Wine Being Made - Red

James Beard, one of the most esteemed writers and critics of American and international wine and food, was once asked how he could, in his travels around the U.S. and Europe, possibly find the truly great chefs. After all, thousands of "great Chefs" existed. He said he liked to visit restaurants in August and September, go to lunch and order a tomato salad. He said, there is only one way to make a great tomato salad. Great tomatoes. No magic dressing can transport a so-so tomato into a great one. The truly great chef knows how to get the great tomato.

The truly great winemaker knows how to get the great grapes.

Even if you can't grow or find the great grapes, you must at least learn to make whatever you do make, drinkable.

Let's think about making some red wine. For this discussion, we'll pick the varieties famous in Bordeaux; Cabernet Sauvignon, and Cabernet Franc.

http://www.winepros.org/aftertaste/recread.htm - tgwg Cabernet Sauvignon makes the most dependable candidate for aging, more often improving into a truly great wine than any other single varietal. Other reds can produce equally great wines, like Pinot noir, Syrah and Nebbiolo, but they do no adapt to different locals so easily. With age, its distinctive black currant aroma can develop bouquet nuances of cedar, violets, leather, or cigar box and its typically tannic edge may soften and smooth considerably. It is the most widely planted and significant among the five dominant varieties in the *Medoc* district of France's *Bordeaux* region, as well as the most successful red wine produced in California.

Long thought to be an ancient variety, recent genetic studies at U.C. Davis have determined that Cabernet Sauvignon is actually the hybrid offspring of Sauvignon Blanc and Cabernet Franc. Cabernet sauvignon berries are small, spherical with black, thick and very tough skin. This toughness makes the grapes fairly resistant to disease and spoilage and able to withstand some autumn rains with little damage. It is a mid to late season ripener. These growth characteristics, along with its flavor appeal have made Cabernet Sauvignon one of the most popular red wine varieties worldwide.

http://www.biology.uch.gr/gvd The best growing sites for producing quality wines from Cabernet Sauvignon are in moderately warm, semi-arid regions providing a long growing season, on well-drained, not-too-fertile soils. Vineyards in Sonoma County's Alexander Valley, much of the Napa Valley, and around the Paso Robles area of the Central Coast have consistently produced the highest-rated (and highest priced) California examples.

Typically, Cabernet Sauvignon wines smell like black currants with a degree of bell pepper or weediness, varying in intensity with climatic conditions, viticulture practices, and vinification techniques. Climates and vintages that are either too cool or too warm, rich soils, too little sun exposure, premature harvesting, and extended maceration are factors that may lead to more vegetative, less fruity character in the resulting wine. Late harvesting practices can result in wines of raisiny bouquets, high alcohol, "hot finishes", Parker 95's and great financial return. In the mouth, Cabernet Sauvignon can have liveliness and even a degree of richness, yet usually finishes with firm astringency. Some of the aroma and flavor descriptors most typically found in Cabernet Sauvignon are:

Typical Cabernet Sauvignon Smell and/or Flavor Descriptors	
Varietal Aromas/Flavors:	Processing Bouquets/Flavors:
Fruit: black currant, blackberry, black cherry	Oak (light): vanilla, coconut, sweet wood
Herbal: bell pepper, asparagus (methoxy-pyrazine), green olive	Oak (heavy): oak, smoke, toast, tar
Spice: ginger, green peppercorn, pimento	Bottle Age: cedar, cigar box, musk, mushroom, earth, leather

Cabernet Sauvignon began to emerge as America's most popular varietal red wine in the mid-60s. By the late 1980s, it had replaced "Burgundy" as a consumer's *generic* term for red wine (as had Chardonnay, replacing "Chablis" as the equivalent for *generic* white wine). This popularity was based partly on the flavor appeal of the grape and partly on its status or snob-appeal as a "collector's" wine. Indeed Cabernet Sauvignon is the wine most subject to inflationary climb, as fans, collectors, and the *Nouveau Riche* bid the supply ever upward.

http://www.biology.uch.gr/gvd Recent studies in ampelography, using the relatively new application of DNA fingerprinting, have determined that cabernet franc is one of the genetic parents of cabernet sauvignon. Both cabernet varieties are among the five major grapes of Bordeaux.

The differences between *franc* and *sauvignon* become apparent when grown and fermented in close proximity.

Cabernet franc vines bear thinner-skinned, earlier-ripening grapes with lower overall acidity, when compared to cabernet sauvignon. Yields are similar, although cabernet franc normally buds and ripens somewhat earlier. http://www.biology.uch.gr/gvd Consequently vineyards in climates where rain is a harvest-time threat often plant this grape, in place of or in addition to cabernet sauvignon. Cabernet franc

vines survive cold winters better than cabernet sauvignon, but are more susceptible to being damaged by spring frosts.

