ETS LABORATORIES

FAQs

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The ETS Oak Aroma Analysis

1. Why is there so much variation in oak aromas?

There are many causes of variation, and they interact to form a wide array of potential aroma profiles.

The source of the oak itself is a substantial source of variation. Oak species differ greatly. To illustrate, the French Pedunculate Oak (*Quercus pedunculata* = *Q. robur*) is known for its relatively faint aroma potential compared to French Sessile Oak (*Q. sessilis* and *Q. petraea*). American White Oak (*Q. alba)* can have a strong, distinctive aroma, sometimes considered overpowering in certain wines. In contrast, Oregon White Oak (*Q. garryana)* seems to have more similarities to the French oaks than to American White Oak.

Geographic origin is linked to botanic species, but different species frequently grow in the same forests, and hybridization does occur.

Growing conditions, age and genetic variation of individual trees can strongly affect wood structure and composition. Even a stave's position on a trunk has been shown to influence its aroma composition.

Stave seasoning and drying are important. Kiln drying is likely to result in a different aroma character than does air drying. Air drying conditions (time spent in open air and humidity level) also have a significant influence on wood aroma potential.

Finally, the cooperage process adds a considerable layer of variability. Definitions of "light" to "heavy" toasts are subjective and vary among coopers. Difficulty controlling toasting levels creates barrel-to-barrel variation. Stave-to-stave variation can occur in the same barrel as some staves may toast more rapidly than others.

2. What is the effect of toasting on oak aroma?

Toasting during barrel processing modifies the structure and chemical properties of the oak. This influences the wood aroma composition and consequently, the release of aroma compounds into the wine.

Increased toasting diminishes the *fresh oak* aromas generally attributed to oak lactones. Simultaneously, *vanilla* and *caramel* aromas associated with vanillin, furfural and 5-methylfurfural increase. At higher toast levels these compounds decrease and are replaced by *spicy* (eugenol, isoeugenol, 4-methylguaiacol) and *smoky* characters (guaiacol, 4-methylguaiacol).

3. How does barrel age affect oak aroma?

Oak aroma potential decreases rapidly with barrel use. However, different compounds are extracted from oak at different rates. While a one year old barrel will certainly impart less oak character to a wine than a new barrel, the aroma compounds it does contribute are likely to have a different profile than a new barrel.

4. How do winemaking processes influence the levels of oak aroma compounds actually present in wine?

The choice of barrels, the proportion of new oak, and the duration of oak-wine contact are the most obvious factors influencing wood aroma in wine. Microbial activity also has an influence. When fermentation is carried out in barrel, aldehydes such as vanillin, furfural, and 5-methylfurfural are partially transformed by yeast into non-aromatic alcohols. Absorption of aroma compounds by yeast cells and macromolecules is also possible.

5. How are sensory thresholds determined?

Sensory thresholds are commonly determined by adding the pure compound to a model solution or neutral wine. The reported sensory thresholds of pure compounds in model solutions do not always adequately describe a compound's sensory impact in wine, since the wine matrix is more complex.

6. How can compounds present below their sensory threshold in wine contribute to wine aroma?

Most volatiles identified in oak aroma seem unlikely to reach sensory thresholds in wine. However, substances with chemical similarities are often released from oak together (such as eugenol, isoeugenol, or other volatile phenols). The combination of similar molecules can result in a perceived sensory effect even when they are below their individual sensory thresholds. These additive and cumulative effects may be quite important in wine.

Dramatic synergistic effects between unrelated volatiles have also been demonstrated. To illustrate, oak lactone's difference threshold has been found to be 50-fold lower in the presence of vanillin (i.e. it is fifty times more potent). Similar effects are likely to occur between oak volatiles and other wine aroma compounds.

The ETS Oak Aroma Analysis

7. What compounds are responsible for *piney, resin, cedar* or *dill* aromas in oak or wine?

Such descriptors, generally associated with American White Oak *Quercus alba*, seem linked to high levels of *cis* oak lactone. *Quercus alba* has also been reported to contain relatively high amounts of terpenes. Although terpenes may contribute to these aromatic characters, key compounds have not been identified.

