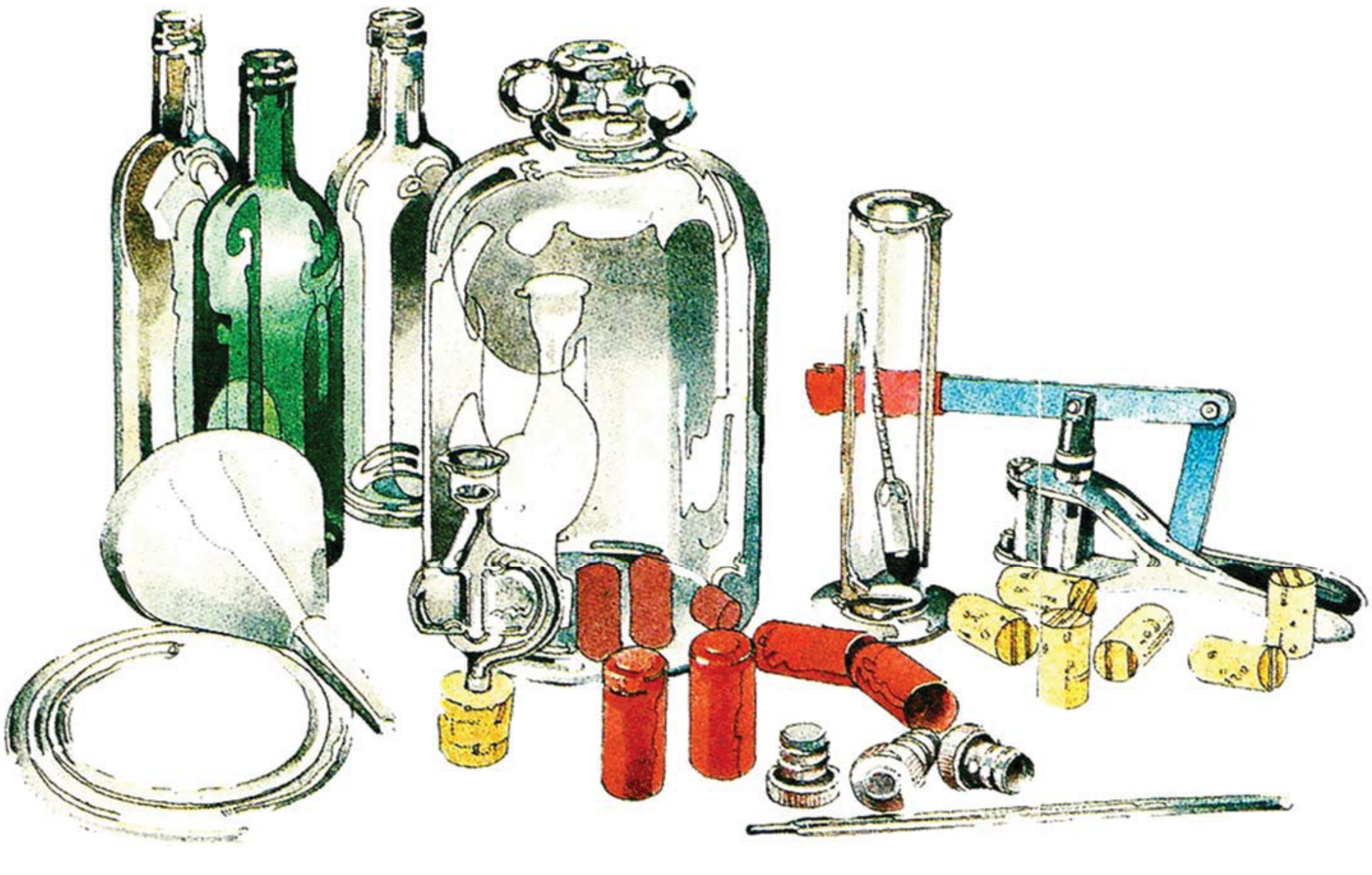
MS-28

Making Wine for Home Use



Missouri State Winery and Distillery

Darr School of Agriculture

Missouri State | William H. Darr School of Agriculture

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Making Wine for Home Use

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Contents

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http://www.homewinemaking.co.uk/beginners_guide.html

Overview

Some questions may arise if you consider making wine at home. Is it legal? Is it worth the effort? Are there a lot of complicated chemical equations involved? Actually, up to one hundred gallons of wine may be legally produced in a one-adult household, and up to two hundred gallons in a two or more adult household (Appendix 1). Although it may be easier to buy your wine at the store, winemaking is an interesting and understandable process that can become a rewarding hobby. Most of all, by making wine for home use, you enjoy the satisfaction of serving your wine to friends and family and reliving your winemaking adventure over a wonderful dinner.

Wine is traditionally the product of fermented grapes. Although country wine can be made from other fruits, this guide deals only with production of table wines made from grapes. Red and white table wines range from dry to sweet and have 14% alcohol or less.

Making Wine for Home Use is written for the beginner, therefore, sophisticated laboratory procedures are not detailed here. Aging in oak barrels is not addressed, however the use of oak chips to impart oak character is. The Reference Section (Appendix 6) will guide you on to further reading. An informative catalog from a reputable supplier is also a good source of information (Appendix 5).

It is advisable that before you begin to make wine at home, you set up a journal or other record system. A log of your winemaking experience through the years is valuable to your personal improvement and your value as a resource to others.

Getting Started. The first decision you need to make is whether you are going to process fresh or frozen grapes, or purchase juice or concentrate. If you decide to start with grapes, you will need more equipment and space. If you are not growing the grapes yourself, you need to locate a source of fresh or frozen grapes. You need about 15 pounds of grapes to yield 1 gallon of juice.

The second decision you need to make is how much wine to make. It is legal for a two-adult household to make up to 200 gallons of wine. If you begin with grapes, you will need an outdoor or indoor area to process them. You will also need an area to handle and store 3 to 5 gallon containers of wine during the winemaking process as well as a place to store the bottles of finished wine. The beginning winemaker is best advised to make from 5 to 20 gallons of wine and then expand from that point if desired.

Once all of the initial decisions are made, you can begin locating sources, ordering supplies, and finalizing your home winemaking plans.

The Winemaking Process. Sugar in the grape juice, through the activity of yeast, is fermented into alcohol in the wine. The equation for this chemical change is: $C_6H_{12}O_6 \longrightarrow 2\ CH_3CH_2OH + 2\ CO_2$ or literally one molecule of glucose (sugar) is fermented to yield 2 molecules of ethanol (alcohol) and 2 molecules of carbon dioxide gas (bubbles). The alcoholic fermentation also produces heat.

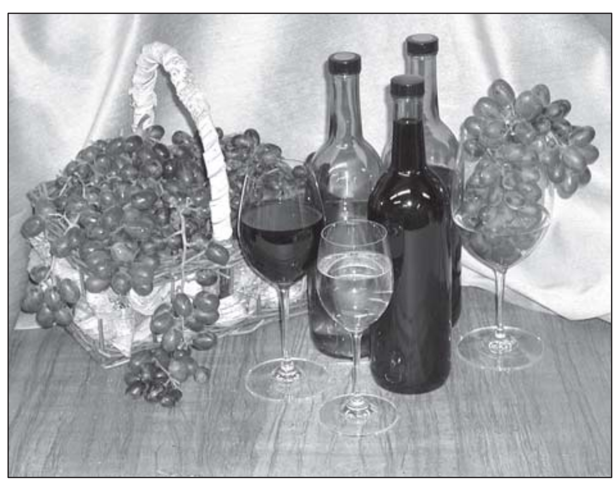
It is necessary to know the level of sugar in the juice you begin with. Sugar level is measured with either a hydrometer or a refractometer. By multiplying the sugar level (in °Brix) by a factor of 0.55, you can estimate the future alcohol level. You want a final alcohol level between 10 and 14% for table wines so you need to start out with a juice that has a sugar level from 20 to 24 °Brix.

