FERMENTATION AND STILL WINE PRODUCTION

CHAPTER FIVE

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LEARNING OBJECTIVES

After studying this chapter, the candidate should be able to:

- Recall the sequence of events that take place during the winemaking process.
- Recognize key terminology associated with fermentation and wine production.
- Understand the differences between red, white, and rosé winemaking.
- Describe the procedures for making sweet wines.
- Discuss what makes organic, biodynamic, and kosher wines different from other wines.

While much of a wine's character is determined by the qualities of the grapes themselves, winemakers have a great deal of influence as well. In this chapter, we examine the basic art and science of winemaking, or enology, beginning with the basic winemaking process for still (nonsparkling) white wines, followed by a discussion of the production of red wines, rosé wines, dessert wines, and some specialty wines. The production of sparkling and fortified wines will be covered in chapters 6 and 7, respectively.

WHITE WINE PRODUCTION

White wines are produced in a range of styles, from light-bodied and delicately scented to full-bodied, well-oaked, and complex. No

matter what the style, the sequence of events in the winery is roughly the same, but with differences in the details. The following idealized description is typical of the production of most white wines in a modern winery. Keep in mind, however, that not all of the following steps will necessarily be carried out for every wine, and that variations are often introduced for the sake of style, tradition, or economy.

PRE-FERMENTATION

In general, it is a priority to begin the winemaking process as soon as possible after harvest. Once grapes are picked, they immediately start to degrade, and oxidation begins to set in. If left alone, unbroken grapes would start to become raisins, while broken grapes and their juice would quickly begin to ferment in unpredictable ways, potentially ending up as vinegar. To minimize these unwanted effects, the winemaker typically keeps the grapes cool and covered and may use sulfur as a preservative while the grapes are en route to the winemaking facility.

Sulfur can be added to the grapes or juice at any of several points during the pre-fermentation period. The sulfur combines with oxygen to form sulfur dioxide (SO2), which inhibits the growth of both yeast and bacteria, thereby reducing the likelihood of premature fermentation and spoilage. It also prevents the juice from oxidizing and turning brown.

The pre-fermentation portion of the winemaking process is often referred to broadly as the "crush," encompassing not only the actual crushing (if any) of the grapes but also everything that gets the juice ready for the initiation of fermentation.

Sorting

The first stop in grape reception may be some type of *sorting table* where leaves, underripe bunches, damaged fruit, and other debris can be removed before processing begins. This is usually done by hand, but it can be partially mechanized. Rigorous selection results

in high production costs and is primarily employed in the production of high-end wines.

Figure 5–1: White grapes in a crusher/destemmer

Crushing and Destemming

From the sorting table, the grapes may be sent through a crusher or crusher-destemmer. This piece of equipment is designed to break open the berries and release their juice. If destemming is intended, the grapes will simultaneously be separated from the stem structure of the bunch. The result of the crush is a quantity of liquid containing the grape skins and the seeds (and, perhaps the stems).

Crushing is differentiated from pressing in that the skins of the grapes are broken and juice is allowed to flow, but no pressure is applied. Crushing is typical but not universal; some wineries eliminate this step for certain wines, preferring instead to crush and press at the same time (which may involve whole-cluster pressing). If done, crushing (and later, pressing) must be done gently, as too much force can cause the release of tannins (and, perhaps, an accompanying bitterness or astringency) from the skins and seeds.

Pressing

When making white wine, contact between the skins and the juice is

usually minimized, primarily in order to avoid coloration. However, an exception is often made for some of the more aromatic grape varieties, which may benefit from a short period of time during which they are chilled, and their skins are permitted to macerate with the juice to extract aromas and desirable phenolics. This "cold soak" is generally done for no more than twenty-four hours.

During the pressing stage, fresh grapes, whether crushed first or not, are poured into the press in order to separate the solids from the juice. By this point, the movement of the grapes since harvest has already caused many of the berries to burst open, so a large amount of juice drains out from the press immediately (more if the berries were crushed first). This is known as the "free run" juice and is typically considered to be juice of the highest quality, rich in sugar and low in tannin. Some wineries keep this free-run juice separate from the later "press juice" for use in the winery's best wines.

After most of the free run has been collected, the grapes are subjected to one or more pressings to extract the remaining liquid. Presses were once mechanical devices that smashed the grapes between two hard surfaces to extract the juice, but modern versions are far gentler. Modern presses are usually *bladder presses* that essentially inflate a large balloon with air or water to squeeze the grapes with just as much force as other presses, but with more flexibility, which is less likely to crush seeds or burst open skin cells. As a result, properly operated modern presses can extract more usable liquid from the grapes than ever before while avoiding the negative consequences of too much pressure.

The cake of dry, compressed skins and pips (seeds) that remains after the final pressing is called *pomace* and is often composted or plowed back into the vineyard to improve soil structure. It can also be used to make pomace brandies known as *marc* or *grappa*.

Must Adjustments

Grape juice that is destined for fermentation is referred to as *must*. After pressing, the must may be ready to move into the fermentation

phase, or the winemaker may determine that must adjustments are necessary. For instance, as sometimes occurs in warm climates or particularly hot years, the grapes may have a level of acidity that is too low for the accompanying sugar levels. In the case of cool climates or unusually cool-to-cold years, the grapes may have developed insufficient sugar. For these and a variety of other reasons, the levels of sugar or acidity in the must may be out of the range that the winemaker needs for the style of wine he or she wants to create.

The issue of low acidity can be solved by adding acid directly to the must, a process known as *acidification*. This is generally done with tartaric acid, the most common acid naturally found in grapes. Acidification should not affect the flavor significantly apart from sharpening the acidic tang and bringing the wine into balance. If necessary, a degree of de-acidification may be achieved through the use of potassium or calcium bicarbonate.

