WINE CLARIFICATION AND STABILIZATION

by

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Today, consumers expect all wine to be bright and clear, so clarification and stabilization have become important parts of the winemaking process. Clarification is accomplished by racking, fining, filtration and aging. Stabilization is done by racking, fining, filtration, chilling, ion exchange, aging and the use of special additives.

Practically all white and blush wines require both clarification and stabilization treatments before they can be bottled. Red wines, on the other hand, often do not require any special treatments other than bulk aging.

WINE STABILIZATION

Sometimes a brilliantly clear wine is bottled, but after a few weeks the winemaker discovers a haze or unsightly sediment in the bottles. So, in addition to being clear, the winemaker must also make sure his wines are stable before they are bottled. The four major sources of wine instability are (1) residual sugar, (2) residual malic acid in red wines, (3) excess protein and (4) excess tartrate.

Wines bottled with residual sugar will likely restart fermentation unless they are stabilized in some way, and fermentation in bottled wine is usually catastrophic.

Bottled wines containing malic acid and lactic acid bacteria can undergo malolactic fermentation (MLF). When MLF occurs in the bottle, the wine becomes spritzy, cloudy and sediment often forms. MLF in white and blush wines can be controlled with sulfur dioxide.

Malolactic fermentation in red wines is more difficult to control, and high pH, red wines containing malic acid will go through MLF sooner or later. This is why commercial red wines are (1) deliberately put through MLF before bottling or (2) the lactic bacteria are removed from the wine with a sterile filter at bottling time.

Stabilizing White and Blush Wine

Most consumers store their wines at room temperature, even in the summer time. White and blush wines are usually chilled to about 40 degrees or so before they are served. Consequently, white and blush wines must be made so they remain stable over a wide range of temperatures. Commercial wines are considered stable if the wine does not show significant changes when exposed to temperatures ranging from 40 to 100 degrees.

Hot Stabilization

Excess protein is not difficult to remove from most wines, and protein removal is considered an indispensable treatment for all white and blush wines. The standard treatment is to fine all new white and blush wines with bentonite to remove excess protein. The amount of bentonite used ranges from 0.5 to 4 grams of bentonite per gallon of wine. But excessive amounts of bentonite can strip wine flavors, so the amount of bentonite should be determined by testing several wine samples in the winery laboratory to determine the minimum amount of Bentonite required for each wine.

Less bentonite is required and protein removal is more efficient if the Bentonite fining is done after the wine has been cleaned up by a rough filtration. Nevertheless, many winemakers find it more convenient to hot stabilize their wines by removing the protein earlier in the winemaking process (see below).

Cold Stabilization

Since most white and blush wines are chilled before serving, these wines must be made cold stable sometime during the winemaking process. Home winemakers and small commercial wineries use a simple method to stabilize their wines. The wine is cooled to about 28 degrees and held at this low temperature for a week or so until the excess potassium bitartrate precipitates out. Wine can be stabilized at higher temperatures, but higher temperatures require longer holding times. Cold stability can be checked easily. Put a sample of the wine in a small, clear glass bottle, and place the bottle in the coldest spot in your refrigerator for a few days. Then remove the sample from the refrigerator and examine the sample for crystals or sediment after the wine warms to room temperature.

Cold wine can hold much more dissolved oxygen than room temperature wine. White and blush wines oxidize easily, so these wines must be carefully handled during the cold stabilization treatment. Tartrate crystals can form in red wines just as they do in white wines, so red wines are often cold stabilized before bottling. However, red wines are not chilled before serving. In addition, the dark color of red wine obscures tartrate deposits. Consequently, many small producers do not bother with cold stabilizing their red wines.

Combined Hot & Cold Stabilization

Since white and blush wines need to be made both hot and cold stabile, some winemakers prefer to combine both stabilization procedures into a single operation. The wine is first fined with bentonite and then chilled to about 28 degrees. The wine is held at the cold temperature while the tartrate precipitate. After a week or so, the cold wine is racked or filtered off the bentonite and tartrate lees.

This combined procedure has several advantages. Tartrate crystals settle on top of the fluffy bentonite lees and the Bentonite lees are compacted. The wine is easier to rack and less wine is lost. In addition, both procedures are accomplished in a single operation, so the wine is handled fewer times and the risk of oxidation is reduced.

