Tannins in red wine

It´s complicated!

Orlando Mason June 2021

Tannins

It is a word thrown around a lot, even if what it actually means often seems as clear as the hieroglyphics in Nefertiti's tomb.

Vanessa Price and Adam Laukhuf in "Big Macs & Burgundy"

Tannins in the red wine change continuously

By forces of nature and by man's interventions

Tannins in red wine are many different chemical compounds that change at every moment of their existence, which starts in the growing grape and ends when we drink the last drop of wine in the glass.

Focus of the presentation:

Our perception of tannins in red wines

- As a result of the **chemical properties** of tannins
- As a result of the density of our **taste buds**:
- As a result of **their source**: skin, seeds, stems, wood, additives
- As a result of the characteristics of the **grape and location**
- As a result of **what growers do in the vineyard**
- As a result of **what producers do during maceration, fermentation and pressing**
- As a result of their **changes in the barrel and in the bottle**
- As a result of **what we do after we open the bottle**

Part 1: Tannins and Us

What nature's mandates

- **Nature and properties** of tannins
- **Contributions** of tannins to red wine
- **How do we "taste"** tannins in red wine"
- How we **describe** the tannins in a red wine

Let us talk about tannins and their characteristic

All kinds of tannins in red wine

- Nature
- Structure
- Properties

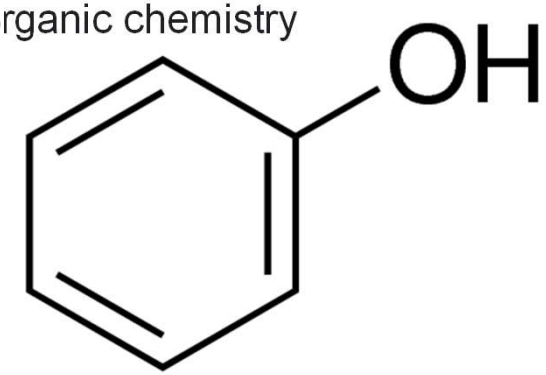
What are tannins?

- Tannins are **bitter and astringent** chemical compounds that belongs to a larger group called polyphenols.
- They **occur abundantly in** the bark of many trees and in a variety of leaves, legumes and fruits, including **grapes**.
- The **primary role of tannins in nature is to make unripe fruits and seeds unpalatable**, thus dissuading animals from eating them.

Phenol: The most basic building block of tannins

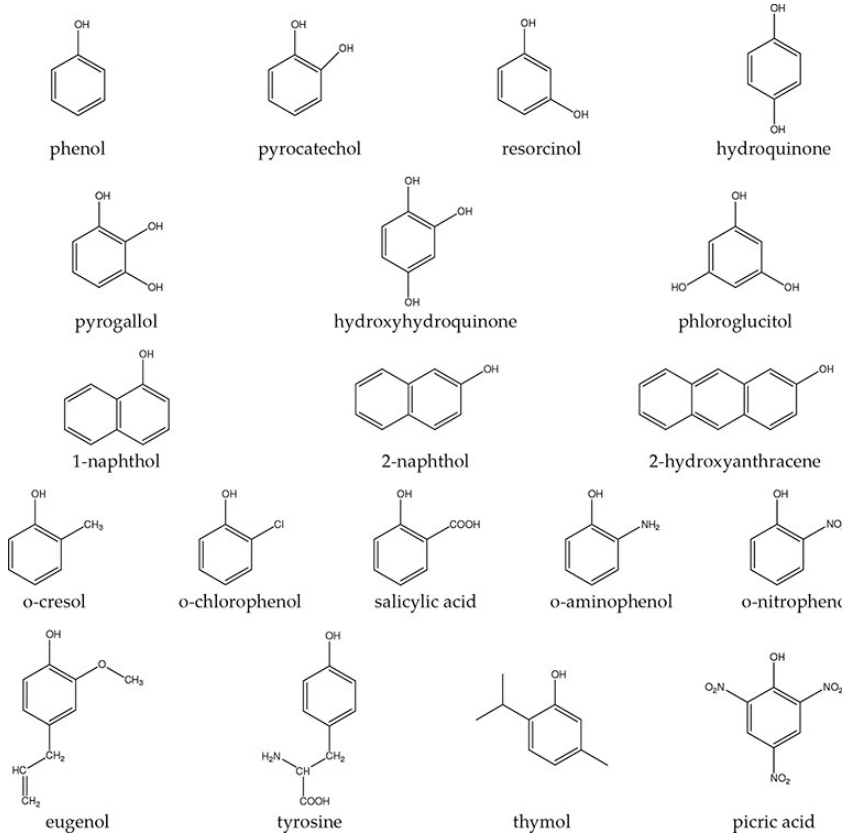
Phenol (also called carbolic acid) is an aromatic organic compound with the molecular formula C6H5OH. It is a white crystalline solid that is volatile. The molecule consists of a phenyl group (−C6H5) bonded to a hydroxy group (−OH). Mildly acidic, it requires careful handling because it can cause chemical burns.