The problem of insufficient sugar is not uncommon in marginal growing regions where grapes may fail to reach optimal ripeness. In such instances, the winemaker may choose to use some form of *enrichment*, such as blending with grape juice or concentrated grape sugar (known as rectified grape must concentrate/RGCM).

In a related process known as *chaptalization*, sugar is cautiously added to the must before fermentation begins. Chaptalization requires that the winemaker incorporate only enough sugar into the must to achieve an acceptable alcohol level in the finished wine. This is not a method of making wines sweet, as the added sugar—along with the original sugar content of the must—is expected to be converted into alcohol.

There are various other methods available for raising or lowering the concentration of sugar or acid in the must, including adding or removing water. However, such procedures are highly regulated in many parts of the world, and wineries are subject to the stipulations of each country or region.

Juice Settling

After pressing, the winemaker may choose to let the juice settle for a day or two before allowing fermentation to begin. This process is called *débourbage* in French. Juice settling may be done in order to let a must adjustment fully integrate with the juice, to wait for some of the solids to settle out of solution so there will be less sediment after fermentation, or to have time to process more grapes that will go into the same batch.

FERMENTATION

The actual mechanics of fermentation are quite complex in that the biochemical process involves about thirty successive chemical reactions, each *catalyzed* (brought about) by a specific *enzyme* (an organic substance capable of causing a chemical change) in the yeast.

Simply put, yeast cells attack sugar molecules ($C_6H_{12}O_6$) and break them apart to release energy, some of which is given off as heat. The smaller molecules that remain after the yeast cells have split apart the sugar are ethyl alcohol (C_2H_5OH) and carbon dioxide. After the yeast cells have worked their way through a tank of grape must, virtually all of the fermentable sugar has been replaced by alcohol and carbon dioxide, the latter of which mostly dissipates into the air. In other words, the must has become wine.

The basic chemical formula is this: $C_6H_{12}O_6$ + yeast $\rightarrow$ 2 (C_2H_5OH) + 2 (CO_2) + heat

Because there are actually many intermediate steps that take place during this process, usually only about 90% of the grape sugars are fully converted into ethanol and CO_2 before fermentation stops. Most of the rest are broken down into various transitional products such as glycerol, succinic acid, acetic acid, lactic acid, acetaldehyde, ethyl acetate, and other alcohols such as methanol.

Figure 5–2: Vintage wine presses

In modern wineries, white wines are often fermented in stainless steel tanks. Stainless steel is considered *inert*, meaning that it does not impact the flavors of the wine. Stainless steel tanks are also airtight and easy to clean, and they provide relatively easy temperature control. Some white wines are barrel-fermented in standard 225-liter (60-gallon) oak barrels to add complexity, introduce some oak flavors, and downplay fruit aromas. Other fermentation vessels, more often seen in older, more traditional wineries, include large wooden casks and concrete vats.

Initiating Fermentation

Yeast cells and spores are commonly found in and around wineries. These include yeasts that were brought into the winery on harvested grapes and others that remain in the winery from previous years' fermentations. Therefore, it is often more difficult to *prevent* fermentation from beginning than it is to make it begin. As soon as the sugar-rich juice is released from the grapes, yeast cells will jump in and begin feasting and multiplying. To stop this from happening too soon or with unwanted strains of yeast, the winemaker will usually add some sulfur. Sulfur is toxic to yeast as well as to other fungi and bacteria. The must may also be refrigerated, which slows or stops most biological activity.

The use of these ambient (native) yeasts—sometimes referred to as natural fermentation—is an important stylistic decision. There are hundreds (if not more) types of yeast, and not all of them are conducive to commercial wine production. In some cases, a certain strain (or strains) of yeast may produce less-than-desirable aromas or flavors, or they may be unable to convert all the fermentable sugar to alcohol (leaving the wine susceptible to spoilage, among other issues). However, native yeast fermentation can be an effective and deliberate wine making technique. In some established wine regions and wineries, generations of natural selection may have fostered a dominant strain of desirable yeast, making native yeast fermentation a possible and positive choice.

The alternative is to add a significant amount of commercially grown yeast. *Inoculation* of the must with cultured yeast gets the fermentation off to a fast start and gives the cultured yeast a substantial advantage over any wild yeast that may be present in the must. The cultivated yeast will rapidly dominate the yeast population.

Most of the yeasts used in winemaking are strains of *Saccharomyces cerevisiae*. Different strains of yeast may be chosen in order to add desirable flavors or aromas to the wine, to speed up or slow down the fermentation process, or to achieve a certain level of alcoholic strength. The specific yeast strain chosen can have a considerable effect on the overall style of the finished wine.

During Fermentation

Once the yeast start to multiply, the must will begin to bubble and foam with escaping carbon dioxide and will grow warm from the heat caused by the fermentation process. The temperature is a critical factor. Cool temperatures between 50°F and 60°F (10–16°C) are best for retaining delicate fruit and floral aromas, which are key features of many white wines.

Figure 5-3: Stainless steel fermentation tanks

As the temperature increases, the yeast cells become increasingly active, converting the sugar into alcohol at a faster pace and further raising the temperature. At elevated temperatures, the fresh fruit and floral essences of white grapes can disappear, giving the wine a more neutral character or even introducing "cooked fruit" aromas more akin to apple sauce than fresh apples. If the fermentation gets out of control and the liquid goes much above 100°F (38°C), the yeast will likely die, and fermentation will stop prematurely. This is the most common cause of a "stuck fermentation," which is very difficult to reverse.