France has by far the most cabernet franc plantings of any wine producing nation with over 35,000 acres. There are significant plantings of cabernet franc in St. Emilion in Bordeaux, the Loire Valley (where it is known as *Breton*), and south west France (aka *Bouchy*). There are cabernet franc vineyards in Romania, Hungary, the Balkans, and the Friuli region of north eastern Italy (aka *cabernet frank*).

New plantings in the 1990s in Australia, New Zealand, and Argentina show promise. In the United States, cabernet franc is planted in Long Island, New York, and in Washington state. California has about 2,000 acres, mostly planted since 1980, over half in Napa and Sonoma.

Depending a great deal on vineyard practices, the flavor profile of Cabernet Franc may be both fruitier and sometimes more herbal or vegetative than Cabernet Sauvignon, although lighter in both color and tannins. But on certain vineyards it can be very spicy, dark and tannic. Most Napa winemaker would kill to get 10% Cabernet Franc into their Cab Sauv blend. Over-cropping and underexposure each tend to accentuate the vegetative flavor elements. Typically somewhat spicy in aroma and often reminiscent of plums and especially violets, Cabernet Franc is more often used as a secondary or tertiary element in varietally-blended red wines, such as Bordeaux or *Meritage*, instead of as a stand-alone varietal bottling.

Typical Cabernet Franc Smell and/or Flavor Descriptors	
Varietal Aromas/Flavors:	Processing Bouquets/Flavors:
Fruit: raspberry, cherry, plum, strawberry	Oak (light): vanilla, coconut, sweet wood
Floral: violet	Oak (heavy): oak, smoke, toast, tar
Herbal: bell pepper, stems	Bottle Age: musk, mushroom, earth, cedar, cigar box

It must also be noted that every year in the Napa Valley, the highest average price per ton paid for grapes by wineries, is for Cabernet Franc, not its child. What can those winemakers be thinking?

Now, we must make some winemaking choices. A few exist.

1. Rosé
2. Light red
3. Whole berry fermented red
4. Medium bodied, low tannin red.
5. Full bodied, high tannin red.

The last two may dabble in oak flavors.

As with white wine fermentation, the wine style depends on when the grapes are harvested and then how they're vinified.

To make a Rosé, we'll have to look at the vineyard. No matter what is growing, in heavy poorly drained soil, the wines made will be light and unassuming…a perfect Rosé candidate. Rosés should be fresh, lively wines. They should be served chilled and drunk young.

Rosé is the French word for pink. Therefore, to make them, a short amount of skin contact is needed. Or, blending can play a part. Since Rosés are fresh and fruity, the wines should be fermented cold. The alcohol yield will be nearly 61% of the juice Brix. To make a 12% alcohol Rosé, the grapes should be picked at 19.5° to 20° Brix. For the Cabernets, the TA will probably be about 0.8 g/100 ml and the pH 3.25. The grapes are crushed, destemmed, SO_2'd (50 ppm), put in a tank and chilled to 45° F. You don't want the fermentation to begin. After about 12 hours, drain some juice from the tank and inspect it. If pink enough, drain all the free run. Should be about 135 gallons per ton. Let the juice sit in a tank overnight and rack the cleaner juice off its lees. Follow instruction given by yeast suppliers and inoculate the juice. Ferment at between 45° and 50° F. The wine should be dry in about 30 days. Rack off the yeast lees, or filter the wine to a full tank. Adjust the FSO_2 to 25 ppm.

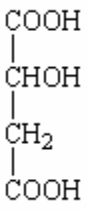
After you drain the juice from the tank, the wet pomace remains. Several choices exist:

Crush and destem another batch of grapes on top of the pomace and treat it like a normal red wine fermentation. Or, use another batch of white or pink juice. Ideally, if it's a red table wine desired, the newly arrived grapes should be 22° to 24° Brix. The resulting blend will be higher in alcohol than the Rosé and have the added advantage of being fermented in a higher than normal percentage of skins. Also, alas, a higher percentage of seeds.

You may have an older vintage wine that is not quite up to snuff. Let, the wet pomace warm up, add a yeast inoculum and after the fermentation start, slowly add the older wine to the fermenter. You don't want to kill off the yeasts. The idea is to get a couple days of fermentation. Once the wine is drained and pressed, often the old problem wine is quite nice.

Now, back to our Rosé. It's dry, SO_2'd and in a full tank. You do not want the wine to undergo malolactic fermentation, so make sure you're not infected with ML bacteria. If it is, filter the wine. You have to decide when you want to release it and at what style. Rosé should be released as early as possible.

The wine must be tasted to determine if it's in balance. If it's too flat, then an acidulation with tartaric or malic acid may be appropriate. Malic acid is less acidic than tartaric acid. It will also not precipitate in cold temperature, like tartaric (KHT). Commercial malic acid come mixed in two isomers. It is known as DL-Malic acid and has 50% of both isomers. Malic acid's isomers are D-malic and L-malic. Isomers are molecules which contain the same number and kind of atoms but which differ in structure.
This is L-Malic acid.



