Tools to manage élevage: barrel grain analyzed over time

Types of oak grain, wine élevage in barrel

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Winemakers always wonder how different types of oak grain will interact with their wines. To answer this, we need to define oak “grain,” which is sometimes misunderstood.

We also need to take a detailed look at élevage, what happens to the wine during time in barrel. In other words, which oak compounds are released, modified and combined—and how does grain impact these compounds?

Grain (re)defined

When we say “tight/fine grain” and “open/wide grain” for French oak, what do we mean?

Grain is defined as the average width between the annual growth rings of the tree. Trees grow outward, from the heart out to the bark, adding a layer every year just under the bark, in the “cambium” area. This incremental layer is called the “annual growth ring.” The grain is the sum of annual growth rings added each year in the life of a tree. Oak belongs to the family of the “ring porous” hardwoods.

When looking under a microscope, a ring is composed of the succession of spring wood (or early wood) and summer wood (late wood).

Vessels in spring wood are numerous and wider than in summer wood. This is because spring is when the tree starts pumping the sap up its trunk to form the buds and leaves. Then, in summer, the leaves use the sun for photosynthesis by the chlorophyll to create sugars/saccharides, which are stocked in the tree’s fibers. Summer wood therefore has a higher density of fibers and parenchyma and fewer vessels.

Spring wood is relatively constant in width. The width of summer wood varies due to the tree’s growing conditions: primarily climate (rain, sun), but also the nearby tree population (height, shade), properties of the soil (drainage, clay vs. rocks) and terrain (hilltop, slope and creek).

This variable thickness of summer wood is what defines grain type. Chêne

ABSTRACT

To choose the proper grain in barrels, it is crucial to understand the definition of grain types and how they interact differently with wine over time. Grain is defined by the average width of annual growth rings on a tree. A growth ring is the succession of spring wood and summer wood. Spring wood appears richer in vessels, which conduct the sap. The composition of summer wood is denser in fibers and parenchyma. This observation would explain why tight-grain barrels tend to taste more aromatic (more vessels) and open-grain barrels give more structure (more fibers).

A study by Chêne & Cie R&D further corroborates this link. The same wine was analyzed over time in tight- and medium/open-grain barrels. The study shows that tight-grain barrels release a greater quantity of wood aromatics (eugenol, whisky lactones), whereas open-grain barrels release a larger amount of tannins (ellagitanins).

Over 12 months, patterns of release of compounds were different. Tight-grain barrels release greater levels of wood and spice aromatics in the later months. Open-grain barrels release more toasty/roasted aromas in the early months (furanes, guaiacol and phenols), which then decrease. This explains why shorter aging can emphasize aromas from the toasting—especially in open-grain barrels. The study showed that the concentration of tannins decreased after eight months in all barrels, as tannins polymerize. Wood tannins (ellagitanins) combine with grape tannins (polyphenols). This combination contributes to a softer, rounder palate.

As medium/open-grain barrels release more tannins faster, they seem a better match for shorter élevages, or for highly tannic juices in long élevages. During long élevages, tight grain will enhance volume and texture of already elegant grape tannins, while offering a wider aromatic palette.
WINEMAKING

Porosity can be misleading
When looking closely at the end of a barrel stave, one can observe that open grain has fewer vessels (spring wood) per foot, and more fiber and parenchyma (summer wood). Vice-versa, tight grain has a greater proportion of vessels and less fiber material.

The fact that tight grain has more vessels means that it contains more void, and is therefore more porous, which goes against a pre-conceived idea that open grain is more porous—it is actually the opposite.

This observation is no doubt counter-intuitive for many of us, but it is crucial in properly understanding the differences in oak grain types. It explains why tight grain seems more aromatic: More aromas are released from the vessels, which makes sense as this is where the sap was with minerals, nutrients and sugars.

Our observation also explains why open grain feels more tannic: The wine gets more contact with fiber material, as there is a larger proportion of summer wood.

With respect to air exchange, several studies have shown it is difficult to draw a conclusion as to whether or not grain tightness influences evaporation loss and oxygenation from the barrel.

The higher porosity of tight grain does not appear to allow more air exchange. It would seem that the air permeability of a barrel is more complex, and less influenced by grain than by several other wood anatomical factors (such as tylosis filling the wood vessels or orientation of medullary rays on the stave).

Over time, compounds are extracted from grain types differently
During barrel aging, a complex exchange...
between barrel and wine occurs. It can be summarized by three main actions:
1. Some aromatic compounds from oak are released into the wine.
2. The wine perfects its structure and texture with the support of oak tannins.
3. Hopefully, the wine acquires balance, notably through the very slow oxygen exchange allowed by the barrel.

How do different types of grain influence these three actions?

A study by the Chêne & Cie research and development team corroborates the main deduction above, and shows that tight grain releases more aromatics and open grain gives more tannins. The R&D team analyzed the same wine aged in tight-grain and medium/open-grain barrels (30-liter barrels to accentuate the wood impact).

This study showed that the wine evolved differently over time in oak barrels made from two different types of grain. One main conclusion of this study was that tight grain releases more aromatic compounds over time than open grain (eugenol, whisky lactones), and open grain releases more wood tannins (ellagitannins).

Looking at the quantity of compounds released over time, it appeared that some molecules were released in the wine very early on, in the first months of barrel
Taransaud

OVUM

« They did not know it was impossible so they did it. »

Mark Twain
Wine aging (such as phenols, furanes and guaiacol), and others only started to appear in significant quantities after a few months of élevage (vanillin and eugenol).