The *first* major step in the wine-making process is to extract the juice from the grapes. This step can be skipped if you begin with purchased fresh juice or juice from concentrate.

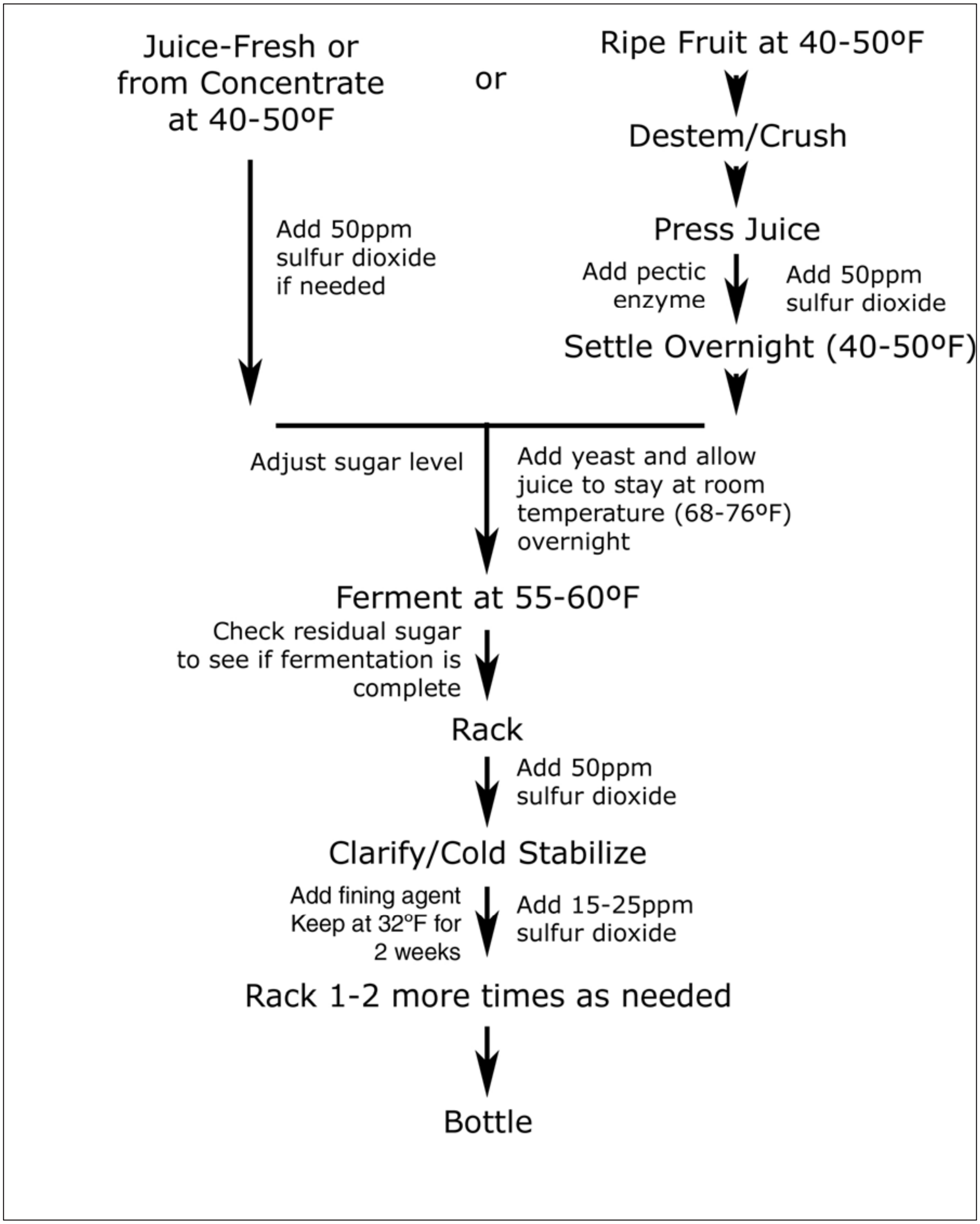
The *second* major step is to ferment the juice and clarify and stabilize the wine.

The *third* major step in winemaking is to bottle the wine and store it properly.

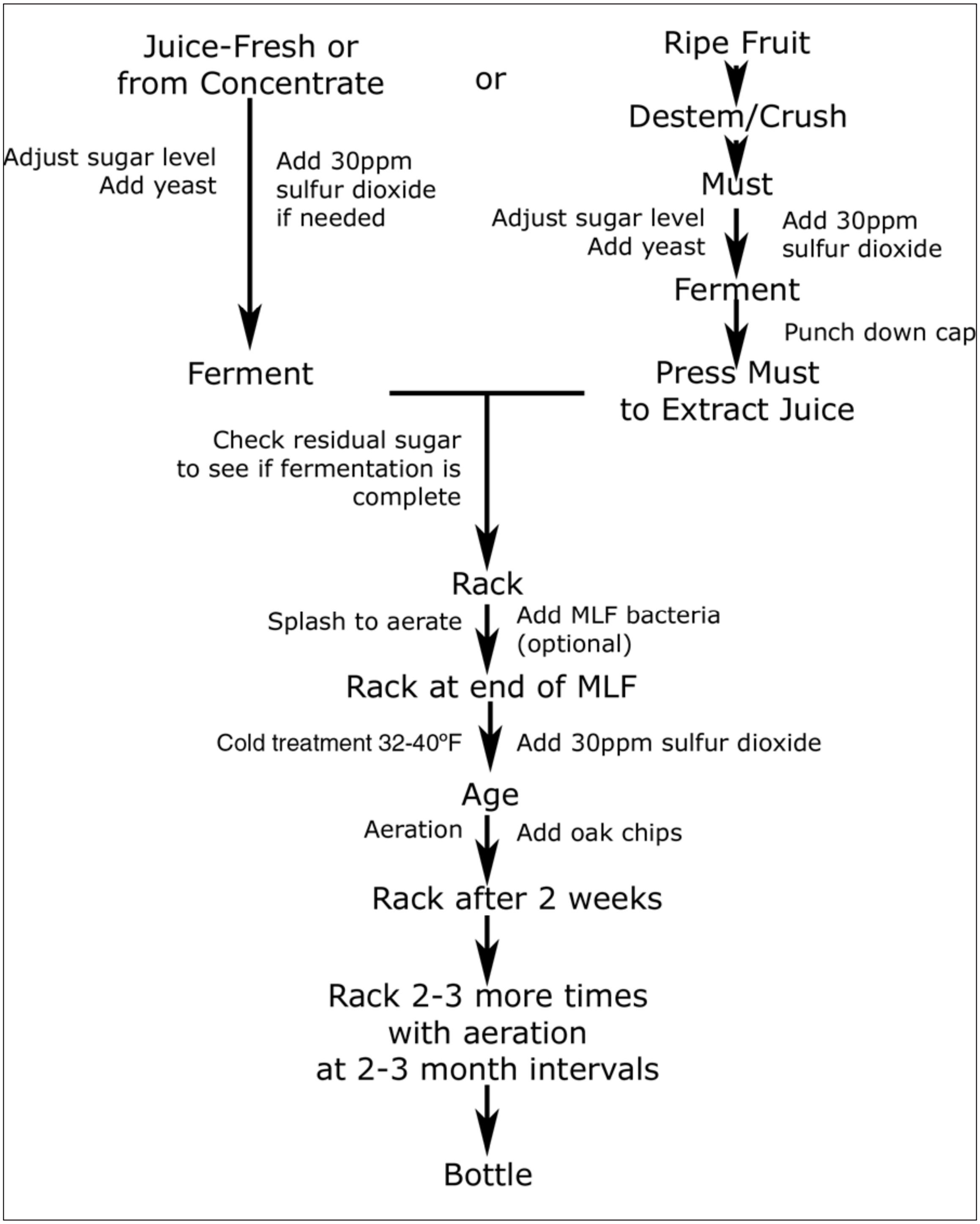
The *last* step is to evaluate and enjoy your wine.