On D-Malic Acid, the –OH on the second C, comes out the opposite side of the molecule. The natural acid in grapes is L-Malic Acid. And more importantly, only L-Malic is used in MLF.

So, when adding DL-Malic Acid to juice or wine, even if it undergoes MLF, 50% of the Malic Acid (D) remains untouched and will add acidity and not be subject to precipitation.

All taste tests must happen in the lab, before actual additions in the cellar. Adding 8 #/m of tartaric acid raises the TA about 0.1 g/100 ml.

Rosés can have other additions to make them more festive. Just prior to the filler bowl, CO2 can be injected into the wine. Not sparkling wine levels, but just a bit *pétillant* (peh-tee-yahn). Most sparkling wine has over 12 g of CO_2 per liter. The typical European *pétillant* wine has about 7 g of CO_2 per liter. Levels closer to 2 g of CO_2 per liter can be very lively but not so seemingly effervescent.

Besides a touch of spritz, maybe a bit of sweetness? Sweetness additions can be very effective if kept in balance with acids and phenolics. There are three ways of sweetening any dry wine prior to bottling; grape concentrate, *muté* and sweet reserve.

Most grape concentrates are made by evaporating grape juice at reduced pressure to eliminate about 75-80% of the water naturally present. The final concentrates are 68 °Brix. This is, by far, the primary method of adding sweetness to wine. The quality is, however, not great. Even though the sugars are concentrated, most of the aromatics are driven off with the water. Also, not the best quality grapes are used for concentrating.

SWEETENING WITH GRAPE CONCENTRATE

Add to 100 ml of wine, the following ml of 68° Brix grape concentrate to get the desired increase in RS

Conc. to Add (ml)	Desired RS Increase
0.074	0.05
0.147	0.10
0.221	0.15
0.295	0.20
0.369	0.25

After you decide what balance you like, the addition can be made. Many choices of concentrate exist.

There are two other methods for adding sweetness to dry wine. These can both be very high quality additions. If we go back to draining our Rosé juice, we can make these two other sweeteners.

After we drain the juice, we immediately filter some of it. It may take two filtration stages, powder and pad. We want to make *muté*. We will keep the juice in a sterile condition until we are ready to use it. After filtration, we can add another 100 ppm SO_2 and put the muté in a cold refrigerated state, both to help control yeast growth. We have retained the entire varietal aroma in the *muté*. Since the *muté* sugar is much lower that concentrate, more will be added to the dry wine prior to bottling than the concentrate. Do the math.

We can go back to draining the juice, but this time, we stay through the yeast inoculum and start of fermentation phase. We will be making sweet reserve. After the fermentation starts and a couple of % alcohol have been formed, a portion of the fermenting wine is filtered to stop fermentation. This is then treated the same way as the *muté*. The difference is that the sweet reserve will be more complex than the simple fruity character of the *muté*. It will have some fermentation bouquet that the *muté* will not. Again, the sweetness level is different than both the concentrate and the *muté*.

Anthocyanins and tannins are the main pigments in red wines. All the difference between white wines and red, depend on these compounds. They give red wines their color and organoleptic character. Red wine aging is tied to the chemical changes in coloring material.

Anthocyanins are red and blue pigments widely distributed in plants.

The tannins are special phenolic compounds characterized by their ability to combine with proteins and other polymers such as polysaccharides. They have an ability to transform fresh hides into rot-proof and barely permeable leather. This "tanning" property arises from their ability to create tannin-collagen matrices. Tannins cause astringency on the human palate caused by precipitation of the proteins and glycoproteins from saliva. Tannins are also used in fining wines because they react with proteins. Lastly, they inhibit enzymes by combining with their protein fractions.

Carbonic maceration (CM), or in French, *maceration carbonique*, is a fermentation method used for certain red wines, notably those of Beaujolais, resulting in fruitier, less acidic, less tannic wines. The public begins consumption of these *Nouveau* wines in the year of the harvest. Instead of crushing the grapes and letting the yeast ferment the juice, whole bunches of grapes are put into tanks that also have CO_2 gas. A different and partial fermentation then occurs within the individual berries. The grapes undergo intracellular or autofermentation. The weight of the fermenting berries soon causes the berries on the tank bottom to split and fermentation on that juice proceeds in the usual manner. The entire tank is emptied, the grapes crushed and pressed and fermentation completed in a normal manner. These wines are not long-lived and are meant for early consumption.

Ripe grapes undergo complex changes when placed in a confined, anaerobic condition. This transformation is created by the grape cells. The intact berries are surrounded with a CO_2 atmosphere and respire and have partial fermentation by the grapes' own glycolytic enzymes. Without yeast, inside the berry, small amounts of sugar is transformed into alcohol.