For both stylistic and practical reasons, temperature control is one of the most important things the winemaker is tasked with during fermentation. The job is made much easier with modern technology, which allows for remote monitoring of temperature levels and effective cooling capabilities through the use of refrigerated jackets, coils, or panels. Before such technology existed, winemakers had to rely on chilly fall weather conditions or work in underground wine cellars to keep the fermenting vessels cool, although these nontechnical methods are still in use today.

End of Fermentation

With proper temperature control and a healthy population of yeast, fermentation should continue until the sugar is depleted and there is nothing left for the yeast to consume. This can take anywhere from several days to several weeks. Fermentation may also come to an end if the alcohol content reaches more than 14% or so, at which point the yeast may no longer be able to survive. This may leave a small amount of residual sugar. Another possibility is for the winemaker to intentionally stop the fermentation while there is still a degree of sugar present. This is done for white wines that are intended to be *off-dry* or *medium dry*, as well as for dessert and fortified wines.

The liquid is now officially wine. While some white wines have an alcohol content as low as 7% abv, most white wines have an alcohol content of 12% to 14%. Next, the wine moves into the post-fermentation phase, where it will be prepared for bottling and sale.

POST-FERMENTATION

Malolactic Fermentation

Malolactic fermentation (MLF) is not a true (alcohol-producing) fermentation but rather a conversion process that can take place simultaneously with the primary (alcoholic) fermentation or after the primary fermentation is complete. Malolactic fermentation is often referred to as *secondary fermentation* or *malolactic conversion*. Malolactic fermentation is carried out by a particular strain of lactic acid bacteria that decomposes the sharp malic acid in the wine and converts it to lactic acid. When this happens, the tart, green apple characteristics of malic acid are replaced by the milder and creamier characteristics of lactic acid. An ester known as diacetyl, created as a by-product of malolactic fermentation, often imparts a "buttery" aroma to wines that have undergone this process.

For many white wines—particularly those that rely on fragrant aromas, light body, and crisp acidity— malolactic fermentation is avoided. Certain styles of Chardonnay benefit from the richness

added by malolactic fermentation, and these are perhaps best-known examples of white wines that undergo malolactic fermentation. However, some producers are using MLF on Chenin Blanc, Viognier, and other white wines. These wines are often described as having notes of butter, hazelnut, brioche (freshly baked bread), and dried fruit.

Lees Contact

After fermentation is complete, the expired yeast cells and any other solid particles in the wine begin to sink to the bottom of the tank or barrel. This sediment is known as the *lees*. In many cases, the wine is quickly removed from the lees through a method of clarification known as *racking*.

In other cases, the wine is allowed to rest in contact with the lees for an extended period of time. This is known as *sur lie aging*, which is French for "on the lees." As the wine rests on the lees, the dead yeast cells begin to decompose, potentially imparting a yeasty aroma, creamy texture, and increased complexity to the wine. To amplify these effects, the sediment may even be stirred back up into the liquid in a process known as *lees stirring* or *bâtonnage*.

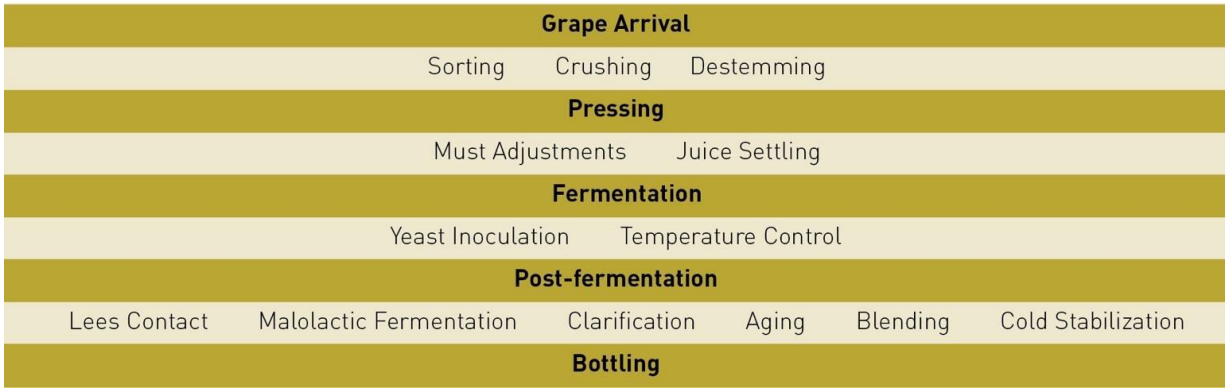

Figure 5–4: White Wine Production Chart

Sulfur Addition

After fermentation is complete, the sulfur level of the wine is typically checked once again. The addition of more sulfur at this point might be necessary to decrease the chance of microbial spoilage or browning in the finished wine. This is particularly

important if there is any residual sugar in the wine, which could potentially lead to unwanted fermentation after bottling.

Clarification

Following fermentation, a new wine has a cloudy, almost murky appearance due to the remaining yeast cells and other solids that remain in suspension. Because modern consumers generally expect their wines to be clear, various methods are used to remove these solids before bottling. Some of these methods are discussed below:

Racking

Racking, the most basic clarification procedure, uses the action of gravity by allowing the suspended matter to settle to the bottom of the fermentation vessel. The wine is then carefully drawn off the sediment and moved into a fresh container. Several rackings may take place over a period of time, each resulting in a brighter, clearer wine.

Although racking removes most of the suspended solids in a wine, some microscopic particles, such as chains of tannins or proteins, will inevitably remain in solution. Although they may be too small to be seen individually, their collective presence may make the wine look dull, or they may eventually coalesce together into larger, visible particles. For these reasons, many winemakers opt for further clarification.