Steps in White Winemaking.



Steps in Red Winemaking.



Missouri Wine Grapes

Missouri produces a variety of wonderful wines from grapes grown in the state. Grapes that are adapted to Missouri include American varieties such as Concord, Catawba, Delaware and Norton/Cynthiana and French-American hybrids such as Chambourcin, Seyval blanc, and Vidal blanc. The vinifera-type grapes grown in California and milder climates are not hardy in Missouri, but the home winemaker may purchase them as frozen grapes or concentrated juice if so desired.

Missouri grape harvest begins in August and may extend through early October. For more information on wine grape growing see *Home Garden Grapes* MSU State Fruit Experiment Station one-sheet (Appendix 6). Guidelines on harvesting grapes for wine production are provided here, in case you want to make wine from the grapes you grow or purchase from a local source.

The Home Vineyard. If you decide to plant a small vineyard as your source for grapes, you must figure out how many vines you will need. In general, a mature vine will yield from 10 to 15 pounds of grapes after it is about 4 years old. You need about 15 pounds of grapes to yield 1 gallon of juice. Grapevines are usually spaced apart 8 feet within the row with 10 feet between rows. So, if you wish to produce 20 gallons of juice, you will need about 20 grapevines and about 1,600 square feet of suitable planting area.

How to Sample Grapes. When it is getting close to harvest, early August for some wine grapes in southern Missouri, you need to collect a berry sample from the vineyard to help determine when to harvest the grapes. It is important that the sample be taken properly, because a small number of berries must accurately reflect the entire crop.

You must sample each variety of grape separately, even if you plan to blend juice at the end. Take up to 200 berries per sample, equal amounts from both sides of each row (e.g., if your rows run north and south, take 100 berries from the east sides of the rows and 100 berries from the west sides of the rows). The berries should be picked at random, so you can walk down the row and pluck an equal number of berries from each side without looking too closely (try not to “select” only ripe berries). Put the berries in a plastic bag and bring them to room temperature before sampling. If you will be in the vineyard for a long time, put the bags of berries in a cooler.

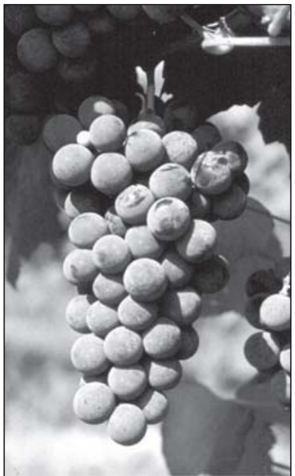
The beginning winemaker may only have the apparatus to sample for sugar. If you use a hydrometer to measure sugar, you will need a larger sample of juice than if you use a refractometer. The more advanced home winemaker may also test for pH and acidity. If you are just measuring sugar or sugar and pH, you can crush the berries with your hands by squeezing the plastic bag and then letting the juice run out. If you plan to test for acid as well, extract the juice by processing it through a “Squeezo” type food strainer (photo above) or crush the berries in a plastic bag with your hands, strain the juice from the pulp in cheesecloth, and then wring out the pulp or pomace in the cheesecloth. Particularly when dealing with slip-skin American grapes, it is important to crush the berries thoroughly to get an accurate acid measurement. If you need to store the berries or the juice in the refrigerator before processing and/or running tests, you need to bring them to room temperature before testing.

Determining When to Harvest. Important components to consider when you determine whether the crop is ready to harvest are cluster integrity, sugar, pH and acid. Beginning winemakers often base their harvest decision on cluster integrity and sugar level alone (photo above - enology technician looking through refractometer to read grape juice sugar level).

A grape cluster of good integrity is not rotting, does not have split berries (which may occur after a rain), does not have fruit flies and wasps flying around it, and is otherwise sound.

Wine grapes, particularly Concord, Catawba and Cayuga White, will not usually reach adequate sugar levels (21 - 24 °Brix) in the field, so sugar will have to be added to the juice. In fact, Cayuga White is often harvested from 15 to 17 °Brix to avoid the “foxy” labrusca character. Delaware, Chambourcin, Seyval blanc, Vidal blanc, and Norton/Cynthiana may reach the desired °Brix. If cluster integrity is compromised, however, grapes must be harvested before the desired sugar level is reached and the juice must be ameliorated with additional sugar. White grapes should be harvested when the pH is between 3.2 and 3.4 and the acid level is between 0.6 and 0.9 g/100ml tartaric, whereas red grapes should be harvested when the pH is between 3.3 and 3.5 and the acid level is between 0.7 and 0.9 g/100ml tartaric.

How to Harvest Grapes. Harvesting grapes can be fun if you are prepared and the weather cooperates. You will need grape cutters or pruning shears to cut the bunch from the vine, adhesive bandages and antibiotic ointment in case you cut yourself, comfortable clothing, and clean picking containers. After cutting a bunch of grapes, place it in the picking container; a lug, bushel basket, or other suitable receptacle. Do not throw the bunches down in the picking container because you will break the skins, lose juice, and attract insects. If you stack the picking containers, make sure the containers on top do not crush the grapes in the containers below. A good plan is to pick grapes in the morning and process them in the afternoon. If you need to store the grapes before processing, store them in as cool a place as possible. Remove rotten berries before processing.

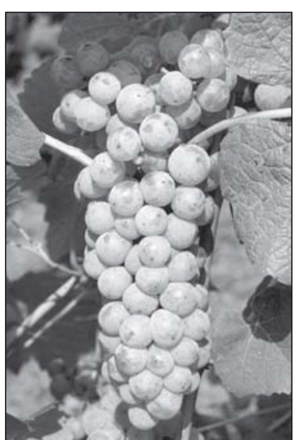

Catawba photo courtesy of Dr. Martin Kaps, SMSU.

Catawba. Catawba is an American *Vitis labrusca* type grape that was discovered by the Catawba river in North Carolina. The 180-day growing season in southern Missouri allows Catawba to ripen fully and avoid the high acid levels encountered in other eastern grape growing areas.

The pink berries of Catawba are large and the clusters are medium in size. It has the “foxy” labrusca character. The vines are hardy and vigorous with susceptibility to several fungal diseases including blackrot and downy mildew. Catawba ripens late, a couple of weeks after Concord.

Catawba is a pink grape that is processed as a white wine grape. It is not fermented on the skins. Rice hulls are recommended for use in processing due to its “slip skin” characteristic. It makes a medium bodied, fruity, labrusca wine that is best made in a sweeter style. The wine is pink to orange in color.

Cayuga White. Cayuga White is a mixed hybrid wine grape released from the New York Agricultural Experiment Station at Geneva in 1972.

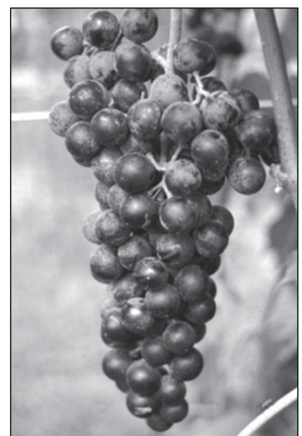

Cayuga White photo courtesy of Dr. Martin Kaps, SMSU.