The grapes are placed in a tank that is sealed, except for a fermentation bung. Fermentation starts after several days. Initially, a vacuum is created in the fermenter and then gas is evolved during the metabolic phase. Inside the berry, the oxygen is depleted and alcohol and CO_2 increase until the grape cells die. After eight to ten days of whole berry fermentation, the enzymes lose their activity and the process ceases. Generally, only 1-1/2% to 2-1/2% of alcohol is produced. Also formed are small amounts of glycerol, succinic acid and several other secondary products from the sugar fermentation.

But also, inside the berry, half of the malic acid disappears. This greatly reduces the must and the final wines acidity. Also occurring is a rise in nitrogen, mineral matter and polyphenols, particularly in the color of the juice. The aroma compounds in the grape skin are extracted by the juice. The cell walls in the skin become permeable allowing the pigments, many of the phenols, and other extractables to leak into the

intracellular fluid. The consistency of the fruit changes also because the pectins in the cell walls are hydrolyzed.

To do whole berry fermentation, the grapes must be handled very gently in transport from the vineyard to the winery. The tanks in which they will be placed are filled with CO_2. The CO_2 comes from compressed gas cylinders or from other fermenters. The grapes are placed in carefully so as not to bruise. There will soon be some grapes splitting and normal fermentation taking place, but the malic acid reduction only happens inside unbroken berries, so care must be taken.

Both sulfiting and acidulation are not recommended. It can be too rough on the grapes while mixing. But some winemakers, seemingly unaware of necessity for grape skin integrity, do both.

The temperature of the CM fermentation will control its length. The ideal temperature is a very high 95 °F and the onset of fermentation is detected with aid of a fermentation bung. Lower temperature requires longer CM fermentation. The CM fermentation is considered complete when the grapes cool down, measured CO_2 production ceases, the Brix of the free run juice, its color and taste.

During the anaerobic phase, yeast may develop on the grapes. It must also be noted after a few days, when the CO_2 production diminishes and oxygen appears so will lactic acid bacteria. This can ruin the entire tank, so be watchful.

Once the CM fermentation is considered complete, free run juice is drained and the remaining pomace pressed. The free run fraction can vary between 50% and 75% of final total volume. When this drainage takes place, generally, about 20% of the grapes have been crushed and have undergone alcoholic fermentation by the yeast, 20% of the grape remain whole and are homes for intracellular fermentation and 60% undergoes both transformations. The press wine is now mixed with the free run and the entire lot finished fermentation together. Depends on temperature, but it could finish in a couple days. In these final days of yeast fermentation, the juice has an almost heavenly aroma. Malolactic fermentation takes place readily, because of reduced acidity and bacteria incubation.

What's good about CM fermentation? One, not as much heat is given off by the fermentation, the wines are much softer (less tannic), acidity is lower and the wines have unique secondary bouquets. The CM bouquet seems to erase varietal character. Some people don't like this. However, this unique nose can transform certain mediocre varieties into lovely wines. The acid reduction is important in cool growing regions unable to grown red wine grapes of character.

Remember, the grapes have not been destemmed. The problem that sometimes occurs is increased astringency resulting from stem contact. Keeping the CM fermentation too long before pressing can cause this. Also, both acetic and lactic acid bacteria can show up very quickly.

The wines of Beaujolais are made from Gamay. Wines labeled Beaujolais and Beaujolais-Villages account for three-quarters of the wine made in the district. The rest comes from ten *crus* situated within the Beaujolais-Villages areas whose wines can carry their own appellation; Brouilly, Chénas, Chiroubles, Côte de Brouilly, Fleurie, Juliénas, Morgon, Moulin-à-Vent, Régnié and Saint-Amour. These wines have aromas described as plums, peach, floral, irises, roe petals, cherry, strawberry and many others. The wines are released to the public on the third Thursday in November of the harvest year.

Now, before we get into normal red wine fermentation, there are two there things to discuss.

Saignée (sen-yay), or tank bleeding, involves the draining off of a percentage of the free run juice/wine from the fermenter. It can be as much as 60 gallons per ton. Some winemakers do it 24 to 36 hours after crushing into the tank. Larger berry varieties sometimes benefit from higher bleeding volumes than smaller. Red wines get all their color and the majority of their phenols from skins. The idea is to remove a portion of the juice to increase the skin to juice ratio. But the skins and seeds can also supply bitter and astringent tannins, so a tradeoff is offered.

Saignée increases both anthocyanins and tannins in the resultant wines. If extraction of these compounds were strictly dependent upon solubility, we would expect the opposite effect, since there is less liquid to dissolve the phenols. So extraction of phenolics is not strictly solubility limited. In both Malbec and Pinot noir, wines with saignée had more tannin, more polymeric pigment, and more color than the control wines. In another study with Syrah, this was true early on, but after six months, the differences had almost disappeared. This has triggered questions about the long-term effects of *saignée*, still unanswered.