Fining

Fining is a time-honored technique in which an inert material that has an affinity for certain particulates is stirred into the wine. The fining agent falls through the wine, attracting and binding with the unwanted material as it settles to the bottom. Both the fining agent and sediment are then separated from the wine by racking. Fining agents include gelatin and egg white, which bind with and remove excessive tannin, and bentonite clay, which attracts and removes proteins.

Filtering

Filtering involves straining the wine through a barrier with very fine

openings in order to trap any particulates over a certain size. With modern technology, filters can eliminate contaminants as small as bacteria. This process, known as *sterile filtering*, removes all microbes (yeast and bacteria) that could cause spoilage later. Filtering must be carefully monitored, as it comes with the risk of reducing some desirable flavor molecules along with the unwanted particles.

Centrifuge
Some wineries may use a *centrifuge* to clarify their wines. A centrifuge is a modern piece of laboratory equipment that uses accelerated gravity to separate the wine from the heavier solids.

After a full course of clarification, a white wine will typically be sparkling clear and have no sediment in the bottle. While this is the norm for white wines, there are winemakers who prefer to bottle some of their white wines unfined and unfiltered, as this can lead to greater depth of flavor, complexity, and texture. Such wines may contain sediment in the bottle or be slightly opaque in appearance.

Barrel Aging
Aging wine in oak barrels allows for a slow oxidation that changes the wine and adds complexity. If the wood is new, it can also add touches of vanilla, oak, wood, coconut, toast, or other aromas to the wine. Such transformations are neither necessary nor beneficial for the majority of light white wines. However, heavier, fuller-bodied styles of white wines, such as those often made with Chardonnay and Sauvignon Blanc, can be produced with some time spent in a barrel.

Blending
Shortly before bottling, many different vats of wine may be blended together to make the finished product. These vats may represent wine from different vineyards, grape varieties, vintages, or even winemakers. Blending is particularly important for branded wines, which need to re-create the desired flavor profile of the brand year after year. Aside from achieving consistency, the practice of blending

is also employed to develop complexity or balance, or to create a particular style of finished wine.

Cold Stabilization

Many styles of wine—particularly white wines, but not exclusively so—tend to be quite high in tartaric acid. This acid is an important component of the wine and is not something that can or should be filtered out in the clarification process. However, when the wine gets cold, the acid may precipitate out of solution and form crystals. These precipitates—often referred to as wine diamonds—may form in the bottle and around the bottom of the cork. While harmless, they look like tiny bits of rock salt and may draw unwarranted complaints from consumers who might mistake them for impurities.

Thus, a winemaker may choose to take certain steps to prevent the precipitation of tartrates after bottling. In some cases, this involves cold stabilization—achieved by chilling the wine to around 25°F (−4°C), holding the wine at this temperature for one to three weeks, and racking the wine off the precipitates. An alternative to cold stabilization is the contact process, involving the use of finely ground bits of potassium bitartrate. These microcrystals—after being added to the chilled wine—act as nuclei and initiate the formation of tartrate crystals within a few hours, after which the wine may be filtered.

Figure 5-5: Bottling line

Bottling

If the wine is not to be sold in bulk, the last task is bottling. Most large wineries have their own bottling equipment, while smaller wineries may rent a mobile bottling facility or have their wine bottled at a larger winery. The typical bottling line receives empty bottles at one end, fills them with wine, seals them with a cork, installs a capsule over each bottle's neck, labels them, and packages them in boxes on pallets. Each of these steps is either automated or done manually. From here, the wine is stored until needed for shipment and sale.

RED WINE PRODUCTION

The procedure for the production of red wine is very much the same as that for white. The differences, intended to capture the flavor and color available in the skins of red grapes, are highlighted in the following section.

Figure 5-6: Red grapes in a crusher/destemmer

PRE-FERMENTATION

Crushing and Destemming

Whereas white grapes sometimes skip this step and go straight to the press, crushing is typically required for red grapes because their skins are used during the fermentation process. Red grapes are crushed in order to break the skins, free the juice, and allow the yeast to begin working.

Destemming may be done as well, either by hand before crushing (which is somewhat rare and very labor-intensive) or by using a crusher-destemmer machine. In some cases, the stems may be added back to the must to provide an additional source of tannin, flavor, and complexity.

Must Adjustments

If legally permitted, the winemaker may choose to adjust acidity or sugar levels as necessary to achieve balance and the desired style in the finished wine, just as for white wines. With reds, there is also the option to add tannin if the grapes are deficient in that category.

This may be done by leaving stems in the must, as mentioned above, or by adding tannin powder.

Maceration

The most important difference between white and red winemaking is the need to extract phenolics such as color, tannin, and flavor components from the skins of the red grapes. In the majority of red grapes, most of the color components are located in the skins; the juice is just as colorless as that of white grapes. During fermentation, as the skins remain in contact with the juice, the red and blue pigments are extracted out of the skins and move into the darkening juice, along with tannins and flavor constituents. This period of contact between the grape skins and the fermenting grape juice is called *maceration*.

Maceration periods run from a few days to a few weeks or even longer, beginning at or before fermentation and potentially continuing well afterward. The length of maceration is one of the winemaker's most important decisions, and is based on the intended style of the wine and the grape variety. Longer periods of maceration yield highly "extracted" wines that are deeply colored, highly tannic, bursting with flavor, and generally in need of time in the bottle to mature. A shorter period of maceration will yield softer, more accessible wines that are often ready for consumption upon release.

Certain grape varieties, such as Syrah and Cabernet Sauvignon, have an abundance of color and extract that is readily pulled from the grape skins during maceration. Others, most notably Pinot Noir, have relatively little and therefore require more time to extract sufficient color.