8. What compounds are responsible for *nutty, roasted almond,* or *roasted hazelnut* aromas?

Combined sensory effect of known volatiles coming from wine or oak, such as diacetyl (*fatty*, *butter*), free fatty acids (*fatty, rancid*), furfural and 5-methylfurfural (*caramelized* tones) may be at least partly responsible for the occurrence of such aromas.

9. What compounds are responsible for *cinnamon* or *nutmeg* aromas?

Cinnamon and nutmeg possess both *woody* and *spicy* aromas. These characters in oak aroma can be attributed to the combination of *woody*, *coconut* oak lactones and *spicy* compounds such as eugenol and isoeugenol.

10. What compounds are responsible for *bread crust* or *toast* aromas? For *gingerbread* aromas?

Very complex sensory impressions can result from the combined effect of wine and oak aroma components. “Complex” descriptors, however, can usually be divided into simpler terms, which can be associated with known wood aroma compounds.

To illustrate, a *bread crust* or *toast* character can be described as *yeasty* flavors (imparted by yeast byproducts in bread as well as in wine), caramelized tones from carbohydrate byproducts such as furfural and 5-methyl-furfural, and *smoky* aromas from guaiacol, 4-methyl-guaiacol.

This also applies to a *gingerbread* aroma, which may be less *yeasty* with additional *spicy* contributors (such as eugenol).

11. A wine lot aged in oak (or in contact with oak chips) developed a disagreeable *dusty, cardboard* smell. It seems *corked* before bottling. What compounds are responsible?

Oak is one possible source of chloroanisole contamination in bulk wine. Chloroanisoles (TCA, TeCA and PCA) are powerful odorants with a *musty, moldy, corked* smell. ETS offers determination of chloroanisoles in wine and oak samples. For more information, see our chloroanisole publications.

12. A red wine lot aged in oak developed a *pharmaceutical, band-aid* or *horsy, sweaty* aroma. What compounds are responsible?

The wine should be tested for 4-ethylphenol (4EP) and 4-ethylguaiacol (4EG). These compounds are byproducts of the yeast *Brettanomyces* and are found together in many wines aged in oak. Periodic screening of wine is recommended to monitor *Brettanomyces* activity during oak aging.

13. How does ETS analyze oak aromas?

Solid phase microextraction headspace technology is utilized for sampling (Headspace/SPME). Analysis is performed using gas chromatography with detection by mass spectrometry (GC/MS). This integrated analytical system allows great specificity and sensitivity.

In the case of oak shavings, chips or cubes, oak material is soaked for several days in a model solution. The soak solution is then analyzed in a method similar to that described for wine

14. How do I submit a sample?

Representative wine samples should be submitted in full glass containers or bottles of at least 125 mL, with minimal headspace. Glass is recommended to avoid any possible interference from plastic polymers.

Oak Shavings, chips or cubes should be submitted in sealed bags or containers (*plastic is acceptable for solid samples*). Minimum quantity required is 50 g.

15. What is a representative sample?

Considering potential variability of oak aroma composition from barrel to barrel, a sampling plan is very important.

Single barrel samples can be used to evaluate barrel-to-barrel variation. For most other applications, composite samples may be a better choice.

16. What does ETS recommend for oak origin? toasting level? cooperage?

Decisions affecting the qualitative and quantitative oak contribution to a particular wine are discretionary, and belong to winemakers. The ETS wood aroma analysis has been designed as a tool to assist winemakers in their efforts to optimize oak contribution to wine aroma.

ETS Laboratories • 899A Adams Street • St. Helena CA 94574 • Tel 707•963•4806 • Fax 707•963•1054 • info@etslabs.com • www.etslabs.com
Satellite Laboratories • Healdsburg CA • McMinnville OR • Walla Walla WA