But this leaves some problems for the winemaker. Red juices produced by bleeding or whole cluster pressing do not always ferment to dryness and can have a tendency toward reductive notes and/or are difficult to get to complete MLF. Amino acids are not equally distributed in the grape berry. For example, with mature Cabernet Sauvignon, about 8.5% of the totals are in the seeds, 15% in the skins, and 77% in the pulp. The separation of the pulp juice, as occurs with bleeding and whole cluster pressing, has a significant qualitative influence on fermentable N. The two amino acids present in the greatest concentration are proline and arginine. Proline cannot be used by the yeast, while arginine can. Indeed, because it has four atoms of N per molecule, arginine is a very good source of fermentable N. In the case of most red varieties, the ratio of arginine to proline is much greater in the skins than in the pulp. In other words, the pulp juice associated with bleeding and whole cluster pressing has a relatively high concentration of proline (approximately 55%) which cannot be used by the yeast, and a small concentration of the more potent amino acid arginine, and others needed to carry out a healthy fermentation. Wines so produced should be given a higher concentration of supplemental fermentable N, in the form of amino acids and vitamins, than is required to ferment the juice remaining in contact with the skins. Do not simply dump in DAP. Too much DAP can lower the production of esters.

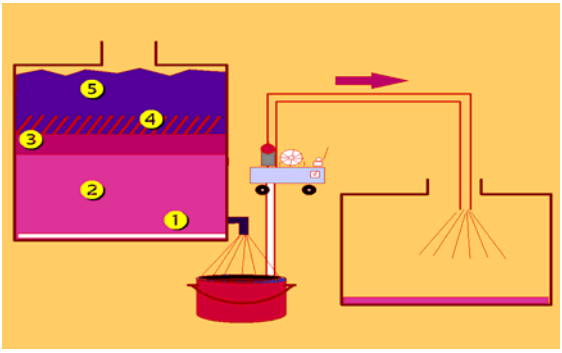
Also, what do you do with the 10 ~30% of your original must volume which now has little to no varietal aromas, tannins, or color? First, these were grapes picked at higher sugar levels than those destined for Rosé. As opposed to 19.5° to 20° Brix, they were probably at 23° to 24° Brix. To make fruity Rosé at 14% to 14.5% is not very exciting. Remember the earlier possibilities for handling the drained Rosé pomace, "Crush and destem another batch of grapes on top of the pomace and treat it like a normal red wine fermentation. Or, another batch of white or pink juice. Ideally, if it's a red table wine desired, the newly arrived grapes should be 22° to 24° Brix. The resulting blend will be higher in alcohol than the Rosé and have the added advantage of being fermented in a higher than normal percentage of skins." So, either the timing of these two has to be perfect or the drained Rosé pomace has to be chilled to prevent onset of fermentation. If not possible, you'll make a high alcohol pink wine to dispose of or correct later.

Délestage involves drain and return during fermentation. Occurring as often as once per day, délestage allows the cap to drain relatively dry. During this process, as much as 40% of the grape seeds can be deported from the fermenter. Seed removal, plus oxidative polymerization of tannins result in a positive

change in the tannin profile of the wine. There is a reduced concentration of astringent, bitter and dusty tannins.

The de-stemmed and crushed red grapes are pumped or dumped into a fermenter. The fermenter is usually open-topped, and equipped with a drain valve at the edge or the center of the tank bottom. The fermentation is begun in the standard way.

First step: Emptying the vat while properly airing the juice and while sending it into another vat
The beginning of the first step

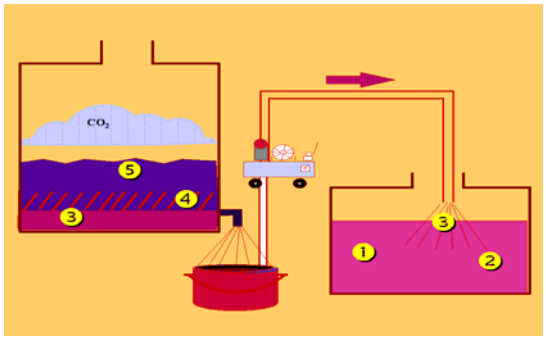


The first step is to drain the tank through a bottom valve, into an intermediate container by letting the juice/wine flow freely across a screen to capture and remove some of the seeds, a step known as seed deportation.

From the intermediate container, a pump then sends the juice/wine to a second tank.
This trip is done with some fanfare: the wine entering the second tank goes in over the top to become aerated, read that 'sprayed,' into the receiving tank. Magnificent aromas fill the fermenting room as a result.
The seed-catching screen is emptied as necessary to keep a good flow without spilling the juice out of the screen or the small intermediate container.

