting thresholds in unoaked wines are around 4 ppb guaiacol for whites, and 6 ppb in red wines. Since guaiacol is also found in toasted barrels, the levels will increase if the wine is treated with toasted oak as part of the wine making protocol.

Reverse osmosis and carbon filtration will help to remove the smoke flavors, but may require multiple cycles since the wine may continue to release smoke related phenolic compounds into the wine by hydrolysis. At some point, the wine begins to lose other phenolic compounds that are important to the taste, color and mouthfeel of the wine, and quality is downgraded. It is also somewhat expensive to make multiple filtration passes which may be required to fix the wine.

Flash détente has also been tried as a technique to remove smoke flavors, but has not been shown to be very effective, removing maybe around 10% of phenolic compounds associated with smoke flavors.

Wine makers who have dealt extensively with this problem agree that you need to test fruit before it comes into the winery if you suspect that it is smoke affected. Next, do your treatments early, and then retest the wine a month or so later to be sure that you are removing the problem. It may take multiple treatments months apart to clean up the wine.

Some wine makers simply decide to send the wine to the bulk wine market rather than deal with treatment, which can be unsatisfactory in the end, and expensive to do.

The Human Factor

Not everyone tastes smoke affected wine the same. It is a certainty that wine makers become very sensitized to the aroma, and react negatively to even small amounts. Other people cannot perceive it in small amounts, and do not notice it. Still others actually like the aroma in limited amounts. Wineries have made many market decisions from selling the wine off in bulk, to creating second labels for wines that have been extensively treated to remove off flavors, to simply accepting the smoke flavors as typical of the vintage, and in a strange way, part of nature's expression for the growing year (this is a minority view in most cases!)

Conclusion

Smoke from forest and brush fires is yet another challenging hurdle that winegrowers must face as we go through dry years. As part of risk management, preparing your vineyard and the area around it to be "fire safe" is a good idea. The larger risk of smoke from distant fires settling over your vineyard can be managed with crop insurance to cover losses. White wine varieties can be cleaned up surprisingly well and probably will be in the market place and sold before any consumers (and wine writers) are aware that it was a smoky year. Red wines affected with smoke can be quite problematic, but can be fixed if the rates of guaiacol and 4-methylguaiacol are not

too high. Wine makers become very sensitized to smoke flavors, and many consumers won't even notice moderate levels. This is yet another challenge to making quality wine when nature hands you an unanticipated problem.

Thanks to Bob Blue, Fetzer Vineyards; Bob Swain, Mendocino Wine Company, and Eric Herve, ETS Labs for providing information for this article.