The clusters and berries of Cayuga White are large and cluster thinning is recommended. The vines are vigorous and moderately winter hardy with susceptibility to several fungal diseases including blackrot, downy mildew and anthracnose.

Cayuga White should be harvested at about 15 to 17 degrees Brix sugar level in Missouri for the best quality wine. It is usually picked about two weeks before Concord.

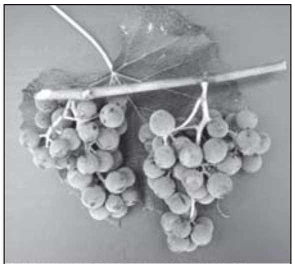
Cayuga White makes an excellent white wine. It has nice, fruity (citrus) notes and could be described as Germanic (Reisling-like) in style. It is light bodied and light green in color.

Chambourcin. Chambourcin is a mixed hybrid blue-black wine grape with beautiful large loose clusters of medium size berries. The vines should be cluster thinned.


Chambourcin photo courtesy of Dr. Martin Kaps, SMSU.

The vine is low to moderately vigorous and is reliably hardy only in southern Missouri. Chambourcin is susceptible to several fungal diseases including powdery mildew and, to a lesser extent, downy mildew. Chambourcin ripens about the same time as Concord.

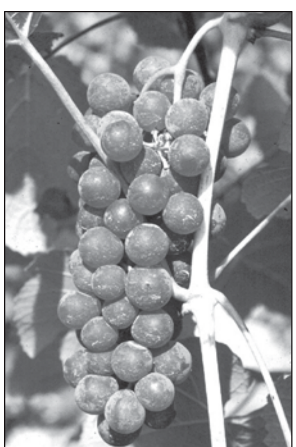
Chambourcin is processed as a red wine grape and is fermented on the skins. Chambourcin makes a good dry red wine, medium in body and fruitiness, possibly with some subdued berry notes. The wine color is medium red.


Concord photo courtesy of Dr. Martin Kaps, SMSU.

Concord. The widely adaptable Concord grape was selected from the wild in the 1840s in Concord, Massachusetts. This American *Vitis labrusca* has the characteristic foxiness associated with labrusca grapes.

Concord has medium size clusters of large berries. Uneven ripening of the berries can be a problem in warm areas like southern Missouri. Sunbelt is a good substitute for Concord in the warmer areas. The vines are very winter hardy and vigorous. They are also disease resistant and not attractive to birds, therefore, well-suited to arbors. Concord ripens in late August/early September at Mountain Grove in south-central Missouri.

Concord is fermented on the skins, as recommended for red wine grapes. Since it is fermented on the skins, it does not need rice hulls in processing even though it is a “slip skin” labrusca type. Concord is best made into a sweeter style wine that is fruity and candy-like. To achieve this style, after fermentation on the skins, it should *then be processed as a white wine*. Concord is medium in body and is deep blue-purple in color.


Delaware photo courtesy of Dr. Martin Kaps, SMSU.

Delaware. The Delaware grape was found in Delaware County in Ohio in the early 1800s. Delaware is an American type grape but does not have much of the labrusca foxiness.

The fruit clusters are small with small pink berries that are very attractive to birds. Delaware vines are vigorous and hardy and are somewhat susceptible to downy mildew. Delaware ripens early, about two weeks before Concord.

Delaware is a pink grape that is processed as a white wine grape and is not fermented on the skins. Delaware may require the use of rice hulls in processing due to its “slip skin” labrusca trait. Of the labrusca types (Catawba, Concord), it has the best fruity notes and the least labrusca character. The wine is pink to white in color.


Norton photo courtesy of Dr. Martin Kaps, SMSU.

Norton/Cynthiana. Norton/Cynthiana is an American grape, *Vitis aestivalis*, and was found in 1835 near Richmond Virginia. Sometimes called Virginia seedling, it is the premium wine grape in Missouri. There is some controversy as to the name. Some call the grape Norton and others Cynthiana, but most consider both one and the same.

The medium-sized clusters with small blue-black berries are attractive to birds in some years. Norton/Cynthiana is very hardy and extremely vigorous and often must be trained to a high-vigor, divided canopy training system. It is one of the most disease resistant grape varieties, with some resistance even to blackrot. Norton/Cynthiana is one of the latest ripening grapes in Missouri along with Catawba, about two to three weeks after Concord.

Norton/Cynthiana is processed as a red wine and is fermented on the skins. Norton makes a dry red wine that is medium in body with some fruity overtones. It is very dark in color. Norton should be used to make a younger style wine. Due to its high pH, it is not recommended for long aging (much longer than a year) by home winemakers.

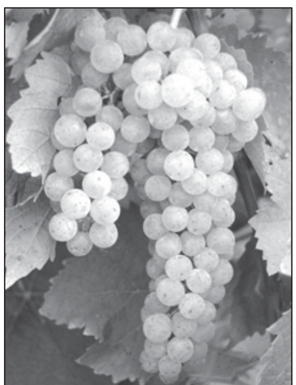

Seyval blanc photo courtesy of Dr. Martin Kaps, SMSU.

Seyval blanc. Seyval blanc is a mixed hybrid grape with large green clusters and medium size berries. Cluster thinning is recommended.

The vines are moderately vigorous and moderately hardy. Seyval is susceptible to fungal diseases including powdery mildew and bunches are susceptible to rot. Seyval blanc ripens about two weeks before Concord.

Seyval blanc is processed as a white wine and is not fermented on the skins. Seyval makes a good all purpose neutral crisp white wine that is light to medium in body. It is light green to straw in color.

Vidal blanc. Vidal blanc is a mixed hybrid grape. It has large clusters of medium to small size berries with small russet dots on them. Vines should be cluster thinned.


Vidal blanc photo courtesy of Dr. Martin Kaps, SMSU.

The vines are moderately winter hardy and susceptible to several fungus diseases including powdery mildew and anthracnose. Vidal blanc is harvested about a week or two before Concord. The clusters resist rot and can stay on the vine for a longer period of time compared to Seyval blanc.

Vidal blanc is processed as a white wine grape and is not fermented on the skins. Vidal blanc makes a very good white wine with fruity and floral notes. It can be describes as “Germanic” in style and is light green to straw in color.

Raw Materials

The quality of the raw materials has a direct effect on the quality of the finished product. If you begin with grapes, they should be free of rot. The sugar, pH, and acid levels of the pressed juice, if not already in the desired range, need to be adjusted. Purchase fresh yeast and bacteria cultures and store them properly. Bacteria cultures should be stored in the freezer and the yeast should be stored in the refrigerator. Dates that the material should be used by are stamped on packets by the manufacturer. Out-of-date materials should not be used.

Mark the date that you received your chemicals on the label. Make note of the shelf-life if this information is available. Store chemicals in closed containers, in a cool, dry place.

Grapes, Juice or Concentrate. The most important supply for any winemaker is, of course, grapes or juice. Are you going to grow your own grapes? Are you purchasing fresh grapes in season? Are you purchasing fresh juice? You can also use frozen grapes or concentrates. Certain varieties of grapes are readily available in Missouri, whereas others, if desired, must be purchased out-of-state.

If you grow your own grapes, you need to measure the initial sugar level of the juice. You should also measure pH and acid if you have the resources. If you purchase fresh grapes, fresh juice, or frozen grapes, you may be able to get this information from the seller. A concentrate will have a set of instructions included that will direct you to dilute the juice to a sugar level consistent with the wine you wish to make. It is advisable to use a yeast nutrient (e.g., diammonium phosphate or DAP) to promote yeast growth and fermentation when you are using juice from concentrate.