If the winemaker chooses to begin maceration before fermentation, the must is chilled to below 55°F (13°C) in order to postpone fermentation. This technique is called a *cold soak*. A cold soak differs from other maceration periods in that the grape solids are macerating in cold grape juice, a large percentage of which is water, as opposed to macerating in fermenting grape juice which contains a

percentage of alcohol and is, therefore, a more effective solvent. The cold soak is one of the techniques that allows the winemaker to control the level of phenolics that are extracted from the grape skins during production.

FERMENTATION

The fermentation process for red wines is similar to that of white wines. The main differences are caused by the presence of the grape skins in the must. In order for the appropriate amount of phenolics to be extracted from the skins, contact between skins and the must needs to be maintained throughout the fermentation. The presence of skins also impacts the selection of fermentation vessels, favoring the use of larger tanks—which are easier to clean—over small wooden barrels.

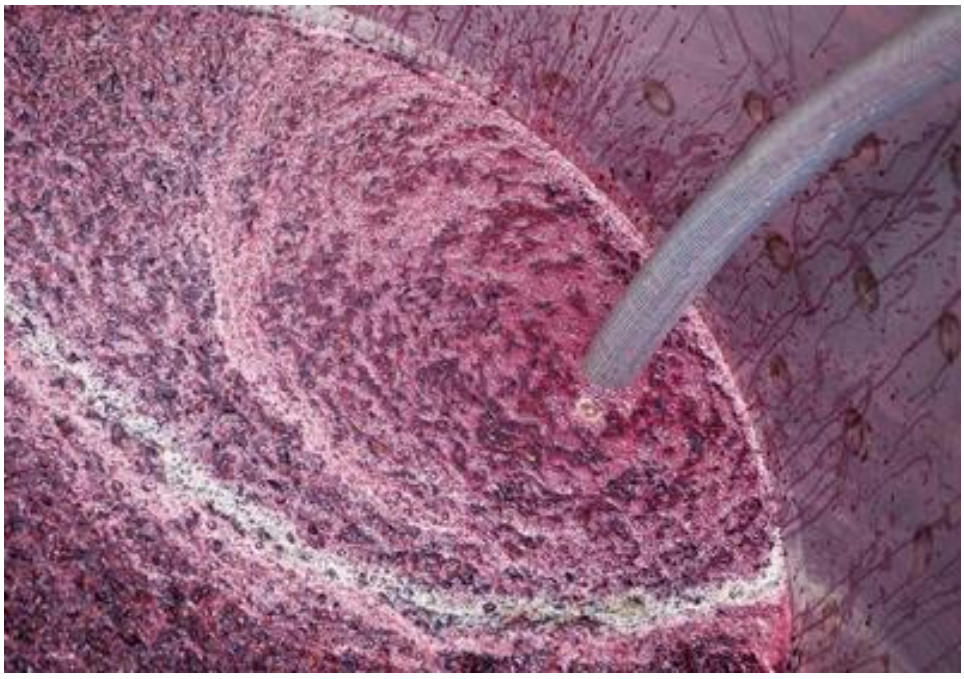

Figure 5–7: Red wine fermentation

Cap Management

Inconveniently, the carbon dioxide that is continuously produced during fermentation forms bubbles that push the grape solids to the top of the fermentation vessel in a fairly dense and compact mass known as *the cap*. Once the cap forms, it becomes the winemaker's

job to break up the cap and reintegrate the skins into the liquid, allowing for optimal extraction. This is known as *cap management*.

Cap management is necessary because the proper extraction of phenolics requires the grape skins to be in the liquid, not floating *on top of it*. Potentially, acetobacter may begin to grow on the cap, which may cause the wine to develop excess acetic acid. Trapped carbon dioxide might even cause the cap to burst.

Four of the most common methods of cap management include the following:

- Punching down: physically pushing the cap down into the juice; also known by the French term *pigéage*
- Pumping over: pumping juice from the bottom of the tank and spraying it over the top of the cap; also known by the French term *remontage*
- Rack and return: draining the fermenting juice into a separate holding tank before it is returned to the original tank by spraying it over the now sunken cap, resulting in considerably more aeration than a standard pump-over; also known by the French term *délestage*
- Rotofermentation: agitating the fermenting must in a specialized fermentation vessel that either rotates on its own or contains an inner paddle that mixes the fermenting must; this eliminates the need for punching down or pumping over, as the contents are mixed at regular intervals; usually controlled by a computer.

Fermentation Temperature

Red wine fermentations are typically conducted at higher temperatures than those of white wines, in part because the light floral and fruit aromas emphasized by a cool fermentation are less important in most red wines. Warmer fermentation temperatures allow for increased extraction of phenolics, which creates a good foundation for robust, age-worthy reds. A winemaker might choose a moderate temperature of 60°F to 70°F (16°C to 21°C) for a light, fragrant Pinot Noir, or a warmer fermentation of 85°F to 95°F (30°C

to 35°C) when producing a tannic blockbuster Cabernet Sauvignon. At the higher temperatures, the sugar may be completely converted to alcohol within a week.

