Red Wine Crush & Fermentation

Wine 3
Introduction to Enology

Tonight's Lecture
- Red grape processing
- Red wine fermentation
- Cap management & pressing
- Red grape varieties
- Malolactic fermentation
- Practice Quiz - No credit
- Test Review

Remember
- Next week is the first exam
- It will cover all material up through tonight’s lecture
- You will need a Scantron form 882-E
- Of the three tests, this one is the easiest for most students.
- There will be a practice quiz and review at the end of lecture

Red Wine Styles
- Red wines have more tannins and body and are less focused on fruity flavors than whites. The additional tannins mean that they usually are aged for longer periods than white wines.
- They can be made with no, low, or a lot of oak character.
- They can be made dry, off-dry (slightly sweet) or very sweet.

Harvesting
- Red wines are made from red grapes; (big surprise) they are harvested in the same manner as whites, but the flavors in red wine are not as sensitive to heat and oxidation so they can be picked under warmer conditions.
- Once they arrive at the winery, like white grapes they are inspected, sampled, and weighed.

Crushing
- The primary difference between white and red wine production is that red wines are fermented on the skins and pressed after fermentation. This process extracts the flavor and red color from the skins.
- Before fermentation the grapes must destemmed and put into a tank for fermentation.
Crushing

- A **Crusher-stemmer** is the most common method to handle red grapes. Fruit is run through the crusher and pumped directly to the tank that will be used for fermentation.
- Crushers are needed for red winemaking but optional for white winemaking.

Functions of Crusher

- Makes the grapes easier to transport (must is easier to pump than auger or conveyor).
- Separates stems, stem contact during fermentation can give a bitter/green taste to the wine.
- Macerates the fruit to aid in extraction of phenols and speed fermentation.

Crushed and Destemmed Fruit

- Must pumps can be used to transport the crush fruit to the fermentation tank.
- Must should be handled as gently as possible after destemming/crushing to avoid damage to the skins and increased solids.
- Crushers can be placed over the fermentation tank for the most gentle processing.

Carbonic Maceration

- In carbonic maceration, red grapes are not crushed or de-stemmed and the whole clusters are placed in a tank with a CO\textsubscript{2} atmosphere, sometimes provided by a small amount of fermenting must in the tank.

Nouveau Beaujolais

- This is the traditional method used to make **nouveau Beaujolais**, a fruity red wine that receives no aging, does not go through malolactic fermentation, and may be pasteurized before bottling. Released on the third Thursday of November.
Carbonic Maceration

- In the whole berries **intracellular fermentation** takes place. This works to a lesser extent if the clusters are de-stemmed but not crushed.

Effects of Carbonic Maceration

- About one fifth of the sugar is converted into alcohol & CO$_2$ and produces more glycerol than traditional fermentation.
- There is less extraction than with crushed fruit.
- Gives a characteristic carbonic maceration odor (bubble gum, strawberry jam).
- When the fruit is pressed the rest of the sugar is liberated and the fermentation finishes.

Partial Carbonic Maceration

- If 100% of the must is whole cluster the resulting wine will be very light in color and have a lot of "bubble gum" character.
- For this reason often only a portion, (10 to 25%) of the must is whole cluster for a more subtle effect.
- This style works well with Pinot Noir & Gamay.

Fermentation Tanks

- Fermentation tanks can be food grade plastic, wood or stainless steel.
- Traditional barrels cannot be used because you can't get the skins in and out of the bunghole.
- A few wineries use barrels with a small door installed in the head of the barrel.

Red Wine Fermentation Tank

- Top Manway with relief valve
- Sample Petcock
- Racking Valve
- Outward Opening Bottom Door
- Large Bottom Valve

Variable Capacity Tanks

- Variable capacity tanks with a bottom door can be used as an open to red fermentation tank
**Fermentation Tanks**

- Concrete tanks, used to be industry standard in California.

**Old Style**

**New Style**

**Wooden Tanks**

- Fermentation tanks are made of oak as well, modern ones have temperature control.

**Fermentation Tanks**

- For home winemaking: plastic drums, barrels with the head knocked out, or food grade garbage cans work well.
- Macro bins (½ and 1 ton) also work well, insulated bins can hold in too much heat.

**Fermentation**

- The tanks are mixed (pumped over) to homogenize the must and analysis is run.
- If necessary they are adjusted with SO₂ and acid.
- After additions the tank is then inoculated with yeast for fermentation.
- Nutrients should be added after fermentation begins.