Stabilizing Wines Containing Residual Sugar

An old wine industry adage says .....the easiest way to restart a stuck fermentation is to bottle the wine. Most of us have had the sad experience of bottling a wine thought to be stable and then discovering a few weeks later that fermentation has restarted in the bottles. Reworking is seldom feasible so fermentation in newly bottled wines is often a complete fiasco. Even small amounts of sugar can cause significant problems, so any wine containing more then 0.2% residual sugar (RS) cannot be considered biologically stable.

Wines containing residual sugar can be stabilized by (1) removing the yeast with a sterile filter, (2) adding potassium sorbate just before the wine is bottled, (3) killing the yeast with a high alcohol content and (4) killing the yeast by pasteurization. An alcohol level of bout 18 percent alcohol is needed to stabilize a wine containing sugar, so this method is not practical for table wines. Pasteurization often produces stewed fruit or other adverse flavors, so pasteurization is seldom used these days. Here are three ways that small producers often use to stabilize wines containing residual sugar.

(1) Chill the wine to less than 45 degrees to stop fermentation and leave residual sugar in the wine. Keep the wine cold and allow the yeast to settle. Remove most of the yeast by racking or filtration. Warm the wine to room temperature, and restart fermentation. Repeat this process several times until fermentation cannot be restarted. Each new generation of yeast consumes nutrients from the wine, and after several generations of new yeast cells, the nutrients are so depleted the yeast can no longer reproduce. This method effectively stabilizes sweet wines and with careful handling, it maintains wine quality. Asti Spumante wine has been stabilized this way for many years. But, this method requires lots of time, effort and skill.

(2) Leave the desired amount of residual sugar by chilling the wine to less than 45 degrees to stop fermentation. Keep the wine cold and allow the yeast to settle. Remove most of the yeast by careful racking or by doing a rough filtration. Then do a tight filtration, keep the molecular sulfur dioxide at 0.8 PPM and keep the wine cold until it is bottled. At bottling time, put the wine through a 0.45-micron membrane filter to remove any remaining yeast or bacteria. This method is only effective if the bottles, corks and all of the equipment contacting wine down stream of the filter are made and kept sterile. Sterile filtration is easy with a membrane filter, but getting and keeping the equipment, bottles and corks sterile is not so easy.

(3) Freeze a portion if the juice to be used later as sweet reserve. Ferment the wine until it is completely dry and cellar the dry wine in the usual way. Just before bottling time, add 250 milligrams of potassium sorbate per liter of wine and raise the molecular sulfur dioxide level to 0.8 milligrams per liter. Then add enough sweet reserve to produce the desired amount of residual sugar. Please note that potassium sorbate does not stop yeast from fermenting. It only stops yeast cells from multiplying. So, sorbate is only effective when added to clean wines that contain little yeast. Some home winemakers add table sugar to sweeten their wines, but using sweet reserve to increase the sugar level produces a better, fruitier flavor.

Stabilizing Wines Containing Malic Acid

The presence of malic acid in a wine always represents a potential stability problem because ML fermentation can occur anytime a wine contains malic acid and lactic acid bacteria. The results are often disastrous when ML fermentation occurs in bottled wine because it results in bottle deposits, off-odors, bad tastes and effervescent wine. So, winemakers must take specific steps to improve long-term stability before any red wine containing both malic acid and lactic bacteria can be bottled.

Several different types of wine bacteria can convert malic acid into lactic acid. These lactic bacteria consist of both cocci (round) and bacilli (rod shaped) microorganisms. The principal bacteria responsible for ML fermentation in wine belong to the Leuconostoc, Pediococcus and Lactobacillus genera. Each genus contains several different species, so the term "malolactic bacteria" refers to a group of microorganisms. When wine undergoes spontaneous ML fermentation, several different kinds of bacteria may be involved. These different microbes react in the wine in different ways, and depending upon conditions, the microbes can produce a variety of byproducts.

Most small wineries deal with the malic acid stability problem simply by insuring that their red wines have completed MLF early in the winemaking process. Malolactic fermentation can be encouraged in several ways. (1) Add only small amounts (30 to 40 milligrams per liter) of sulfur dioxide to the grapes when they are crushed. (2) Keep the wine pH values greater than 3.3 to encourage the bacteria. (3) Keep the wine temperature above 68 degrees. (4) Keep wine on yeast lees for several weeks after the sugar fermentation is complete to encourage MLF. (5) Inoculate the wine with a commercially prepared liquid or dry form of malolactic bacteria.

Many commercial wineries put their red wines containing malic acid through a sterile membrane filter at bottling time to remove the ML bacteria. Sterile filtration is an effective means of preventing ML fermentation in the bottle, but sterile bottling requires considerable equipment and it is a difficult process for small producers.

