

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 the 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 var-

ABSTRACT

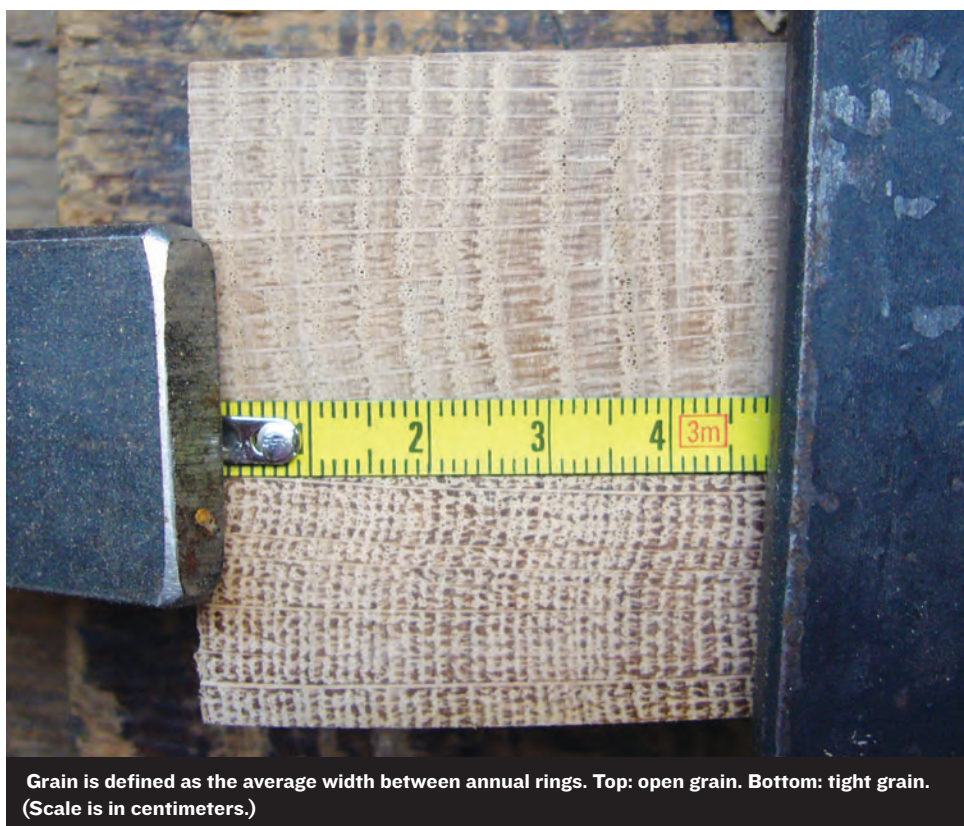
To choose the proper grain in barrels, it is crucial to understand the definition of grain types and how they interact differently with wine over time. Grain is defined by the average width of annual growth rings on a tree. A growth ring is the succession of spring wood and summer wood. Spring wood appears 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.

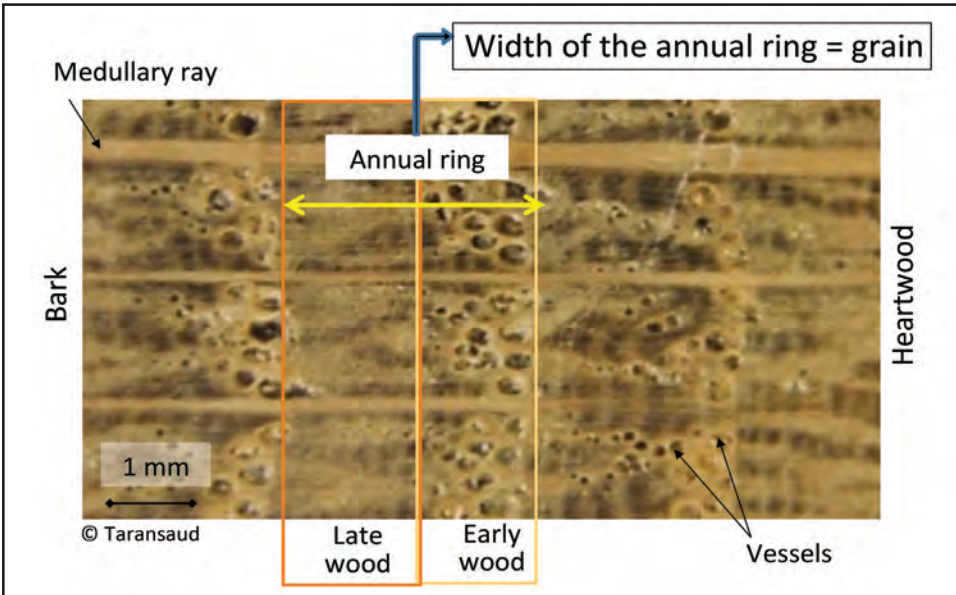


Grain is defined as the average width between annual rings. Top: open grain. Bottom: tight grain. (Scale is in centimeters.)