Rice Hulls. Slip skin labrusca grapes that are processed as a white wine (not fermented on the skins) will yield more juice if crushed with the addition of rice hulls.

Rice hulls are usually sold in 1 pound lots by home winemaking suppliers. One pound of rice hulls should be enough for about 200 pounds of grapes.

Sugar. Another raw material that can be very useful is sugar. Adding sugar to the juice is not an uncommon industry practice in the East, and will cause the finished wine to have a higher alcohol content. The formula for adding sugar is detailed in "Procedures and Discussion" under sugar adjustment formula. By measuring the initial juice sugar level, the winemaker can calculate how much sugar to add to end up at a given alcohol level in the wine (multiply °Brix of sugar by 0.55 to estimate the final alcohol level). These estimates are subject to some error, but they generate a ballpark figure and can be used to produce a consistent level of alcohol from year to year from grapes in which the natural sugars will vary.

Yeast. Second to grapes, the most important live component of winemaking is the yeast, a type of fungus. Without yeast, the sugar will not turn to alcohol and the juice will not turn into wine. Grapes often have wild strains of yeast on the skin surface when harvested, and these will eventually begin to ferment if left uncontrolled. These yeasts may or may not be desirable, so winemakers add sulfur dioxide to control wild yeast and later add a certain dosage of wine yeast to ferment the juice.

Active dry wine yeast typically comes in a 5 gram packet which is enough to ferment 5 gallons of juice. Yeast can be purchased in larger packages as well. Store yeast in the refrigerator and be aware of the expiration date stamped on the package. Wine yeast is available in wine and beer supply stores and catalogs.

Malolactic Bacteria. Malolactic bacteria convert malic acid to lactic acid during malolactic fermentation (MLF). MFL is an optional step in the production of red wines that results in reduced acidity (desirable in high acid wine), higher pH, and greater flavor complexity.

Some commercially available bacteria cultures can be added directly to the wine to initiate malolactic fermentation. The cultures come in packets. The packet should be stored in the freezer.

Chemicals. Chemicals of various types can be added to the wine either to clarify it or to prevent spoilage. This guide only presents a few of the most common wine chemicals and their purpose. For specific dosing or usage, please consult the manufacturer, supplier, and where applicable the Material Safety Data Sheet (MSDS).

Sulfur dioxide (SO_2) - This chemical is added to the wine to stop bacteriological activity, to inhibit yeast growth, and as an antioxidant. A certain amount of SO_2 is necessary to prevent wine spoilage and oxidation, but too much can lead to sulfur off-flavors and off-odors. Potassium metabisulfite is 58% SO_2. Free SO_2 is the active form in the wine.

Bentonite - This clay material is mixed with water into a slurry and added to the finished wine to precipitate proteins.

Enzymes - Various pectic enzymes can be used immediately after crushing the grapes to promote the settling of the juice before initial racking in whites. In red wines, enzymes can also work to maximize color extraction.

Diammonium phosphate (DAP) - A yeast nutrient that promotes yeast growth and activity.

Others - The array of other possible additives and clarifying agents is too long to list here. Take some time to look at a wine supply catalog if you need help with a specific problem. Also, be sure to have cleaning supplies on hand for your containers and bottles, again making sure that all cleaners are food safe.

Equipment and Supplies

The equipment necessary for home winemaking will vary greatly depending on several factors. First of all, how many grapes will be processed annually? Hand stemming enough grapes for a 5-gallon batch is more realistic than hand stemming for a 50-gallon batch. Secondly, how much of a financial investment will be made in winemaking? How much space and time do you have? Some pieces of equipment would make the job quicker and easier, but may be impractical for the home winemaker due to size, cost, or the need for facility improvements (220 volt outlets, air compressors, etc.)

The beginning winemaker definitely needs a hydrometer (or refractometer) to measure initial sugar level. Fermentation containers, fermentation locks, racking supplies, cleaning supplies and bottles are also necessary.

Stemmer Crusher (photo left). The first step in making wine is to get the juice out of the grape. You need to remove the stems from the berries, by hand or machine, to prevent the absorption of off-flavors from the stems into the wine during fermentation. After removing the stems, the grapes need to be lightly crushed to free the juice from the berries. They should not be ground to a paste because undesirable components will be released from the seeds. Splitting the berry, however, is necessary to facilitate juice extraction or fermentation on the skins.

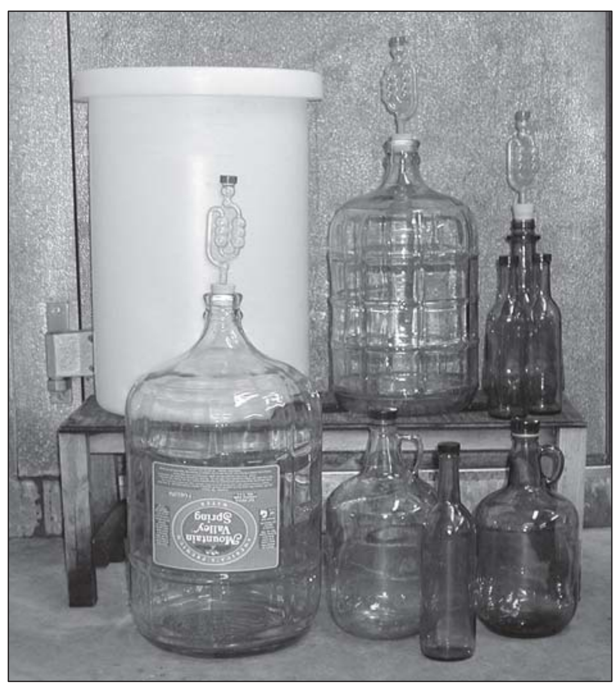
These processes can be performed by hand on smaller batches, but for larger batches and to process the grapes easily, a commercial crusher or stemmer/ crusher is recommended.

Wine Press (photo left). The other major investment that might be needed is a wine press. The function of a press is to separate the liquid fraction from any seeds, pulp, and remaining stems. For white wines this is done prior to fermentation, and for red wines it is done immediately after fermentation. Again, for small batches a little ingenuity can save money. A few containers, some food safe screening material, and a way to apply pressure is all that is needed. However, if the funding is available, or the mechanical ability is not, then there are a wide variety of presses available from suppliers; from simple screw type basket presses to more complex bladder presses of different designs. Choose the press that will best fit your facility and the size of your production.

Containers. Containers, either food grade plastic, stainless steel, or glass, will be necessary. Glass carboys (photo lower right - top row center, bottom row left) are available in a wide range of sizes and are great for white wine fermentation, as well as for racking, storing, and fining both red and white wines. Fermentation locks seal air out while allowing fermentation gases to escape. Red wines are typically fermented in larger tubs (photo lower right - top row left) or containers rather than multiple carboys. They require “punching-down” (mixing) which promotes even skin contact and helps remove built up gases and heat. Again, you can be somewhat creative, but bear in mind only food grade plastics and other materials should be used. If in doubt, consult the manufacturer, or obtain your containers from a food supply or wine supply facility.

Don’t forget that you are going to need bottles for your finished wine. Standard bottles are 750 ml but both larger and smaller sizes are available. You will also need bottle closures, either cork or screw cap, depending on your preference.

Fermentation Locks (photo right). Fermentation locks or air locks are fitted into a stopper that fits on the top of your fermentation container. Even red wines that are fermented in a large, open-mouthed container, will be transferred to a 3 or 5 gallon glass carboy fitted with a fermentation lock. The locks are designed in different ways, but all hold a column of liquid, preferably Everclear or vodka as water is easily contaminated, between the wine and the outside air. The lock in the photo is shaped something like a sink trap. Liquid is trapped in the



middle allowing the gas to escape from the wine but not allowing the outside air to get in.
It is important to keep the fermentation locks clean and sanitized during the fermentation.