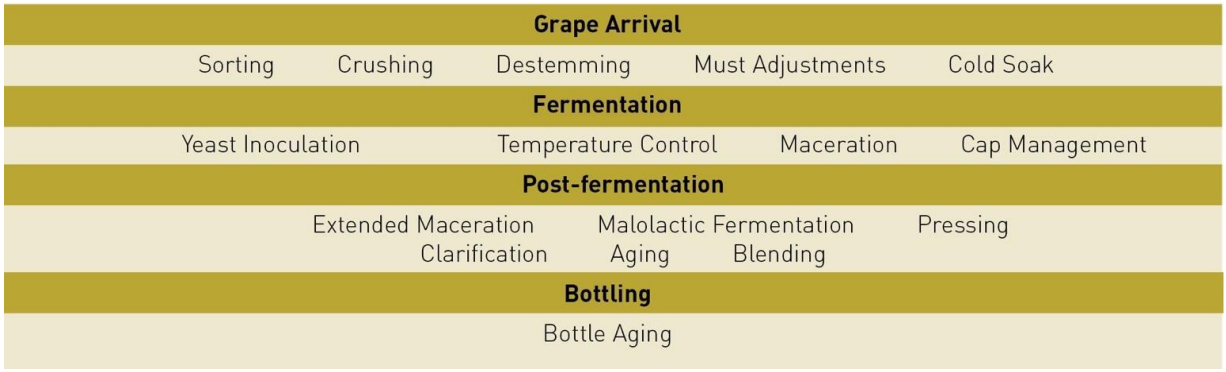

Figure 5–8: Red Wine Production Chart

POST-FERMENTATION

Extended Maceration

The winemaker decides the precise time to remove the grape skins from the liquid based on the desired amount of extract in the wine. With extremely tannic grapes, some winemakers opt to end the maceration phase *before* the completion of fermentation by pressing the skins away from the still-fermenting juice. More commonly, the skins remain in contact with the wine until it has fermented to dryness and the cap loses its buoyant carbon dioxide support. In some cases, when the fullest extraction of phenolics is desired, the new wine may be allowed to remain in contact with the grape skins for several days to several weeks, or even longer, after fermentation is complete. This is known as *extended maceration*.

Malolactic Fermentation

Malolactic fermentation is more often used in the production of red wines than in the production of white wines. In most reds, high acidity is unnecessary and possibly even undesirable, making the added complexity introduced by malolactic fermentation a plus. MLF can also result in the production of a more microbially stable wine by reducing the amount of malic acid available for bacteria that can cause spoilage to attack. Malolactic fermentation in red wine is often

spontaneous, or it may be initiated with an inoculation of lactic acid-producing bacteria. This may be done anytime between the beginning of the alcoholic fermentation and the transfer of the wine into barrels for aging.

Pressing

As the wine rests after fermentation, a considerable amount of solids may build up in the bottom of the fermentation tank. These solids include the former cap, the dead yeast cells, and other precipitated sediment. When it is determined that the wine has absorbed enough phenolics from the solids, the free-run wine is racked off into a different tank or directly into barrels. The remaining solids are then pressed to release any remaining wine. The press wine is very rich in tannin and color and may be added to the free-run wine or used in a separate blend.

Clarification

After pressing, the wine may be moved into a tank for clarification. One or more rackings will likely be performed to remove additional sediment. The wine may be fined or filtered, although this will inevitably take out some of the phenolics as well, so these practices are not done as frequently with red wines as they are with white wines.

Oak Aging

Aging in barrels can be very beneficial for red wines, particularly those high in tannin. The slow infusion of oxygen that seeps through the wood and into the wine helps the tannin molecules combine with each other in a process called *polymerization*. These long, polymerized tannins feel softer and richer in the mouth compared to the shorter, harder type of tannins found in grapes. The use of new or young barrels can also add vanilla, toasty, or woodsy aromas to the wine. When properly balanced with the fruit and other characteristics of the wine, oak aging can add substantial complexity to the finished product.

For these reasons, many mid- and upper-range red wines spend

some time in barrels. The most exalted
Cabernets and similar wines usually go into new oak barrels for several years or more. Less powerful or less expensive wines may be aged in less costly used barrels or in a mix of new and used barrels.

Variations in Oak Barrels

The choice of barrel affects the results of the aging process in many ways, such as the following:

- New barrels impart significant flavor to the wine. With each year of use, the barrel imparts less oak flavor into, and has less of an influence on, the wine. After about four years of use, most of the flavor components have leached out of the wood.
- Larger barrels have less of an effect than small barrels. The smaller the barrel, the more oak flavor will be imparted to the wine.
- The two principal sources of oak for barrels are France and the United States. French oak is considered more subtle and refined in flavor, due to its tighter grain, while American oak is more assertive and less expensive. Recently, barrels from the Baltic states, Canada, Russia, and other regions have become available internationally, with each region's barrels exhibiting their own qualities and characteristics.
- Barrels are made by hand over an open fire, which softens the wood enough to bend it into shape. The amount of "toast," or charring, on the wood affects the flavors imparted by the barrel.
- Winemakers choose their barrels by shape, size, and type of wood, and by light, medium, or heavy toast.

Figure 5–9: Red wine aging in barrels at Kanonkop Estate in Stellenbosch, South Africa

At a cost of $1,300 per new French oak barrique, the use of barrels is generally reserved for high-end wines. Alternatives to oak barrels —such as oak chips or planks—are available for inexpensive wines that would benefit from oak flavor but cannot support the cost of the barrels. Obviously, the effect is not quite the same without the oxidation that the barrel enables. Some wineries use a procedure called *micro-oxygenation*, which involves bubbling a tiny amount of oxygen into the wine in an attempt to simulate the oxidization effects of barrel aging.

CARBONIC MACERATION

Carbonic maceration is an alternative method of red winemaking involving an enzymatic fermentation that requires neither yeast nor bacteria. It will occur in whole, unbroken grapes in the absence of oxygen. To begin the process, grapes are carefully placed in an enclosed fermentation vessel and blanketed with carbon dioxide. In this environment, enzymes in the grapes themselves will begin to break down the grape sugars and create some alcohol within the berries, along with other compounds that may affect wine flavor.