**Fermentation Tanks**

- Barrels with access door for must.
Red Crush

Oak adjunct during fermentation
- Winemakers noticed that reds that finished their fermentation in new barrels had better color and aroma and less vegetative character.
- To get this effect in stainless steel tanks oak powder or sawdust can be added prior to fermentation.
- Tannins extracted from oak also will work.

Starting Fermentation
- The temperature must not be too hot or cold for yeast inoculation.
  - If it is too hot, the fermentation can start too fast.
  - If it is too cold then fermentation will start too slowly.
- Remember yeast culture should be within 10º F of must temp before it is added.

Temperature of Fermentation
- Temperature is important to the rate of fermentation and color extraction.
- Too hot and fermentation will be too fast and yeast may be killed by excessive heat.
- Too cold and fermentation will be sluggish and you will get poor color extraction.
- Ideal range is to start at about 70 to 75ºF and have the fermentation peak at 80 to 85ºF.
- The cap of skins and the middle of the tank can be much warmer than it is at the edge of where the temperature probe is located, especially if the tank is large.

Cold Soaking
- Used on Pinot Noir and other varieties with poor color for extra extraction.
- Fruit is crushed and SO₂ is added then soaks at 40 to 50ºF for several days before yeast is added.
- This can also be done to allow must with a lot of raisins to release all of its sugar (common problem with high Brix fruit). More on this in wine additives lecture.
Cap Management

- Most of the color, taste and body of a red wine is derived from the skins, so it is very important to mix the skins and the juice throughout fermentation to insure that the flavor compounds are fully extracted from the skins.

Punching down

- Punching down is the oldest and gentlest method, works best in small open topped fermenters.

Pumping Over or Irrigation

- Pumping over, typically done 2 to 3 times a day for 15 to 45 min.
- Works similar to a drip coffee maker.

Pumping Over or Irrigation

- Done by hand or with an irrigator. Pump over ½ to 1 times the volume of wine 2 to 3 times a day.
**Rack and Return**

- Rack & return is where the fermenting juice drained through a screen from the fermentation tank into a second tank which is usually filled from the top. Then the juice is returned to the fermentation tank over the top of the skins.
- Sending the wine through a screen during pumpover is called delestage (‘del-ess-TAHJ).

**Delestage**

- This incorporates air into the fermentation and removes skins.

**Rotary fermenters** are wine tanks that work like a cement mixer to mix the cap with the must.

- Their main advantage is that the mixing can be automated and that it is easy to remove the skins after fermentation.

**Other methods of Cap Management**

- Submerged cap, holding the skins down in the juice by mechanical means.
- Rolling the tank with compressed air or inert gas.
**Aeration**
- After the fermentation has begun, oxygen can improve color stability and facilitate fermentation.
- Rack & return provides extraction and aeration.
- Air (oxygen) can also be added through by venturies during pumpovers.
- Air should only be added after fermentation has started and cut off at about 5º Brix.

**Controlling Flavor**
- The amount of time of pump over or the method of keeping the cap wet is a major stylistic consideration in the amount of color, tannins, and flavor extracted in the fruit.
- When and how often you pump over or punch down has a huge effect on a wines ultimate color flavor and body.

**Pressing**
- When the wine is dry (typically 10 to 20 days) the juice is drained off and put through a screen or the press to remove any skins.
- This is the easy part, now you have to get the skins to the press.

**Removal of skins after dejuicing**
- Shoveling is the most common method to remove skins after the juice has been drained.
- The skins are shoveled either into bins or a portable must pump.
**Removal of skins after dejuicing**

- If a must pump is used juice has to be added back to the skins to make them fluid enough to pump.
- Some wineries spray wine into the tank to “hydraulically mine” the skins out of the tank to avoid shoveling.
- Dejuicing tanks are not used because the skins would jam up because they are so dry.

**The Dangers of Carbon Dioxide**

- Removing skins from tanks is the most dangerous job at a winery and a number of cellar workers have lost their lives in tanks.
- Safety precautions must be taken before entry is allowed (by permit only).
- Even if you are doing everything right if you do not document your training and procedures you are in violation of the law.

**Confined Space Entry**

- Government regulations treat wine tanks as a confined space.
- A “permit” must be filled out before a tank is entered.
  - Training
  - Atmosphere testing and monitoring
  - Rescue equipment must be on hand

**Sample Permit**

**Warning Sign**
When to Press?

- Like cap management, this is a stylistic consideration. There are four different points in the fermentation when it is usually done.

1. Pressing when the wine still has residual sugar. Good for young fruity style wines, light character, usually 2-5°Brix.

When to Press?

2. Pressing as soon as dryness occurs, good for medium to full bodied reds.

3. Pressing several days after dryness, often tasting is done every day to monitor the extraction and see if flavor is improving.