Phenol is a basic building block in organic chemistry

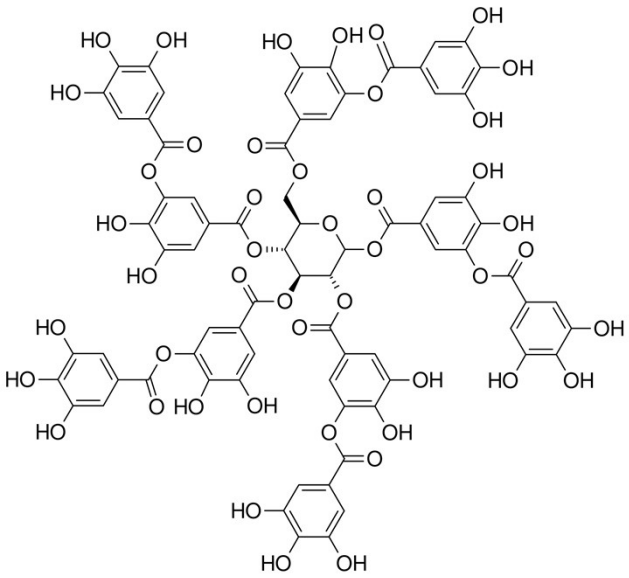


Other phenols are also building blocks

Compounds which posses one or more hydroxyl groups (–OH) directly connected to the aromatic system



How do tannins look?



Polyphenols

Polyphenols are a large family of naturally occurring organic compounds characterized by multiples of phenol units. They are abundant in plants and structurally diverse. Polyphenols include flavonoids, tannic acid, and ellagitannin, some of which have been used historically as dyes and for tanning garments. Wikipedia

Polyphenols are compounds that we get through certain plant-based foods. They're packed with antioxidants and potential health benefits. It's thought that **polyphenols** can improve or help treat digestion issues, weight management difficulties, diabetes, neurodegenerative disease, and cardiovascular diseases.

There are many kinds of tannins in red wine

And they are changing all the time

- Tannins in red wine are actually a **mixture of components that change continuously** while they are in the grape, in the winery, in the bottle and in the glass.

Some properties of tannins relevant for wine making

They polymerize and bind with proteins. They dissolve in alcohol

- Tannin have a unique ability to **easily combine with proteins**, causing them to precipitate. This is the basis of leather production.
- Tannins **polymerize** creating larger molecules of different compositions and forms and with different chemical reactivity with proteins.
- Tannins are much **more soluble in alcohol than in water**.

Let us talk about what tannins do for red wine

And how we perceive these contributions

- What is the nature of the tannins in red wine
- What are the tannins' contributions to red wine
- How do we perceive these contributions

How do we “taste” tannins in the wine?

They precipitate proteins in the saliva.

- There are many kinds of tannins in the wine but all have one thing in common: **they bind and precipitate proteins**, i.e. separate them out.

- **Human saliva is full of protein**. Tannins in red wine will bind to those proteins and causes the **feeling of astringency and graininess** in the mouth.