Fumaric acid can also be used to prevent ML fermentation in bottled wine and years ago winemakers often added about 500 milligrams of fumaric acid per liter to red wines containing malic acid. But, fumaric acid increases TA and it can change the taste profile of some red wines. These days, winemakers use Lysozyme to prevent MLF when bottling wines containing malic acid. The Lysozyme kills the ML bacteria and then slowly decomposes into harmless materials. The effective time is short lived in red wines, so Lysozyme is best added just before bottling.

CLARIFICATION

Wines can contain many types of hazes, but yeast and bacteria, excess protein, tartrate or phenolic polymers cause most clarity problems. Quality red wines are often bulk aged for a year or so before the are bottled, and red wines usually become clear and stable without any additional treatment during bulk aging. But, this is not the case with white or blush wines. These wines almost always require specific treatments before they become clear and stable.

Microbial Hazes

Yeast and bacteria seldom cause long-term haze problems. Yeast cells and most bacteria are large enough to settle out of the wine in a few weeks. However, malolactic fermentation (MLF) can cause significant turbulence in a small tank, and the sometimes the turbulence prevents the smaller particles from settling out. MLF can continue long after the sugar is gone, but the particles can settle out when the malic acid is gone and the wine becomes quiet. Attempting to prematurely clarify wines with microbial hazes by filtration will often be a futile exercise. The filter pads will plug quickly and the much time and expense will be wasted.

Protein Hazes

Grapes contain small quantities of protein, and the protein is carried over from the grapes into the wine. Protein molecules are much too small to be visible in the wine. However, under certain conditions, protein molecules can link together (polymerize) and become larger and larger. After much linking together, some protein molecules become so large they are visible in the wine, and they are too large to remain suspended. This protein linking process is very slow at normal cellar temperatures, but protein molecules can grow in size rapidly when wine becomes warm. At temperatures of about 120 degrees, protein molecules link together and form large particles in a short time.

Protein hazes often form when bottled white or blush wines are subjected to warm storage conditions, so winemakers call protein hazes hot instability because warm storage conditions cause protein to polymerize. When protein precipitates out of wine, the residue produces a swirling white cloud when the bottle is disturbed, so protein hazes can be very unsightly. Protein hazes can be removed by filtration, but only the very large polymerized particles will be removed. The wine can still contain excess protein in the form of small molecules. A new haze can form if the small protein particles polymerize and become larger, so filtration may not be a practical way to clarify or stabilize white or blush wines containing excessive amounts of protein.

Protein hazes are seldom a problem in red wines. Red wines contain much more phenolic compounds than white wines and the phenolic material cause the excess protein to precipitate out during the early stages of the winemaking process.

Potassium Bitartrate

Grapes contain both potassium and tartaric acid, and potassium reacts with tartaric acid and forms a material called potassium bitartrate (cream of tarter). Potassium bitartrate has several properties that are important to winemakers. (1) Only small amounts of potassium tartrate can dissolve in grape juice. (2) Alcohol is formed when grape juice is fermented, and less potassium bitartrate can remain dissolved after the alcohol has formed. (3) Cold wine can hold less tartrate than warm wine.

Grape juice contains about all the tartrate it can hold. During fermentation alcohol accumulates, and as the alcohol increases, the liquid becomes more and more saturated with tartrate. By the end of fermentation, the new wine is super saturated with potassium bitartrate, and tartrate crystals are precipitated out of the wine.

The following example illustrates a common tartrate instability problem. A new white or blush wine is clarified and aged for a few months and then bottled. The newly bottled wine is clear, but it is still saturated with tartrate. Then, a bottle of this unstable wine is put into a refrigerator to chill for a few hours before serving. The wine cools down, and after a short time, tartrate starts precipitating out of the wine, and an unsightly deposit of crystalline material forms in the bottle.

Tartrate precipitation is very slow at cellar temperatures and under normal conditions, the tartrate molecules are much too small to be removed with a filter. Therefor, practically all white and blush wines require a cold stabilization treatment to remove the excess tartrate material before these wines can be bottled.

Phenolic Polymers

Phenolic compounds in wine are responsible for the color, bitterness, astringency and some of the odors and flavors. Some types of phenolic material polymerize just like protein molecules. These phenolic molecules slowly grow in size, and they can cause haze problems and excessive bottle deposits in red wines.