Comments: *Delestage can start once there is a pomace cap formed. The initial vat is entirely emptied of juice and oxygen is added to the juice. An open jet in a tub ensures real oxygenation of the juice (transfer of 2-4 mg/liter of dissolved oxygen). Other methods are just as equally efficient: direct injection of oxygen in the juice reception vat or the insertion of a porous stainless steel coupler on the pipes used for pumping.*

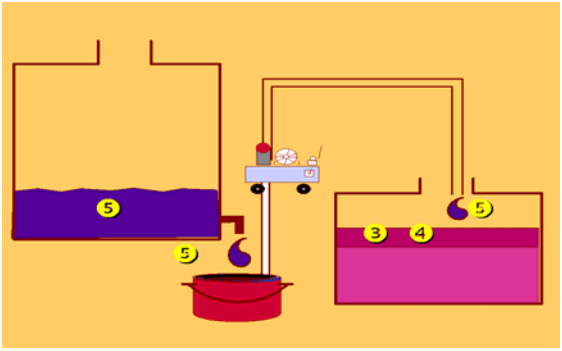
The end of the first step



Comments: *Emptying all of the juice is a key factor in successfully carrying out a délestage. It ensures that the juice that is the most concentrated in polyphenols receives oxygen. This juice is located directly under the cap. The suspension of all yeasts and their oxygenation is one of the key elements to an alcoholic*

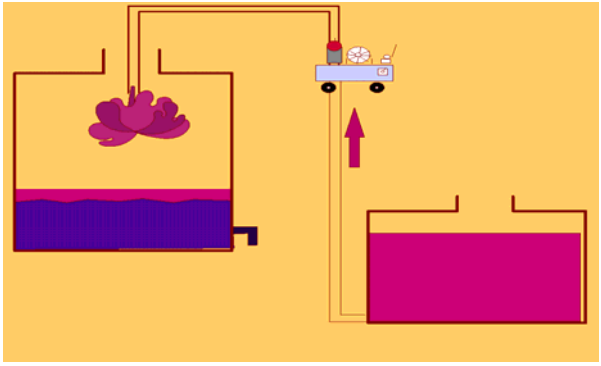
fermentation. The juice under the cap is not completely renewed by a traditional pumping over; a punching of the cap renews this juice, but doesn't add oxygen to it during fermentation.

2nd step : Thoroughly draining the pomace at the bottom of the vat for 1 to 2 hours



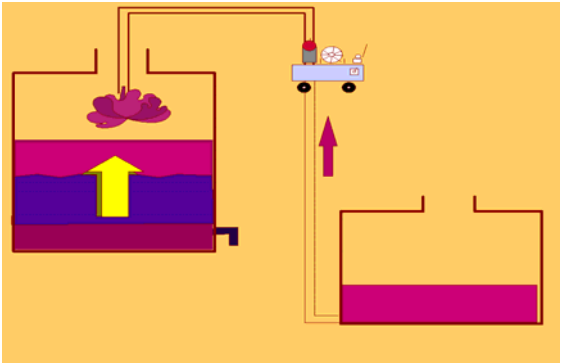
Comments: Complete draining of the pomace helps achieve a better diffusion of the grapes' valuable elements: pigments, tannins, the pulps and the zone under the skin's polysaccharides. Complete airing of the juice is a safe way of ensuring stabilization, of coating tannins and of preventing reduced smells.

3rd step : Pumping over the juice again by spraying the pomace with a freely flowing, low pressure jet



Comments: Pumping of juice or wine again over the pomace using a low pressure jet, limits the mechanical grinding up of the pomace. It isn't necessary to wash the entire pomace surface: either the pomace is completely covered with juice when the pressure is sufficient or the cap disintegrates and mixes well with the juice.

4th step : Rising up of the cap to the juice's or the wine's surface



Comments: *When the pomace remains intact, it rises up through the juice or wine, permitting thorough exchanges between the pomace and the liquid without however grinding up the marc and the liquid. In other situations involving the pomace and the vat, it disintegrates resulting in equally intense non aggressive exchanges.*

Whether the *délestage* process is performed once a day, twice a day, or every other day, seems to vary from winery to winery. The amount of seed deportation varies as well, being somewhat dependent on the slope of the tank bottom and the location of the drain valve used. The fermentation is normally completed in five to seven days.

Several beneficial things occur in this process:

First, in any red fermentation the major reason for disturbing the fermenting must (grape pulp and skins) is to re-distribute the heat being produced by the yeast while it converts sugar into alcohol and carbon dioxide. That is what punching down, or *pigeage*, (pidgee-AHJ), and pumping over, are all about. Some studies have shown that *délestage* behaved closer to pump-overs, rather than punch-downs, in terms of extraction.

Délestage does well to introduce oxygen into the early process to stabilize fruit and color, and to encourage the joining up of harsh tannin molecules into bigger, softer ones. *Délestage* also minimizes the impact of seed tannins.

Now, we can discuss standard red wine production. Much of the information of nitrogen content in grapes, SO_2 additions and levels, yeast inoculation, pectolytic enzymes, malolactic fermentation and wood aging can be found in Winemaking Choices-White.