It is rare for wine to be produced completely using 100% carbonic maceration, as any breakage in the grapes will lead to yeast being introduced to the juice. Instead, carbonic maceration is often used in the initial stages of wine production, after which any remaining sugar is converted by a normal alcoholic fermentation.

Carbonic maceration generally results in red wines that are low in tannin, brightly colored, and showing aromas and flavors of tropical fruit and red berries. Carbonic maceration is used in many parts of the world, but it is primarily known for its use in the Beaujolais region in France–particularly the very popular Beaujolais Nouveau.

ROSÉ WINE PRODUCTION

Rosé is basically defined as a pink wine—although the actual color may range from pale pink to dusty rose, or even an orange-tinged pink sometimes called *salmon* or *onion skin*. Rosé wines are produced—at least in part—from red grapes, and are made in many styles including still (non-sparkling), sparkling, dry, off-dry, and sweet. While many consumers assume that any pink wine is sweet, in reality, the amount of residual sugar in a rosé depends on when the fermentation is halted—a decision that is purely up to the winemaker.

The amount of color in a rosé wine depends on the grape varieties themselves and the amount of time the juice is allowed to remain in contact with the grape skins. Alternative methods of rosé production include fermenting a portion of white grapes together with a batch of red grapes (co-fermentation) or blending a small amount of red wine with a finished white wine (although this practice most often seen in the production of sparkling wine).

The most common method for making a rosé is to limit the contact time between the skins and juice so that only a small degree of color is extracted from the grape skins into the wine. In the process, red grapes are crushed, and fermentation is allowed to take place on the

grape skins for anywhere from a few hours to several days. When the juice has extracted the desired amount of color from the skins, it is pressed off the skins, and the fermentation and winemaking process continues using just the juice.

In the *saignée* method of rosé production, red grapes are crushed, perhaps destemmed, and vatted for a length of time, typically from 2 to 20 hours. Next, a certain amount of the juice is run (or bled) off to make rosé. The remaining juice remains vatted with the skins and is made into red wine. The saignée method produces both a rosé and a concentrated red wine from the same batch of grapes.

Very pale rosés, such as those produced in Provence, may be made using the *direct press* method. In this method, the grapes, either destemmed or whole cluster, are crushed immediately after harvest. The juice is then pressed—either straightaway or after a short period of maceration—resulting in pale pink juice, which is then fermented. In France, such wines are often referred to as *vin gris*. (Note: As the term *vin gris* is not regulated in many parts of the world, outside of France it is not unusual to see the term used on the labels of rosé wines produced using other methods as well.)

Rosés should always be fruity and refreshing, with medium to high acidity. Rosés that are slightly sweet are often called *blush* or, if made from a single variety, *white*, as in White Zinfandel. *Rosé* is the French term and is widely used in English-speaking countries as well. Other terms include *rosado* in Spanish, *rosato* in Italian, and *Weissherbst* in German.

THE ROLE OF THE WINEMAKER

There are many schools of thought concerning the role of the winemaker and their appropriate impact on the final style of the wine. One such dichotomy might be informally described as "terroir-focused" versus "process focused." The more traditional, terroir-focused view is that the natural aspects of a vineyard and production

facility are paramount; and that grapes and wine should reflect their physical environment as closely as possible. On the other hand, some people believe that while terroir plays a significant role, grapes are simply raw materials to be molded—as far as possible—into a desired form by human artistry, expertise, and technology. Of course, neither of these points of view are absolute, and most winemakers accept the tenets of many different viewpoints.

The winemaker's activities are most intense from just before harvest through the end of the fermentation process. During the remainder of the year, the pace is slower, as the winemaker checks on the progress of the aging wines, decides when to bottle, and plans for the next vintage. Because this schedule is heavily weighted within a three- or four-month time frame, some "flying winemakers" are able to travel between the Northern and Southern Hemispheres to make wine twice a year.

SPECIAL WINEMAKING PRACTICES

SWEET WINES

Sweet wines can be made from many different grape varieties, by using diverse winemaking techniques and, in many cases, by using specific viticultural practices. Some of these include the following:

- *Botrytis:* If the *Botrytis cinerea* (noble rot) fungus affects grapes at the right time, it causes water to evaporate from the berries, thereby raising the concentration of sugar. This most famously occurs in the Sauternes area of Bordeaux in France, but also in the Loire Valley and in other locations that have similar climatic conditions. Sémillon and Chenin Blanc are two grape varieties that have a particular affinity for botrytis due to their thin skins. Noble rot adds distinctive honeysuckle and apricot aromas to the wine.
- *Late harvest:* If growers wait beyond the typical optimal ripeness point to harvest the grapes, the berries will continue to

gain sugar as long as there are green leaves on the vine. They will begin to lose some water as well, making them very sweet. However, they also lose acidity during this period, so this technique works best in cool climates and with varieties that have high natural acidity, such as Chenin Blanc and Riesling.

- *Dried grapes:* After harvest, grapes can be allowed to dry out and become partially raisinated. This is an ancient tradition that is still practiced in many places around the Mediterranean. The grapes may be spread out on mats or hung from the rafters of a drying room for as long as several months, retaining sugar but losing water content. The dried grapes may be fermented into a dry, high-alcohol wine, as in Italy's Amarone, or more often, into a sweet wine.
- *Freezing:* In some cold regions, primarily in Germany and Canada, growers may leave the grapes on the vine until the weather turns cold enough to freeze them. This may be as late as January or February in the Northern Hemisphere. By this time, the grapes have developed significant sugar content. Following harvest, the frozen grapes are pressed immediately, resulting in extremely sweet, rich juice. Riesling, Gewürztraminer, Chenin Blanc, and some cold-hardy hybrids are the most common varieties used in these styles of wine, known as ice wine (icewine) or Eiswein. Red versions of ice wine are also produced, typically using Cabernet Franc. A similar style of sweet wine can be achieved using late-harvest grapes and freezing them, post-harvest, in a commercial freezer. This mechanical freezing process is known as cryoextraction. Products produced using cryoextraction are distinguished from true ice wines and may not be labeled as such.