The large polymerized particles can be easily removed by filtration. But, the smaller particles will still remain in the wine. The smaller particles will continue to grow in size, so filtration is not a practical way of eliminating phenolic hazes or bottle deposits. Winemakers avoid phenolic problems by removing excess phenolic material from their red wines by fining with one the protein materials such as gelatin, casein, egg white, isinglass, etc. Red wines are often lightly fined with one of these materials several weeks before bottling. The light protein fining does not significantly change other wine characteristics, but the treatment can prevent gross bottle deposits from forming later in the bottles. Dark red wines are seldom completely phenolic-stable, and practically all red wines will show some bottle deposit when they are several years old. White or blush wines contain little phenolic materials, so phenolic hazes rarely occur in these wines.

PROCEDURES

Most red wines come clear and bright without any fining or filtration. The tannin in red wine acts as a fining agent, and after a red wine has aged a few months and has been racked a couple of times, the wine is usually quite clear. Even so, dark red wines often produce heavy bottle deposits unless they are lightly fined with a protein material. Contrary to current hype, practically all red wines are either fined and/or filtered before bottling.

Practically all white and blush wines require specific clarification and stabilization steps. These steps often include extra racking to eliminate excess particles. Then the wine may be fined with a proprietary material such as Sparkolloid to improve clarity. Then the wine may be fined with bentonite to remove excess protein. Then the wine may be chilled to a cold temperature to remove tartrate. Then the wine may be put through a tight filter to improve clarity. Sometimes special materials such as potassium sorbate are added to stabilize wines containing residual sugar.

Racking

The accumulated muck on the bottom of wine storage containers is called lees, and wine is separated wine from lees by a process called racking. The wine is transferred to a clean container leaving the lees behind. Racking helps purify the wine, and the wine becomes clean, clear and bright. Racking also contributes to long-term wine stability.

Home winemakers often rack their wine by placing the wine container on a sturdy table or bench. Then, the clear wine is siphoned off the lees into a second container on the floor using a piece of clear plastic tubing. Commercial wineries rack their large tanks using two-inch hoses and powerful pumps.

White wines are usually racked off the gross yeast lees shortly after alcohol fermentation is complete. They are racked a second time after the wine has been hot and cold stabilized, and a third time just before bottling. Red wines are often not racked until ML fermentation is finished. Dark red wines are usually racked two or three times the first year and every six months thereafter.

Fining

Fining materials are added to wine to remove unwanted color, hazes, bitterness, astringency, etc. Some fining materials neutralize the electric charge on the unwanted particles, and the particles then settle out faster. Other fining materials become attached to the unwanted particles, and the larger particles then settle faster. Very little of the fining material remains in the wine when the fining procedure is done correctly.

Bench tests are done on wines to decide (1) which fining material is best for the job and (2) how much fining material is needed. Tests are made by adding small, measured amounts of the proposed fining material to a small, measured quantity of the wine to be treated. Usually several wine samples are made, and each sample contains a different quantity of fining material. After an appropriate time, the winemaker examines the samples to see if the desired results were obtained.

Typical applications of several common fining materials are shown in the Figure.

SOME COMMON FINING MATERIALS

Egg White - to remove astringency from red wine, a typical dose is 2 or 3 egg whites for 60 gallons of wine.

Bentonite - to remove protein from white wine, a typical dose is 1 to 2 g/gal.
- for general clarification, a typical dose is 1 g/gal.

Casein - to remove browning in white wines, a typical dose is 0.25 g/gal.
- to remove bitter taste in white wine, a typical dose is 2 g/gal.
- to remove excess oak flavor, a typical dose is 2 g/gal.

Gelatin - for white wine clarification, a typical dose is 0.125 g/gal.
- to remove bitter tastes from white wine, a typical dose is 0.25 g/gal.
- for tannin reduction in red wine, a typical dose is 1 g/gal.

Sparkolloid - for general white wine clarification, the typical dose is 2 g/gal.
- used as a topping over bentonite, a typical dose is 0.5 g/gal.

Filtration

A local winemaker once told me that winemakers who put "this wine is unfined and unfiltered" on their labels don't know how to fine and they can't afford a filter.

This may be something of an over statement, but regardless of label statements, practically all commercial wineries do fine and filter their wines. The advantage of filtration is that the unwanted particles are mechanically removed, and when filtration is done properly, wine can be clarified **without any significant** reduction in quality or color.

Summary

In wine production cellar processes include clarification, stabilization, bulk aging and bottle aging. In addition to being clear, wines must also be made stable before they are bottled. Most white and blush wines require special clarification treatments, and these wines require both hot and cold stabilization treatments. Most red wines do not require any special clarification or stabilization treatments. So, red wines are easier to make than white or blush wines.