- In general, **smaller tannin polymers**, which mainly come from seeds, stems, and newer oak, **taste bitter.**

- **As tannins polymerize, change shape and react with other chemicals in wine they become less astringent and eventually softer in mouthfeel**

Contributions of tannins to red wine

Structure, longevity, aromas

- Tannins are important for **the mouthfeel of the wine. Too little and the wine feels thin and bland. Too much and the wine feels harsh.**
- Tannins give **structure** to wine and a well structured wine will have **tannins in dynamic balance with fruit, alcohol and acidity.**
- Tannins are the primary determinant of the **longevity** of red wines
- Some chemical transformations of tannins generate compounds that **improve the wine**

Tannins act as antioxidant

They reduce damage to the wine and help to improve it

- Tannins help to **intercept oxygen** and prevent it from changing the aromas, taste, color and other properties of the wine.
- Tannins are **easily oxidized** and this has two effects:
  - Lowering the tannins makes the wine a little milder and smoother to drink because content of **tannins reactive toward salivary proteins decrease.**
  - Break down of tannins form phenolic compounds which are more volatile and **shape the wine's aroma**. The more the oxygen the **more red fruit notes**

Tannins and perception of astringency

Molecular size and presence of other chemicals

- The **feeling of astringency** results from the interaction between the polymerized phenolic compounds and the saliva proteins but **only tannins with a molecular weight of 1000-3000 daltons are able to induce these reactions.**

- The **memory characteristics of tannins depend on their structure.** Those with a higher molecular weight are perceived as tart, while those with a smaller molecular weight increase the perception of acidity

- **The presence of other chemicals in the wine also change our perception of astringency.** For example, higher alcohol and higher malic acid content increases astringency perception.

Red wine preferences are dictated by genetics

The density of taste buds in your tongue are key in your perception of tannins!

- In the Essential Guide to Wine of Wine Folly, M. Puckett and J. Hammack Ask: **How many taste buds are within the area of one hole punch in your tongue?**

- **Non sensitive: 10 to 25% of people**. Less than 15 taste buds. Feels no bitter, enjoys spicy food, loves richest bolder flavors: **Primed for most intense wines**

- **Average taster: 50-75% of people.** 15-30 taste buds. You can taste bitterness like tannins and not wince in pain. **Capable of loving most wines.**

- **Hypersensitive: 10-25% of people.** 30+ taste buds. Everything tastes intense. Do not like bitterness. **Leans toward smooth wines**

How do we perceive tannins

Is a function of our taste buds and of the wine

- Our individual endowment of gustatory pupil makes a big difference: High density of pupils increase perception of harshness
- The sensory characteristics of tannins depend on their structure. Those with a higher molecular weight are perceived as tart, while those with smaller molecular weight increase acidity (diners or truners)
- A tart taste in wine is usually sharp or sour and leaves a taste in the mouth that can be tangy and tingling.
- Wine ratings oppose soft to tannic. Implicitly tannic is harsh

The mouthfeel of tannins

Texture and maturity characteristics

- The nature of tannins is **closely linked to the grapes' level of ripeness** when picked and, therefore, will mirror the nature of the wine's fruit profile.

- Texture: Are the tannins **soft, velvety, silky? Or coarse, grainy, chalky**? These are textural characteristics that mirror the sensations tannins can cause in your mouth.

- Maturity: Do they make you think of **green, crunchy, unripe fruit? Or of juicy, smooth and sweet pulp?**

- Tannins are not flavor compounds but they **can produce a feeling of bitterness in addition to the mouth-coating grip.** This is particularly true for young red wine

How to describe tannins?

From green to resolved

- When tannins are described as “**green**,” they’re slightly bitter and have unpleasant astringency.
- When a wine has a pleasant amount of tannins, noticeable but unobtrusive, it’s often described as “**grippy**.”
- **“Polished” or “elegant”** tannins will be very fine-grained in texture, noticeable but pleasant.
- Smoother tannins are described as **silky, plush or velvety**.
- Mature wines are often described as having “**resolved**” tannins, **which are smooth, soft and no longer hard astringent.**

How do tannins integrate in the wine?