PHOTO BY TARANSAUD

ies 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



Microscopic view of structure of French oak grain showing early/spring wood and late/summer wood.

PHOTO BY TARANSAUD

& Cie defines tight grain as less than an average of 3 mm per annual growth ring (spring wood + summer wood); larger than this is open grain.

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

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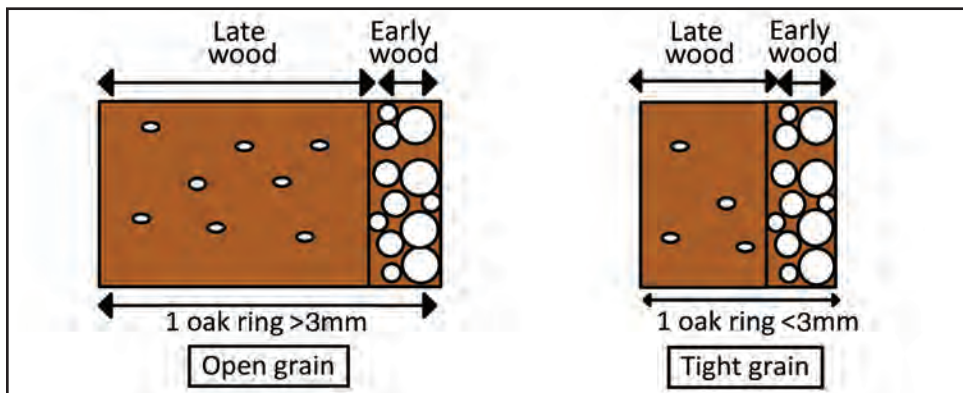
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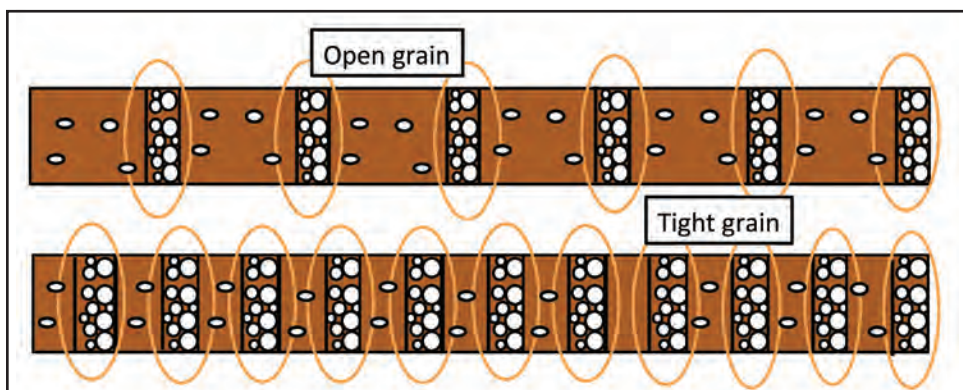
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Schematic view of a section of two growth rings. Early wood—or spring wood—contains more and larger vessels. Late wood—or summer wood—contains more fiber and parenchyma.



Schematic view of the side of two staves. The open-grain stave has more fiber (brown), and the tight grain stave shows more vessels (white circles).

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

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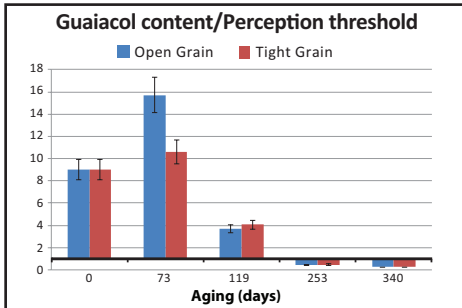


Figure 1. Open-grain barrel releases more guaiacol. The perception threshold is 75 ug/L in red wine. Vertical axis shows ratio between the measurement and the perception threshold in ug/L. Aromatic descriptors often associated with guaiacol are wood fire and fireplace, and it contributes to flavors of roasted coffee.

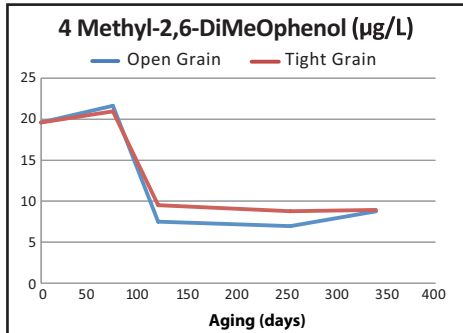


Figure 2. Open grain has more phenols that reinforce toast perception. 4 Methyl-2,6-DiMeOphenol acts in conjunction with other aromatic compounds, to reinforce the toast perception. It can also be associated with aroma of India ink.