Analytical Equipment. Analytical equipment is used by commercial winemakers for quality control and to determine the overall condition of the wine. While most of the laboratory equipment is unnecessary for the average home winemaker, a few items are useful.

A ***balance*** of some form may be necessary to measure out chemicals for addition to the wine, although some chemicals are available in tablet form for home winemakers.

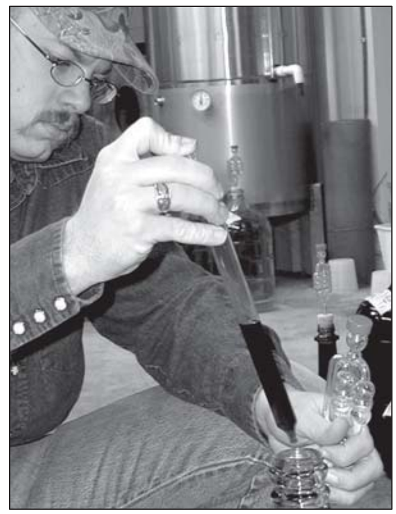
A ***hydrometer*** (photo left) or a ***refractometer*** is needed to measure the initial sugar content of the juice. This will allow the winemaker to estimate the alcohol of the finished wine. A ***residual sugar kit*** may be used for monitoring the dryness of the wine and the end of fermentation.

A ***pH meter*** may be useful to measure the pH of the juice or wine. A ***total acidity laboratory kit*** will allow you measure the acidity of the juice or wine.

Kits for determination of free SO_2 are available from winemaking suppliers and serve to take the guesswork out of the amount of SO_2 needed during the winemaking process.

If you are making red wine and decide to perform a secondary malolactic fermentation, a ***chromatography kit*** is available to monitor the fermentation and to determine when it is complete.

Miscellaneous Equipment. Miscellaneous items that are necessary include food grade tubing, graduated cylinders, and beakers/cups. These items are used to transfer the wine, to make stock solutions, or to take measurements. A thermometer is needed to make sure procedures are carried out at the recommended temperature. A spare refrigerator is very useful to control the temperature for cold stabilization and/or fermentation.



A wine thief (photo right) is a handy tool that extracts a small amount of wine or juice from a carboy for analysis. It is a hollow tube with holes at both ends. Insert the wine thief into the container of juice or wine, plug the hole at the top with your finger, and you have a juice or wine sample. Be sure to clean the wine thief before and after use as well as between samples with a sulfur dioxide sanitizing solution.

You will also need some cleaning supplies including brushes, buckets, and towels. Rubber gloves, protective eyewear, ear protection, and respirators may be needed when working with certain chemicals or pieces of machinery. The items you need depend on the materials and equipment you use. Make sure you follow all the safety precautions of the manufacturer and/or supplier.

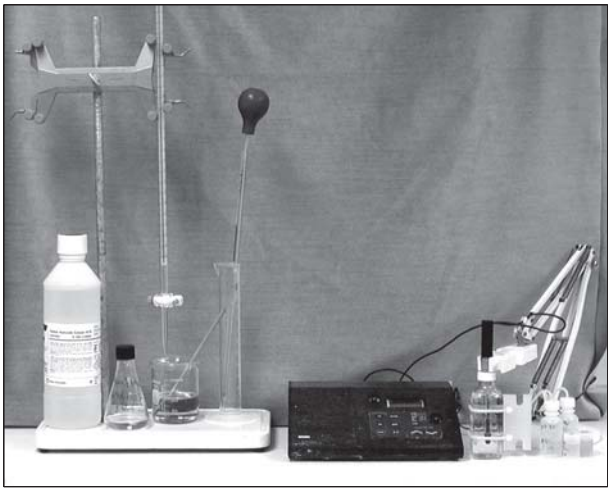
Cleaning Agents. The main purpose of cellar hygiene is to prevent the contamination of the wine/juice by microorganisms as well as to produce a superior product. The goal is to remove soil and spoilage microorganisms from equipment. Remember, wine is a food product, so don't use cleaners that cannot be effectively rinsed or removed or contamination may occur. Observe all safety rules and labels/MSDS sheets to protect yourself and prevent mixing incompatible chemicals.

A general-use sanitizing solution of potassium metabisulfite (to yield a concentration of approximately 200 mg/L SO_2) and citric acid (to reduce pH to 3.0) can easily be prepared. Approximately ¼ level teaspoon of potassium metabisulfite per gallon of water will yield 230 ppm SO_2. The amount of citric acid necessary will vary based on water pH (a pH meter or a pH test paper can be used to measure the pH of your water).

Some things may be effectively cleaned with steam, hot water, or regular soap and water in the sink or dishwasher. Screw caps or other small items can be soaked in hot water or boiled for sanitization.

There are also a number of commercial alkaline cleaners available specifically for use in the brewing, winemaking, or dairy industries. These cleaners are designed to thoroughly clean yet be easily removed by rinsing leaving little to no residue. Contact a supply house for more information.

For your safety, make sure you are protected with gloves, goggles, and apron when recommended. Make sure you properly use and dispose of cleaners. If you are working in a garage with no floor drain, consider using a small plastic swimming pool or tub to wash in so the cleaning solution is not washed out into the street or a neighbor's yard becoming a hazard to people or animals. Again your supplier will be able to help you with concerns you may have.



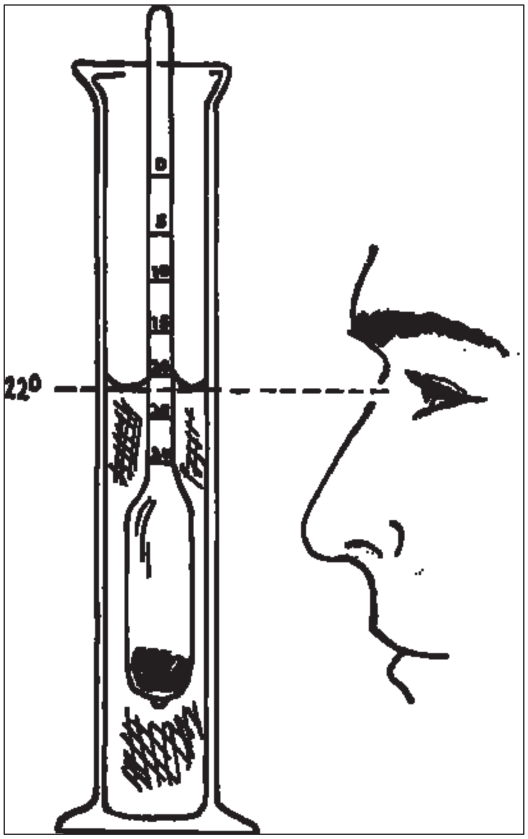
Procedures and Discussion

Many of the procedures discussed in this section should be carried out at certain temperatures. Note the temperature of the surroundings and/or solutions to make sure procedures are carried out as recommended.

It is also important to measure and weigh out materials correctly with measuring spoons and/or an accurate balance or a digital scale. The Weights and Measures section (Appendix 3) will help you determine amounts. Most of the kits and chemicals you buy for home winemaking will have the detailed instructions included either on the label or on a separate paper. Keep the instructions in a safe place and make sure labels do not become damaged. Clear packing tape applied over chemical labels will keep them clean and dry.

Remember to keep records of how much material you add to each container of wine and when you perform a particular procedure. It is a good idea to put masking tape on each carboy or container of wine and note each treatment and date on the tape. Remembering what you did to a particular batch may not seem difficult, but you may be surprised and confused later on if you don't record the procedures your performed.