When you describe a wine, ask these questions:

- Do tannins immediately coat the mouth, or do they appear slowly?
- Do they dominate the wine, or are they matched by freshness and fruit?
- Are they integrated and gentle, or assertive and harsh?

Tannins change and are made to change

In the grape, in the vineyard, in the winery, in the cellar, in the bottle, in the glass

- **In the grape**: Maturing from bitter to astringent and sometimes to smooth.
- **In the vineyard**: Leaves management and irrigation: More or less tannins, more or less mature tannins
- **During maceration, fermentation and pressing**: Tannins concentration increases as more alcohol is produced and contact with skins and seeds is extended.
- **In the barrel**: They get more and different tannins. They polymerize, change shape and react with oxygen and other chemicals
- **In the bottle:** They micro oxidize, become smoother and contribute to generating new aromas and tastes.
- **In the glass:** They aerate, react with oxygen, loose light chemicals and become smoother

The winemaker role in tannins development

From grape choice to bottling

Winemakers do many things to change the amount and nature of the tannins in red wine.

The results are not always predictable

Tannins management by winemakers

An art, not a science, with no simple guidelines

- **Good tannin management avoids harshness or bitterness,** which happens when grapes are not sufficiently ripe or when overextracted.

- For winemakers to craft a wine with a **tannin structure that matches their stylistic goals, steps need be taken at every stage of grape growing and winemaking**—from grape variety choices to the vineyard site and right up to bottling.

- Whether they aim to create a lighter, less tannic or to get as many tannins into the wine as possible, **winemakers deal with an issue for which there's no single answer or natural form.**

Tannins uncertainties and risks

There are many variables even in a single grape variety

- Because numerous factors affect extractability between grape varieties and ripeness levels over different vintages, **there is no easy way to anticipate what a wine's total tannin content will be based on a particular grape's total tannin content.**

- **If a red wine has harsh, bitter and unbalanced tannic structure to begin with, no amount of aging will even them out.**

Different tannins from different sources

Smaller from seeds, stems and newer oak are bitter

- Tannins in wine can come from five sources: **grape skins, seeds, stems, oak, and additives**.
- **Skin tannins are large and smoother**, as they tend to polymerize more than tannins from other sources.
- **Seed tannins are shorter, and harsher.**
- Stem tannins vary in size; they can be as small as seed tannins or as large as skin tannins **depending if they come from the inside or outside of green or dried stems.**
- **In general, smaller tannin polymers, which mainly come from seeds, stems, and newer oak, are bitter and harsh.**

Different grapes, different climates, different tannins

Thin or thick skins less or more tannins. Hot or cold, smooth or angular tannins

- **Some grape varieties have more tannins than others**. Examples that **can make really tannic wines** include Cabernet Sauvignon, Nebbiolo, Mourvèdre, Malbec, Tannat and others.

- Wines made from grapes like Pinot Noir, Gamay and Grenache, which have **much thinner grape skins, are much less tannic.**

- Ripeness also matters. A **hot climate** produces grapes that are super ripe, making the tannins particularly **smooth, lush and rounded**. In the **temperate regions** the tannins come across as **more structured, drying and angular**.

Tannins in the grape

Tannins as sunscreen lotion for the grape

- **Tannins accumulates in the grape as it grows, until the grapes begin to change color**.
- Tannins in the skins protect the grapes from the sun—**the more light that reaches a grape's surface (or the more intense that light is), the more tannins the skins produce.**
- This is a factor in **leaves management**.
- Light reaching **higher-altitude vineyards** is more intense and therefore contributes to conditions that yield more intensely tannic wines.

Tannins in the vineyard

Harvest time and watering affect the level and types of tannins that develop

- Grapes that are **picked earlier,** tend to yield **more aggressive tannins**
- **Vintages and grapes harvested later** will have more **developed, softened tannins**
- **Midseason irrigation** has a big impact on berry size, which affects tannin levels. Tannins accumulate before berry swell, so **larger berries will have a lower concentration of tannins.**
- **Irrigation in the final stages of maturity can soften tannins,** furthering polymerization in berries: It helps to stretch out the ripening time, maturing and smoothing of tannins.