Pressing Reds

- The berries are broken down by the end of fermentation, tannins and bitterness increase as you go from light to heavy press, sometimes press fractions are not separated.

- The skins are not as "slippery" after fermentation so press aids are not needed. The cake drains quicker and press cycles are faster than with whites.

Press Fractions for Reds

- Often press lots are not kept separate for reds.
- If they are kept separate it gives you the option of blending them in at a later date if desired.
- Heavy press lots can be finned if needed.

Pressing Reds

- Dejuicing tanks are not used because the skins would jam up because they are so dry.

Cake formed pressing Reds

Pressing Reds

- Extended maceration after fermentation the tank is sealed up and pumpovers stop and you wait 1 to 6 weeks after dryness before pressing, the cap sinks, harsh tannins settle out to make softer wine.

- I personally think this method was developed by cellar workers who wanted a weekend off at the end of harvest.
Post Fermentation
- After pressing the wine is placed in tanks and allowed to settle before racking into barrels.
- Sometimes they are racked several times or splash racked to incorporate oxygen into the wine and blow off residual CO₂.

Post Fermentation
- After malolactic fermentation is complete, they are adjusted with SO₂ and acid (if needed) before they are put into barrels.
- Malolactic fermentation can also finish in barrels.

Red Grape Varieties
- We will cover some of the most popular red grape varieties that are grown in California before moving onto malolactic fermentation.
- Red wine varieties make up 57% of the 2013 California wine grape harvest.

Malolactic Fermentation ~ MLF
- Not as dramatic as primary (alcoholic) fermentation but just as important to get it right.
- My first wine, a 1981 Cabernet Sauvignon made in a dorm room closet, tasted great ~ until summertime.

Malolactic Fermentation ~ MLF
- The conversion of malic acid to lactic acid by bacteria.
- ML Bacteria use malic acid as an energy source, unlike yeast that use sugar to make alcohol.
- MLF is often called secondary fermentation as opposed to primary (alcoholic) fermentation.
- MLF usually occurs after primary fermentation and happens more slowly.
Malolactic Fermentation ~ MLF
- Malolactic bacteria are the most common microbe found in wine.
- Fortunately not many species of bacteria can grow in wine (no pathogenic species at any rate).
- Winemakers used to consider it spoilage, until they discovered their wines went through MLF without them even realizing it!

Principal Acids in Juice & Wine
- Tartaric and malic acids make up over 90% of grape juice acid. Malic acid is common but tartaric acid is rarely found in other fruits.
- Lactic acid, very little in juice; small amounts are formed by yeast, much more from ML bacteria.

Principal acids in wine

Malic acid | Tartaric acid | Lactic acid
---|---|---
| COOH | COOH | COOH |
| HCH | HC-OH | HO\(-\)C-H |
| HO-CH | HC-OH | CH3 |
| COOH | COOH |

Carboxylic acid groups are in Yellow

Principal acids in wine

Malic acid | Tartaric acid | Lactic acid
---|---|---
| COO\(-\) + H\(^+\) | COO\(-\) + H\(^+\) | COO\(-\) + H\(^+\) |
| HCH | HC-OH | HO-\(-\)C-H |
| HO-CH | HC-OH | CH3 |
| COO\(-\) + H\(^+\) | COO\(-\) + H\(^+\) |

Disassociated Carboxylic acid groups

Malolactic Fermentation
- The formula for malolactic fermentation

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\[
\text{Malic Acid} + \text{Lactic Acid} \rightarrow \text{Lactic Acid} + \text{CO}_2
\]
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Effects of MLF

- What malolactic fermentation does to a wine:
  - Deacidification
  - Microbial Stability
  - Sensory

Effects of MLF

- Since lactic acid has one less acid group than malic acid has MLF deacidifies wine
- The higher the ratio of malic acid in the wine the more MLF lowers acidity.
- Deacidification, good in high acid wines bad in low acid wines.

Effects of MLF

- Microbial stability, If the fermentation is completed in the cellar you don't have to worry about it starting in the bottle.
- MLF raises pH (lowers acidity) which makes the wine a more favorable environment for spoilage microbes.

Effects of MLF

- Flavor Change, provides buttery flavors especially in white wines like Chardonnay.
- Lowers acid, makes wine less tart.
- More viscosity (body) creamy mouthfeel.
- Slightly lowers fruity character of wine.
- Other than lowering acidity MLF has a less obvious sensory affect on reds.