Figure 5–10: Grapes drying for dessert wine

Note that chaptalization is not considered an acceptable way of increasing the sweetness of wine. Chaptalization is allowed only in situations where the grapes are unable to ripen sufficiently, and then only to the degree necessary to bring the alcohol level up to a minimum standard, not to create a sweet wine.

Fermentation begins for a sweet wine the same as for any other wine. However, this can be a difficult fermentation, as the yeast may struggle to stay alive due to the high sugar content.

A winemaker may choose to use one of the following procedures in the making of a sweet wine:

- *Refrigeration:* Chilling the must during fermentation stops yeast activity while there is still sugar left. However, it does not kill the yeast, so additional procedures, such as sterile filtering or sulfur additions, are necessary to make sure that the wine does not begin fermenting again after bottling.
- *Adding sweetness:* The wine can be allowed to ferment dry, and then it is made sweet through the addition of sugar, grape concentrate, or unfermented juice (rectified grape must) after

fermentation is complete. This also poses the risk of restarting fermentation unless protective measures are implemented.

- *Fortification:* Adding distilled spirits during fermentation can raise the alcohol level high enough to kill the yeast before all the sugar is gone. This is discussed in greater detail in chapter 7.

Other methods of creating a sweet wine include interrupting the fermentation by killing the yeast via pasteurization or adding large amounts of sulfur.

ORGANIC WINES

The National Organic Program (NOP) of the US Department of Agriculture, which sets labeling rules in the United States, limits the term "Organic Wine" to wines that are made from a minimum of 95% certified organic grapes and that do not use anything in the winemaking process that is defined as "prohibited" according to the NOP's National List of Allowed and Prohibited Substances. Wines that meet these and other specific NOP criteria qualify as "Organic Wine" and are entitled to display the USDA Organic Seal on the label. Wines that meet these criteria and are made solely using certified organic grapes may use the term "100% Organic." Only a small proportion of the wines produced worldwide are organically made; however, they may be the safest wines for those who have asthma or a sulfur allergy.

Figure 5–11: USDA NOP logo

By far, the most significant restriction in organic winemaking concerns the use of sulfur in the winery. Sulfur is the single most effective substance for controlling the bacteria and fungi that threaten to spoil wine. An effective alternative that does not overtly change the character of the wine is yet to be found. However, sulfur is an inorganic element, not an organic substance, and therefore sulfur additions in the winery are not allowed for wines labeled as "Organic Wine."

A wine may be labeled with the phrase "Made with Organic Grapes" if the wine was sourced from 100% *certified* organic grapes and if any added sulfur dioxide yields less than 100 parts per million in the finished wine. Wines with less than 100% organic grapes or higher sulfite additions cannot use that specific statement, although they can list the percentage of organic content in an ingredient statement on the label. In neither of these cases may the USDA Organic Seal be used.

Because of the careful, hands-on treatment of the grapes, organic wines are often of high quality. Even so, without the protective properties of sulfur, they are unlikely to remain in top form as long as other wines. Accordingly, they must be handled more attentively once they leave the winery, for example, by placing them in refrigerated units when they are sold in retail establishments.

Other countries have their own procedures for certifying wines as organic; however, wines sold in the United States cannot be labeled as organic without being certified by an NOP-accredited body.

As of August 2012, organic wines produced and sold in the European Union may be labeled "Organic Wine" or "Vin Biologique." These wines must contain 30% to 50% less added sulfur than nonorganic wines. No additives are permitted, and the winemaking process must be fully traceable.

For more details on organic viticulture, see chapter 4.

BIODYNAMIC WINES

Starting with 100% biodynamically grown grapes, the production of biodynamic wines is guided by the principles of minimal manipulation and low impact on the environment. Certification is based more on progress toward an extensive list of goals than on a strict set of criteria, although there are a few prohibitions, such as the one against the use of genetically modified materials. Sulfur use is permitted, but it is to be kept to a minimum. Thus, under US regulations, biodynamic wines are subject to less regulation than organic wines. The term *biodynamic* is trademarked and controlled by a private organization known as *Demeter International*, rather than by government regulators.

KOSHER WINES

Kosher wine is certified by Jewish religious authorities to conform to biblical laws as "proper" or "fit" (the literal translation of *kosher*) for consumption by observant Jews. Outside of Israel, kosher wine can generally be made from any grapes. However, from the time the grapes arrive at the winery, the materials may only be handled by observant male Orthodox Jews under the supervision of a rabbi, using equipment that is used for no other purpose. In addition, animal-based products such as gelatin and egg whites for fining may not be used in the production of the wine.

All kosher wines, once bottled, may leave rabbinical control without losing their status until opened. From the point of opening through consumption, the wine must again be untouched by non-Jews or nonobservant Jews.

Mevushal wine, a subcategory of kosher wine, is free from limitations on who may handle it. Mevushal wine is briefly subjected to high heat via flash-pasteurization, either as must or as wine, before leaving the winery.

ORANGE WINES

The tradition of orange wine is thought to have originated in the

country of Georgia approximately five thousand years ago. In the production of orange wines, juice from white grapes spends a significant amount of time macerating with the grape skins in order to extract tannin and color and to achieve some oxidative resistance. Depending upon the winemaker's preference, contact may last for as short as three days or as long as several weeks or even months. As a result, these wines develop a coppery or orange hue.