Measuring Sugar Level. It is necessary to measure the sugar level of the juice you plan to make into wine. The initial sugar level may or may



not be adequate to produce the alcohol level desired in the finished wine, and additional sugar may be needed. The percent sugar in the juice, for all practical purposes, is the degrees Brix. You need the following equipment to measure sugar level:

1. A hydrometer calibrated to read sugar levels from 0 to about 30°Brix (also called a sacchrometer).

(A hydrometer measures the specific gravity of a liquid on the Brix scale).

2. A graduated cylinder or a long glass tube in which to put the juice and the hydrometer.

3. A thermometer.

The procedure is as follows. Please note that hydrometers are calibrated to a particular temperature, usually 68°F. You must compensate for differences in temperature. A compensation table will probably be included with your hydrometer.

1. Fill the graduated cylinder or glass tube with your sample of juice. Make sure the juice is at room temperature (68°F) or make temperature corrections.

2. Insert the hydrometer and spin it by twisting the top of it. Wait for it to stabilize.

3. Read the sugar level in degrees Brix at the bottom of the meniscus or the "cup" at the top of the liquid level in the tube (drawing left).

A refractometer may be used to measure the sugar level instead of a hydrometer. A refractometer measures the amount the juice can bend light passing through it and translates the amount of refraction to the Brix scale at room temperature. The advantage of using a refractometer is that you do not require as much juice to read a sample as you do with a hydrometer. It is useful for a home grape grower who must determine when to harvest several cultivars of grapes and must process several samples prior to harvest.

Sugar Adjustment Formula. Adding sugar to the juice will cause the finished wine to have a higher alcohol content if fermented dry. By measuring the initial juice sugar level, the winemaker can calculate how much sugar to add to ultimately end up at a given alcohol level. These calculations are subject to some error, given that not all solids in the juice are fermentable sugars, but they provide the ability to control alcohol level within a reasonable amount.

The formula to use is:
S=0.125(v)(B-A)

Where **S** = the amount of sugar in pounds to add

0.125 = the amount of sugar in pounds needed to raise 1 gallon of juice 1 Brix degree

v = the volume of juice in gallons

B=desired final Brix value in degrees (usually 22)

A=current measured Brix value in degrees

For example: Your juice measures 17.5 ° Brix, and you have 10 gallons of juice.

You want a final Brix of 22 °.
So, S=0.125(10)(22-17.5) or S=5.625 lbs.
This means you need to add just less than 6 pounds of sugar to your juice prior to fermentation to get the desired Brix level.

Sugar can also be added to a finished dry wine immediately prior to serving. This will allow you to enjoy a sweeter style of wine without some of the problems of storing a wine containing sugar. Approximately 7.5 grams (about 2 level teaspoons) of sugar needs to be added to a 750 ml bottle to yield the equivalent of 1% residual sugar. Higher residual sugar levels can be achieved simply by adding more sugar. Make sure not to overfill the bottle as you add the sugar, or you may have to pour the wine into a larger carafe for serving. Sweet wines commonly have residual sugars in the 1-4% range, but certain wines may have levels much higher.

Care should be taken to keep unpreserved sweet wines refrigerated to avoid re-fermentation and the possible buildup of gas and explosion of the wine bottle. This is especially dangerous with a partially full bottle secured with a screw cap. These wines should be consumed within hours of being sweetened.

pH and Acidity. The pH and acidity are very important characteristics of wine, but the beginner may not be equipped to measure them.

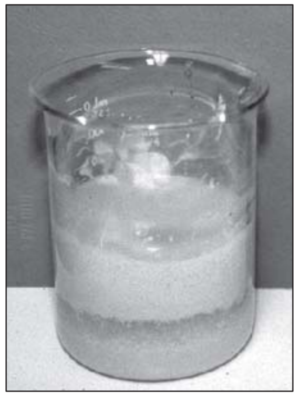
The pH is the concentration of positive hydrogen ions in solution. The more H+ ions, the more acid the solution. The pH scale goes from 1 to 14, where 7 is neutral, above 7 is basic and below 7 is acidic. The pH of juice for wines should be between 3.2 and 3.5. pH is difficult to change and it is best if you begin with a juice with a pH in the desired range. pH is important in maintaining microbial stability, so the wine doesn't spoil. pH is measured on a meter at room temperature or at the temperature specified on the equipment. The pH meter must be calibrated using buffer solutions of pH 4 and pH 7 (or as specified by the manufacturer).

The acidity level is the amount of tartaric, malic, lactic and citric acids in the wine. Acidity is expressed as grams per liter of tartaric acid since tartaric is the major acid in wine. Juice for wine should have acid levels between 0.6 - 0.9 grams/ 100 ml tartaric (0.6 - 0.9% Total Acidity). Acidity is important since it balances sweetness in the wine. A wine will be flat with too low an acid level or sour with too high an acid level. Acidity in wines is measured by performing an acid-base titration. A known amount of juice is diluted in distilled water and a known concentration of base (sodium hydroxide) is used to titrate (measured amounts mixed into the sample at intervals) to an end point, shown by a phenolphthalein indicator or a pH meter. Once the endpoint is reached, the amount of base used to reach the endpoint can be inserted into a formula that will calculate the amount of acid based on tartaric acid. (See Determination of Titratable Acidity, Appendix 2.)

Sulfur Addition. The use of SO_2 is necessary in the production of wine to control oxidation and the growth of microorganisms capable of spoiling wine. The lower the pH of a wine, the more effective SO_2 will be in controlling microorganisms. The addition of too much SO_2, however, can result in the aroma of a burnt match which also gives a burning sensation to the nose. The lower the pH of a wine, the greater the chance the wine will give off an offensive burning odor for a given level of SO_2 (the SO_2 becomes more volatile).

Trying to determine how much SO_2 to add to a wine without measuring the amount already present is a guessing game. SO_2 is used up as it controls oxidation, and as wine is exposed to oxygen during handling (racking, bottling), it needs to be replaced. During the yeast fermentation, the SO_2 added to the must is no longer available and needs to be replaced once the fermentation of sugar is complete. The addition of SO_2 to a must that is fermenting is not advisable and will result in the SO_2 being quickly bound to compounds being produced. In general, red wines need less SO_2 to protect them from oxidation as the compounds that give red wine its color and astringency also help protect it from oxygen. Also, when a red wine is put through malolactic fermentation, some of the SO_2 that was bound to other compounds will be released and available again as free SO_2. SO_2 additions that occur after the first one made at the completion of the yeast fermentation (50 ppm for white wine at the first racking and 30 ppm for red wine at racking following malolactic fermentation) will be based on guessing and experience unless one analyzes for available (free) SO_2.

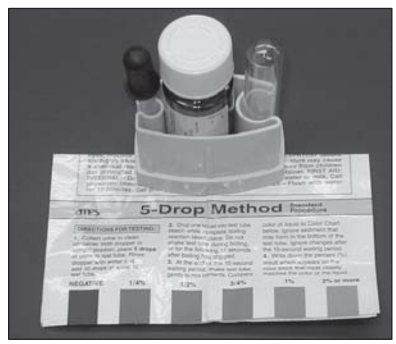
Home winemakers add SO_2 in the form of potassium metabisulfite (58% SO_2). Potassium metabisulfite is available as a powder or in tablet form which can be directly added to the wine or juice. If using the powdered form, it should be dissolved in water first. A 1/4 teaspoon will supply enough SO_2 to five gallons of wine to raise the SO_2 level about 40 to 45 ppm. This amount of SO_2 should be dissolved in about 25 ml of water. Care should be taken when handling potassium metabisulfite and the use of a respirator appropriate for this compound is suggested. Potassium metabisulfite should be kept dry and replaced every year or two. Older stocks of this compound can be used to make sanitizing solutions where the actual SO_2 concentration is not critical. Tablets may be also be used to add SO_2. Note that some tablets must be crushed before using.