Another study by the Chêne & Cie R&D team showed that these differences in the timing of the impact can be explained by how wine soaks into the oak stave. (Analysis for five different toast levels, on 10 barrels each, at three different layers, up to 9 mm deep in the wood.)

Over time, wine soaks into the stave and reaches progressively different layers. Generally speaking, during the élevage wine slowly soaks about 3–4 mm deep (about 1/8 inch) into the oak stave. When crossing this analysis of compounds released over time with the grain parameter, we can analyze élevage along several key dimensions: concentration of a given compound, time spent in barrel and grain type. The layers of the stave help classify the aromas into different groups.

Wood layers release different aromatics

Toasting mostly impacts the surface of the stave. As you go deeper in the stave, the wood has been less transformed by the fire of the toast. One could compare this process with the cooking of a steak. As wine soaks into the stave, it will get different impacts from successive layers. These layers help explain the different phases during élevage.

Three layers may be distinguished in an oak stave:

The first layer is particularly rich in aromatic molecules created by the toasting process. For example, analyses showed that the concentration of guaiacol in wine increased for the first 75 days in the barrel and peaked around that time. After that peak, the concentration decreases (see Figure 1).

This trend could be explained by the fact that guaiacol comes from thermal degradation of the cellulose of the wood during the toasting process, which occurs on the stave surface. More guaiacol is therefore released during the first months as the wine soaks into the surface of the stave. Then some compounds disappear.

This trend of release of guaiacol is the same in both grain types, but the concentration was more important for the open-grain barrel, especially at the peak. The difference between grain types appears to come from the fact that open-grain wood has more fiber material, more cellulose, and therefore releases more guaiacol.

Something similar happens over time...
with another phenolic compound created by the toasting process, 4-methyl-2,6-dimethoxyphenol (see Figure 2). The evolution of these two phenolic compounds can explain why the toast impact can seem very dominant in the first few months the wine is in barrel, especially with open grain, and then is tamed down as the wine ages in the barrel.

The second layer would be best characterized by pastry-like aromatics such as vanillin. Our analysis shows this compound only starts being released in significant quantity in the wine after 60 days in the barrel, once the wine soaks into the wood (see Figure 3). Here there is very little difference between the open and tight grain.

The fresh oak and spice aromatics are likely to come predominantly from a third layer, deeper in the stave. At that depth within the stave, the impact of the toasting process has been much less. The wood has not been modified as much by heat and flames.

The concentration in the wine of cis-whisky-lactones and eugenol, for example, increase after two to three months and even faster after eight months. In addition, the concentration of these compounds is significantly higher for the wine aged in tight-grain barrels (see Figures 4 and 5).

**Tannins interact and soften**

The studies found that open-grain barrels release more tannins (ellagitannins) into the wine over time than tight-grain barrels. We expect this is due to more fiber and parenchyma material being in contact with the wine.

But for both open grain and tight grain, tannins released by the oak barrel follow a very different trend compared to other compounds. Their concentration increases linearly between one and eight months, and then decreases after eight to nine months in barrel, as the tannins soften.

This softening is due to several reactions: polymerization, oxidation and precipitation as well. The most important is the polymerization, by which tannins from the grape (polyphenols) combine with tannins from the oak (ellagitannins). This combination forms new tannin compounds that contribute to a softer, rounder, silkier mouthfeel.

By polymerizing, tannins lose some of their astringency. This is why it is often said that tannins from the oak provide a “coating,” a softening of the grape tannins. Tannin combinations are believed to be a critical element in the perfection of many gustative dimensions of wine (structure, texture, density, creaminess and suppleness).

Among the new tannin compound families created by this polymerization process, one is particularly striking: Acutissimin A. It is formed by the combination of a polyphenol from the grape (flavonoid) and an ellagitannin from oak (vescalagin). In 2003, scientists established for the first time that red wine aged in oak barrels contained flavonofellagitannins formed during aging, and which were not present in oak or wine separately. Among these flavono-ellagitannins, scientists also established that Acutissimin A had an extremely high anti-carcinogen effect.

We would like to think this is the French cooper's contribution to the French paradox. Perhaps there is a hidden attribute to oak tannins and grain, beyond being a crucial tool to adapt élevage to the specificity of each wine.

**Acutissimin in cancer prevention research.**

Researchers at the University of Bordeaux have shown that Acutissimin A, a compound found in oak barrels, has significant anti-carcinogenic properties. The compound has been shown to inhibit the growth of cancer cells in vitro and in vivo.

**The French paradox in winemaking.**

The French paradox suggests that red wine consumption is associated with a lower risk of cardiovascular disease and certain types of cancer. This paradox has been attributed to the presence of flavonoids and other phytochemicals in wine, which have been shown to have health benefits.

**New compounds formed during barrel aging.**

Polymerization, oxidation, and precipitation are three key reactions that occur during barrel aging, leading to the formation of new compounds in wine. These reactions are influenced by factors such as oak type, grain, and level of toasting.

**Figure 6.** Open/medium-grain barrels release more ellagitannins than tight grain. In both grain types, concentration of ellagitannins increases after two months, peaks around eight months, and then decreases, as tannins polymerize.

**Figure 4.** Tight grain barrels release more whisky lactone (associated with fresh wood smell, coconut and whisky) over time. The perception threshold is 74 ug/L in red wine. Vertical axis shows ratio between the measurement and the perception threshold in ug/L.