Which Wines benefit from MLF?
And which don't

- Most Reds and some white wines benefit from MLF.
- Look at the effects of MLF and ask yourself:

  Would the style of wine I am trying to make benefit from what MLF does to a wine?

MLF for Red

- Most reds go through MLF, why?
  - Higher pH than whites
  - Ageing in wood (often used) cooperage
  - You do not have to filter them as tightly
  - I recommend MLF for most reds unless they are very low acid and you also have access to a sterile filter.
MLF for Whites
- Depends on the wine
- Fresh and crisp style,
  - Such as: Riesling, Gewürztraminer, Pinot Gris, Sauvignon Blanc, and Muscat, avoid MLF
- Rich and creamy style,
  - Such as: Chardonnay use MLF

Inoculating your wine for MLF
- Buy bugs (malolactic bacteria), you don’t have to, but it is worth the cost to prevent headaches.
- CHR Hansen, Lalvin, and Wyeast are all good brands.

Inoculating your wine for MLF
- ML bugs are sensitive, follow rehydration and culture buildup directions.
- Some cultures are direct inoculation and can be added directly to the wine others require a “build up” step before inoculation.
- Use old wooden cooperage.
- Cross inoculate with a wine that has had MLF.

Freeze-dried Malolactic Bacteria
- Some Freeze dried cultures can be added directly to wine.

When to inoculate
- If you are going to do MLF you want it to start as early as possible so you should inoculate when the primary fermentation is finished.
- Usually for red wines, the best time is right after pressing or at the end of alcoholic fermentation.

Co-Fermentation
- Some winemakers prefer to add during the primary fermentation so the MLF will get a head start.
- There is a link to a paper discussing co-fermentation of yeast and ML bacteria on the class website.
- I have been having success with this method.
MLF in Barrels
- For white wines, I prefer to inoculate directly to the barrel when it is getting topped after fermentation is complete.
- For reds I prefer to have the MLF finished before putting the wine in barrels in case it needs an acid adjustment upon completion, some winemakers prefer to let it finish in barrels.

Which Strain of ML Bacteria to Use?
- There are many types of malolactic bacteria, some are better than others.
- Most winemakers use *Oenococcus oeni* (old name *Lactobacillus*). Ferments quickly leaving few off odors, tolerant to low pH and has clean aromas.
- When viewed under a microscope has round cells that form short chains.

Oenococcus oeni

O. oeni on the surface of a membrane filter and through a light microscope.

Undesirable Malolactic Bacteria
- *Pediococcus*, grows in unclean wine cellars, leaves a vegetal/dirty socks smell, round cells in pairs.

Undesirable Malolactic Bacteria
- *Lactobacillus* rod shaped, fast fermenter, that leaves earthy aromas at the expense of fruit, sensitive to air.
- If it goes through MLF in the presence of sugar, it results in high VA (Vinegar).

Other Microbes
- There are many more microorganisms that can grow in wine we will go over a lot of them in our wine spoilage lecture.
- Remember, there are no human pathogens that can grow in wine.
Promoting MLF

- Keep pH >3.4 in reds (>3.2 in whites).
- Low / No SO₂.
- Warm Temp >65°F.
- Don’t clarify; wine bugs like the nutrients in dirty wine
- **Careful!** These are the same conditions that spoilage microbes like.

Preventing MLF

- For wines that you do not want to go through MLF it should be discouraged.
- Start early so the bacteria do not get a chance to start growing.
- Use a combination of the following methods for the best results.

Preventing MLF

- Keep pH low
- Add SO₂
- Clarify wine and keep it cool
- Put in clean cooperage
- Sterile filtration to remove bacteria
- If you cannot sterile filter try:
  - Fumaric acid (.03 to .04 % in pH < 3.8)
  - Add lysozyme (250 PPM)

When MLF is done

- You know MLF is completed by the absence of malic acid on a paper chromatogram or enzymatic method ([Malate] < 0.25 g/L considered complete).

Paper Chromatography

- Make sure it is done before bottling or take precautions.
- For homemade wine if you don’t want MLF and you cannot sterile filter, use fumaric acid or lysozyme and drink your wine young.
- For low-acid red wines made in the Central Valley MLF is often not done.
In Conclusion

- Don’t leave MLF up to chance
- Do it if it will make you wine better
- Don’t do it if it won’t
- Make sure it is done before bottling or take precautions

Practice Quiz

- Five Questions in four minutes
- It will not be graded.
- In the real test you will not be allowed to sit next to each other.
- Calculators are not required for the 1st test, but they will be needed for the 2nd & 3rd tests.
- Phones cannot be used as a calculator

Next week:
- First midterm
- Wine Chemistry