Each grape variety and appellation produces a different wine style. The vast majority of red wines are crushed, destemmed, SO_2'd, yeasted, fermented between 75°F and 85°F, punched down or pumped over three times a day, undergo MLF and are aged in wooden containers. *Saccharomyces cerevisiae* generally produces a wide range of alcohol levels. If you take the °Brix and multiply by 54% to 61%, you'll get the expected alcohol (% by volume) range. Since red fermentation temperature is higher than whites, the alcohol yields are lower, because more alcohol is vaporized during fermentation.

Using 54% conversion, 21° Brix to 26° Brix will yield alcohols of 11.3% to 14%. Many winemakers, after lengthy hang time, are picking grapes at 27° Brix to 29° Brix, giving alcohols of 14.5% to 15.7%. In many cases, the yeast has difficulty surviving at these alcohol levels and if they do, resulting wines are often dealcoholized. We will not discuss dealcoholization, but the winemaker must be aware of the option.

In many different red wine growing regions, a form of <u>maceration</u> is used. To macerate is to cause to become soft or separated into constituent elements by or as if steeping in fluid. We make grape skins, pulp and seeds get soft and separate by soaking them in juice or wine. In our white wine discussion, we called it skin contact. The three forms of maceration are cold maceration, carbonic maceration and extended maceration. Carbonic maceration, or *maceration carbonique*, has already been discussed. Cold maceration involves the cold soaking of crushed red grapes, generally without stems, for several days prior to commencing fermentation. Extended maceration is keeping wine in contact with skins, pulp and seeds, in a sealed tank, for up to 50 days before draining and pressing.

Cold Maceration, or cold soak, is the period of time used to extract color and flavor prior to the start of fermentation. This time period can be extended by chilling the macerating fruit to prevent fermentation. Larger wineries use refrigeration equipment to chill the grapes. The must is usually cooled to about 15° C (60° F), or lower, to slow commencement of fermentation. A heavily colored juice appears in a day. Either then, or in a day or so, the must is inoculated. The cooled must may take a couple days to be at a established fermentation. Needs to reaches close to 70 °F.

Smaller wineries pick their grapes into 1/2-ton bins and, once at the winery, add dry ice to the bins to chill the bin contents. Putting dry ice (which is solid CO_2 and has a melting point of -79 ° C, or -121 ° F) in contact with whole grapes or must certainly freezes the grapes in its close proximity. Freezing the must before fermentation breaks cell membranes and seems to be an effective technique for releasing anthocyanins. Interestingly, when dry ice was used to freeze the must, several studies reported a two-fold increase in both anthocyanins and tannins, in all Merlot, Cabernet sauvignon and Cabernet franc tested. This had the added benefit of protecting the berries from oxygen before fermentation.

Cold soak produced little difference in anthocyanin and tannin levels, or sometimes, produced even less anthocyanins, color intensity, and flavonols than non cold-soaked wines (for example in Pinot noir). Even in cases where cold soak was able to increase anthocyanins, a long-term impact on color would not be expected since the polymeric pigments needed to stabilize them would not have been affected. More study is needed.

If no cold maceration is used, the grapes are crushed and destemmed to a fermentation tank. In a few cases (generally Pinot noir) a portion of the stem are retained in the must. The addition of stems to red wine fermentation is very controversial. It is not universally accepted, especially among Pinot Noir producers. After putting the must in the fermenter, decisions on SO_2 and yeast inoculum must be made. The same choices exist as for white wine production.

Once red wine fermentation begins, the sugars are fermented to produce EtOH and hundreds of other compounds. The simple fermentation equation is:

$$\underset{\text{Solid}}{C_6H_{12}O_6} \rightarrow \underset{\text{liquid}}{2\,C_2H_5OH} + \underset{\text{gas}}{2\,CO_2}$$

This is only a rough summary of a complex reaction sequence which was already set up in 1815 by Lavoisier. What the CO_2 does is evolve. It drags other things with it, like grape seeds, pulp and skins. At the top of the fermenter, these solids form the "cap". If the fermentation continues uninterrupted, the cap will stay lodged on top. Since all the red wine color and most of the flavor and phenols will come from the cap, a way must be found to get the fermenting juice to come in contact with the cap contents. The methods also depend on the geometric shape of the fermenter. The possibilities are:

1. Straight sided tanks without tops
2. Straight sided tanks with tops
3. Straight sided sealed tanks on their side
4.

All of the above can be made of various materials. In the U.S., it's mainly stainless steel. Around Europe it's generally wood, tile or cement.

Now, any of the straight sided tanks will still have a levitating cap. To mix the fermenting juice the cap can be mechanically forced down into the juice. This is called punching down (PD) or *pigeage*. Every home winemaker making garbage can wines uses this method with piece of wood or their own hands. The larger the tank, hydraulic mechanisms are needed to punch down. The cap can be pretty thick, and some so solid, a man could lie on the top without immediately sinking.