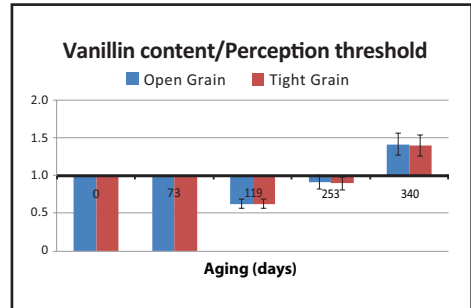


Figure 3. Both grain types release vanillin slowly. The perception threshold is 320 ug/L in red wine. Vertical axis shows ratio between the measurement and the perception threshold in ug/L.

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

Different aromatic compounds are released as wine soaks into the stave

- First layer releases toast aromas
- Second layer releases spices, pastry
- Third layer releases fresh oak aroma

Impregnation of barrel staves by the wine.

SOURCE: TARANSAUD

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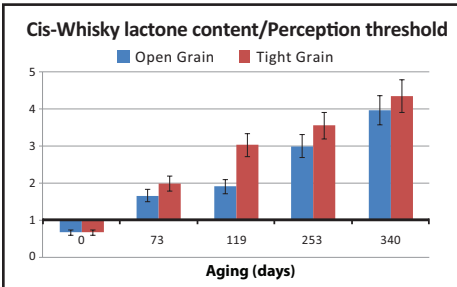


Figure 4. Tight-grain barrels release more whisky lactone (associated with fresh wood smell, coconut and whisky) over time. The perception threshold is 74 ug/L in red wine. Vertical axis shows ratio between the measurement and the perception threshold in ug/L.

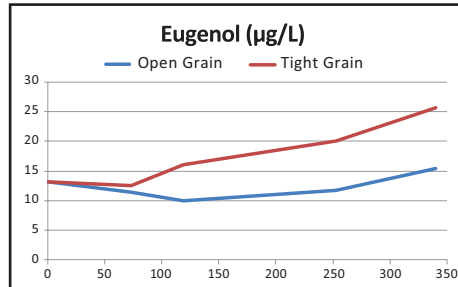


Figure 5. Tight grain releases larger concentration of eugenol. The perception threshold can vary, therefore the graph only shows concentration. Aromatic associations are cooking spices and cloves.

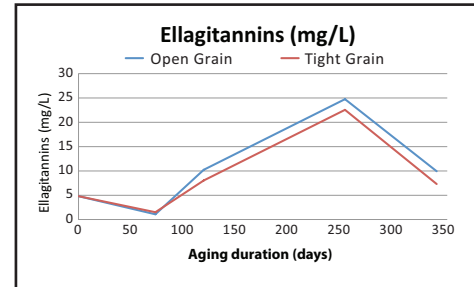


Figure 6. Open/medium-grain barrels release more ellagitannins than tight grain. In both grain types, concentration of ellagitannins increases after two months, peaks around eight months, and then decreases, as tannins polymerize.

with another phenolic compound created by the toasting process, 4-methyl-2,6-dimeophenol (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 reac-

tions: 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 flavono-ellagitannins formed during aging, and which were not present in oak or wine separately. Among these flavono-ellagi-

tannins, scientists also established that Acutissimin A had an extremely high anti-carcinogen effect.**

We would like to think this is the French coopers’ 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. [PWV](#)

* An experiment was carried out with medium-toasted, 30-liter barrels made with tight grain and medium/open grain. The wine was red Bordeaux from Margaux AOP. Two barrels per grain type were filled after malolactic fermentation, and the wine was analyzed for several compounds at regular intervals during one year of *élevage*. The wood-wine exchange was greater in this small barrel because the wood contact surface with the wine in a 30L barrel is 2.3 times greater than for a 225L barrel.

** Dr. Stéphane Quideau at Institut Européen de Chimie et Biologie of Pessac, together with other scientists, found that when the oak tannin vescalagin interacts with phenols in red wine aged 18 months in barrels, Acutissimin A is created. In separate studies this phenolic compound has been shown to be much more effective than certain drugs in stopping the growth of cancerous tumors. “DNA Topoisomerase Inhibitor Acutissimin A and Other Flavono-Ellagitannins in Red Wine,” Dr. Stéphane Quideau *et al.*, November 2003, *Angewandte Chemie International Edition*.