Tannins and colorants during maceration and fermentation

Long solids contact with the liquid increases tannins and color

- **color and tannins are extracted** by the liquid from the skin, seeds and stems.
- **Tannins are more soluble in alcohol** than in water. **As the alcohol concentration increases during fermentation so does the concentration of tannins in the liquid.**
- The **longer and more extensive the contact** of the liquid with the skin, seeds and stems during maceration and fermentation the **higher the concentration of color and tannins in the wine.**

Tannins react with skin colorants

Anthocyanins stop polymerization which keeps color and astringency

Anthocyanins are phenolic compounds found throughout the plant kingdom, being frequently responsible for the blue to red colors found in flowers, fruits and leaves. In **wine** grapes, they **form when the skin changes color from green to red to black.**

Maceration allows the diffusion of anthocyanins, tannins and other phenolic compounds from the solid parts of the grapes **into the must or wine.**

During maceration and fermentation colorant anthocyanins react with some tannins and stop their polymerization, preserving color and astringency.

Tannins management during maceración and fermentation

Alcohol extract more tannins. Cold water more color

- A **short maceration** - cold-soaking of unfermented grape juice in the crushed solids - allows **less time for tannins and color to leach** from the skin, seeds and stalks into the wine: Rose wines.

- **Higher temperatures during fermentation increases tannins and color extraction.**

- **Colorants in the skin are more soluble in water than alcohol. To get more color and avoid extracting too much tannins during fermentation, wine makers can begin with cold maceration at temperatures below those of fermentation.**

- Winemakers can **increase tannins extraction** by carefully pushing the grape skins back into the must, fitting tanks with nets that keep the rising grape skins submerged, pumping back bottom or separated liquid over the grape skins or by using roto-fermenters.

- **Adding more stems - including whole bunches - increases tannins in the wine**

- Extended **post fermentation maceration lighten color, increase tannins and decrease bitterness.**

Tannins can be increased during pressing

Mixing wines with different tannic extraction helps consistency

Once red wine has finished fermenting, it's pressed, which separates the liquid from its solids. **Higher pressure extract more tannins from the solids.**

Some winemakers press in different batches at different pressures for greater control, wherein the **batches under the highest pressure will be the most tannic.**

Employing a variety of **wines with varying degrees of tannic extraction enables the winemaker to achieve a particular blend** consistent across numerous vintages.

Tannins from the barrel and oak additives

A mouthfeel of fine graininess, taste, aroma and color stabilization

- Oak barrels can contribute tannins to wine during the **first few years of use.**
- **Producers also use additives** such as oak powders, chips, nuggets and other to increase and **balance kinds of tannins.**
- **The additional tannins contribute to color stabilization and to improve aroma and taste through their reaction with anthocyanins**.
- When they’re abundant, barrel-derived tannins in wine **tend to impart a sensation of a fine graininess on the tongue.**

Tannins during the aging of wine

- It is known that the wine **astringency decreases over the aging process**. This change that was **attributed to a decrease in the total tannin content** in the wine, is now believed to be a more complex process.

- Tannins are very complex molecules with different sizes, conformations and reactivity. The decrease in the astringency intensity during aging **is now believed to be the result of a number of factors,** including:
    - **reactions** with oxygen and other compounds that generate smaller less astringent molecules,
    - **precipitation** from solution due to insolubility situations,
    - **changes in the shape** that make of the tannins molecule less reactive
    - **interactions with other components** such as colorants

Tannins and oxygen in the barrel and in the bottle

Effect of micro oxidation

- During micro oxidation **at first tannins become more perceptible**, the wine becomes more tart and the intensity of aroma is reduced.
- **Later tannins are perceived as more gentle, wine becomes more delicate, aroma is strengthened and becomes more varied**.
- This process observed in the lab mimics reports from wine experts indicating that in the early years of maturation **wines go through a "dumb" period before becoming much better with aging**.
- **Unfortunately not all wines get to be better. Only those well made**

Changing perception of tannins as wine matures

Mouthfeel changes from bitter and harsh to astringent to smooth

Initially, some of the tannins leached into a wine are **smaller molecules perceived as bitter and harsh.**

With time, **tannins grow by polymerization, change shape and react with other chemicals to progressively loose angular astringency and be perceived as smoother.**

If tannins molecular size keeps on growing they gradually loose astringency and eventually fall out of suspension, which creates a deposit and leads to sediment in some bottles.