Or, a hose can be connected to the bottom of the fermenting tank and that to a pump (usually a centrifugal pump to keep from plugging with seeds) and from the pump a hose is hauled to the top of the tank and the fermenting juice is sprayed over the entire cap. May take anywhere from 10 to 30 minutes, depending on the tank size. This is called pumping over (PO).

There are various methods of accomplishing both PD and PO with mechanical aids to cut down on labor costs and cellar worker negligence.

Two other methods of mixing the cap and fermenting juice are the rototank and submerged cap methods. The rototank works like a cement truck. It is programmed to periodically rotate to mix the fermenter contents. Very expensive tanks. Lower labor costs. Very good mixing. The submerged cap has a lattice near the tank top. The grapes are crushed into the tank. The lattice is put in place before fermentation begins. It's placed right on top of the rushed grape surface. Once fermentation starts, the CO_2 caused the cap to rise, but the lattice stops it. So, during the entire fermentation, the cap is submerged in the fermenting juice.

Both PD and PO should happen three to four times a day. Not only does it give good mixing of the cap with the fermenting juice, but it also keeps the cap from getting too dry and chances for bacteria to make a home in the cap.

Not only should the cap be managed properly, it is very important for the winemaker to visit each fermenter at least twice a day. Once the "crush" starts and the grapes start arriving at a winery and the fermentations begin, it is important that each fermenter be monitored and observations recorded. Even at very large wineries, the monitoring should be done by the winemaker, not a lab tech. Not only can they check the present sugar level and temperature in the fermenter, but they can smell and taste the fermentation. Note scan be recorded on a clipboard and re-examined at every visit. Every winemaker should do this. No exceptions.

Now, red wine fermentation, after any maceration should take three to five days.

For some wines, like Pinot Noir, the wines can be drained from the fermenter and the remaining pomace pressed and the wine sent to a barrel to complete fermentation. The wine can go dry and be racked to another container, inoculated with ML bacteria, topped and the MLF watched until early spring. It would then be racked, SO_2'd and placed in full containers to age until bottled.

Other wines, can go dry, be topped, inoculated with ML bacteria and left *sur lie* for 18 to 24 months.

Other wines, especially Bordeaux reds, can have their fermenters sealed when fermentation stops and kept in this stage for up to 50 days. This is extended maceration. It is the extra time that the red wine is in contact with the skins and seeds after primary fermentation have completed. In this method, after the normal management of red wine fermentation, as the fermentable sugars were nearly consumed, the winemaker would seal the red wine tank with all the must and seeds inside, providing only a vent for the

carbon dioxide to escape. And wait. Different producers process the pomace (fermented must) at various lengths of time after closing the tank. I've observed that the tannin components continued to increase over 14 days or so, and then stabilized. At that day 14, or so, the wine was the harshest in its history. During the next two weeks, the chemically measurable amounts of tannins would remain constant, but the harshness of the wine, as perceived by tasters, would decrease gradually and continually. The wine gets softer on the palate. At the 30-day point, the rate of change is slow. With the tank lid closed, there seems to be no hazard of forming acetic acid, or vinegar, on the top layer of the wine/pomace, but I have seen extended maceration tanks form acetic acid. In normal extended maceration, the pressing is done close to day 30, with the result that color and fruit are quite alive and the tannins are quite soft. The tank can be drained and pressed. I have had 47 day macerations.

Both *délestage* and extended maceration achieve a part of the desired result, but each accentuates only a part of the wine development. On the other hand, extended maceration is sparing of oxygen in the early part of fermentation with either *pigeage* or pumping over for heat re-distribution. In the extended skin contact period all oxygen addition is stopped and development of larger, softer tannin molecules goes on anyway, in the presence of grape skins and pulp, in a process that is still not well understood. Extended maceration tended to increase tannin, but not anthocyanin. This is because anthocyanins peak on days 4 and 5 of skin contact, with little gain after day 10.

Another process should be quickly addressed. Some grape varieties like Petite Sirah are very tannic (puckery). But, Petite Sirah has very dark colors. Say, you have this lot of grapes and have trouble using the resulting wine. The colors from the grape skins, the anthocyanins, are water soluble. So, when you crush your Petite Sirah, after a couple days of fermenting it's already dark red. But it is still not very puckery. So, you keep fermenting, pumping over and tasting. When it gets down to 10° to 12° Brix, it is very dark, very fruity and has just begun to get tannic. You immediately drain the fermenting juice/wine through a shell-and-tube heat exchanger and drop the temperature to 45° F and spray all the chilled wine over the left behind cap in fermenter. This suspends everything. Then drain, press and ferment the wine at 45° F in another tank until dry. This can make a dark, fruity, soft, marketable red wine.

So, after you have chosen or been given a grape variety, region, wine style, budget and energy level a red wine can be brought from the fermenter, aged and bottled. Your wish is it is drinkable.