Mature wines are often described as having “resolved” tannins, which are smooth, soft and no longer astringent.

However, if a red wine has harsh, bitter and unbalanced tannic structure to begin with, no amount of aging will even them out.

Tannins in the bottle

Polimerization and oxidation

- Over time in the bottle the tannins change as a result of polimerization and oxidation creating a smoother more drinkable wine. These processes reduce the amount of young harsh tannins and make them smoother. ¿?
- Oxygen interact with polyphenols. A more detailed description: Tannins begin to soften and breakdown. However, that is not exactly true and a whole lot has been written on what is happening to tannins.

Tannins in the bottle

Good tannins get even better

Mouthfeel changes as a red wine matures. Initially, the tannins leached into a wine are smaller molecules. With time, these tannins start to combine and form larger chains—a process called polymerization.

One theory is that this aging process reduces the tannins' reactive surface, which produces a softer mouthfeel. These tannin chains become so long that they fall out of suspension, which creates a deposit and leads to sediment in some bottles.

It's not clear whether this reaction is the only thing that makes aged wine less astringent. In any case, mature wines are often described as having "resolved" tannins, which are smooth, soft and no longer astringent.

However, if a red wine has harsh, bitter and unbalanced tannic structure to begin with, no amount of aging will even them out.

In the glass

Aereation and our perception of tannins astringency

- Aeration allows the wine to “breathe”. One result is that we perceive a **softening of the tannins.** Aeration also improves the flavors and aromas in the wine (release fruit).
- These effects are consistent with the reaction of tannins with oxygen that decrease tannins and generate new aromas and previous **studies indicate that during aeration there is a reduction of tannins and organic acids.**
- **Some experts believe** that aeration **is the prime source of change of wine in the glass.**
- **Apparently aereation both releases light chemicals** into the air **and oxidize some compounds** which when present increase our perception of astringency of the wine.
- **Alcohol and malic acids also increase our perception of astringency of tannins** and their concentration in the wine decrease significantly during the first hour of aeretion.

What we do to and with red wine matters

- Aereation
- Good food pairing

Our perception of tannins in red wine

A function of many variables

- The **quantity and quality of the tannins present in the wine at that particular time**: Amount, chemical composition, molecular size, shape and reactivity to proteins of the various tannins present in the wine.
- **Our endowment of taste buds and personal preferences**
- **The food that we are eating**

Food and perception of astringency in highly tannic wines

For some, proper food pairing is critical for the enjoyment of these wines

- **Dietary lipids** are crucial molecular agents impacting our sensory perception during wine consumption. They **decrease the perception of astringency and bitterness of tannins.**
- **Large amounts of protein in the food also compete with proteins in the saliva to precipitate tannins**. Consequently both proteins and lipids (fat) in the food impact our sensory perception of the astringency and bitterness of tannins.
- **Pairing high tannin wines with fat and protein rich food to reduce perception of astringency can improve the enjoyment of both,** particularly for people with high density of taste buds and high sensitivity to tannins.
- **People with high density of taste buds should avoid trying highly tannic wines without well paired food because they will perceive them as excessively astringent.**

References

There is a lot of good information in the Web

- Decanter.com. Several articles on tannins
- WineFolly.com. Several articles on tannins
- daily.seven fifty.com “The Science of Tannins in Wine”
- WineMag.com “What are Tannins, Really” Wine Enthusiast
- masterclass.com “Learn About Tannins in Wine: Definitions, Orígins, and 7 Ways Tannins Affect Wine"
- everwonderwine.com “How to deal with Highly Tannic Wines”

The end…is only the beginning