Yeast Addition. Wine yeast is available in several strains, usually in 5 gram packages enough to inoculate 5 gallons of juice.

Re-hydrate the yeast by suspending it in 10 times its weight of water (e.g., 5 g yeast in 50 ml water) at 104°F. Stir lightly, wait 15 minutes, then stir again.

If adding to cool (60°F) white juice, add the warm yeast/water mixture to an equal volume of juice to be fermented over a period of 5 minutes to reduce the chances of a cold temperature shock to the yeast (atemperation step). It is important to have a temperature difference of less than 18°F between the yeast starter mixture and the bulk must you are adding it to. This atemperation step may be repeated when working with a cooler must (temperature closer to 50 than 60°F).



Measuring Residual Sugar. The ability to measure the dryness of a wine (the amount of fermentable sugars) is a valuable tool for the home winemaker. Kits (Clinitest, formerly Dextrocheck, see photo above) are available to detect reducing sugars in wine down to the 0.1 to 0.2% level. This level of residual sugar is generally regarded as being low enough to bottle without the use of a preservative (sorbic acid) or sterile filtration to keep yeast from causing a re-fermentation in the bottle. Re-fermentation in the bottle can result in clouding of the wine, off odors, gas bubbles, and the possibility of bottle breakage if enough sugar is present. The sugar testing kits will only measure reducing sugars (primarily glucose and fructose in wine) with sucrose, a non-reducing sugar, going undetected. Sucrose added to the must will be readily converted into glucose and fructose by grape and yeast enzymes. After the alcoholic fermentation and fining with bentonite, wine will usually have very little of these enzymes available. Under these conditions, the conversion of sucrose into glucose and fructose is dependent on the low pH of wine and can take several months or longer. A dry, dark red wine will tend to register higher reducing sugar levels than a dry white wine due to the reducing properties of the red pigments.

Racking. Racking is the process of moving the wine from one container to another, leaving behind sediments. The juice/wine will need to be racked several times. The first racking for white wine will be after the pressed juice has settled. The first racking for red wine is typically a day after pressing, after small solids settle out of solution.

You will need about 6 feet of food grade tubing ($^3/_8$ or ½"), a table or stool, and containers. You should have enough hose to reach from the *bottom* of your full container to the *bottom* of your empty container while the full container is on a table or stool.

Begin with the full (source) container on the table, the bottom positioned at a higher level than the neck of the empty (collection) container on the floor. Put the hose into the source container below the surface and create suction to move the wine into the hose. One way to do this is to loop the hose into a "U" shape and fill the lower half of the "U" with clean water. Take one end of the hose and put it in the full container (do not dump the water into the wine). Lower the free end of the hose into a catch bucket and allow the water to drain, sucking the wine shortly behind. Keep the source end of the hose submerged. After clearing the water from the hose, crimp the free end to stop the flow of wine, insert the free end into the collection container, and release.

Position the hose slightly above the sediment surface in the source container, trying not to disturb the sediment layer. Towards the end of the racking, you may tip the source container to create a deeper pool to draw from. On the collection end, the hose should be below wine surface for white wines (to prevent oxidation). For red wines, allowing the hose stay above the wine surface of the collection container, letting the wine splash out, will aerate the wine. Aeration can improve red wines destined for longer aging.

Fining. Fining agents are added to wines to clarify, stabilize, and/or improve quality. White wines usually need fining with bentonite, and sometimes require further fining. Red wines often do not need fining. The use of fining agents is determined on a case by case basis. Fining agents commonly used include the following:

Bentonite - to remove protein haze and stabilize for future protein haze problems in the bottle. Many wines will clear in their own given time, but may be prone to producing a haze in the future.

Sparkalloid - to help clarify.

Isinglass - helps to clear and soften wines and unmask fruit flavor.

Gelatin - to remove astringency and harshness.

The use of fining agents usually results in the formation of sediment that requires racking and results in the loss of wine volume.

Malolactic Fermentation. Malolactic fermentation (MLF) is the fermentation of malic acid into lactic acid and carbon dioxide by malolactic bacteria. MLF is an *optional* step in the production of red wine that reduces acidity (desirable in high acid wines), raises pH, adds to flavor complexity, and is thought to contribute to biological stability against further growth of malolactic bacteria. Direct addition cultures of malolactic bacteria can be purchased and added directly to the wine after the yeast fermentation.

Things that promote malolactic fermentation include:

- addition of a bacteria starter culture
- low sulfur dioxide (limit sulfur dioxide additions to 30 ppm added to the crushed grapes at the beginning of the yeast fermentation)
- temperature above 64°F
- pH above 3.2
- ethanol levels lower than 14%

Malolactic fermentations can be monitored through the use of a paper chromatography kit (photo above left) that tracks the appearance of lactic acid and the disappearance of malic acid. The carbon dioxide bubbles given off as part of the breakdown can be used as a less accurate indicator of an ongoing malolactic fermentation, however residual carbon dioxide from the yeast fermentation can result in false positives.

Oak Treatment. The use of oak barrels for the aging of wine on a home winemaking scale is not recommended due to the costs and logistics of using oak barrels with small volumes of wine. Oak extractives can be added to wine through the use of oak chips. A suggested rate for chip addition is 4 to 7 grams per gallon. The chips should be left in the wine for 1 to 3 weeks. After the removal of the chips by racking, bottling should be delayed for three to four weeks to allow for the precipitation of ellagic acid. Ellagic acid is extracted from the oak and is unstable in wine.

Oak treatment can be used for red wines, although it is not usually recommended for Concord. Seyval blanc, a white wine, may be a candidate for oak treatment.

Cleaning and Sanitation. Several materials are available from home winemaker suppliers for cleaning and sanitizing winemaking surfaces. Rinsing bottles before they are allowed to dry will make them much easier to clean. Bottles and glass carboys can be sanitized by rinsing with a solution of 200 mg/L SO_2 and enough citric acid to lower the pH of the solution to 3.0 or slightly less (a pH meter or pH test paper will help determine water pH). Winery equipment should be cleaned and sanitized after a 1 to 2 hour delay in processing because microorganisms can readily increase in number in grape juice (contamination on equipment) and dilute grape juice (after partial cleaning).

Making White Wine

The basic steps involved in making white wine are detailed in this section. Briefly, the process begins with cool grapes or concentrated juice. If using concentrate, follow the instructions provided. If using grapes, start with cool, ripe, clean fruit. Remove the berries from the stems and crush. Press the juice out of the crushed berries and treat the juice with SO_2 and pectic enzyme. Collect the juice in a glass carboy and keep the juice cool and allow to settle overnight. Adjust the sugar level if needed and add yeast to ferment the juice. When fermentation has ceased and the yeast have settled at the bottom, the residual sugar is checked and the wine is racked (siphoned) off of the lees. Add 50 ppm SO_2 after fermentation and racking. Clarify the wine with bentonite (clay) and stabilize it through a cold treatment. Add 15 - 25 ppm SO_2. Rack 1 - 2 more times as needed and then bottle. Serve at 50 - 60 degrees F. Wine may be sweetened with sugar to taste at serving.

The entire process from fruit to bottle should take about 4 to 5 months.

White Wine Grape Processing. The wine grapes should be cool (40 - 50°F) before they are processed. The home winemaker may not find this to be practical, but one should try to work with fruit as cool as possible. The fruit should be clean and free of rot. Discard any rotten or unripe fruit as needed.

The next step is to destem and crush the grapes. If you crush the grapes without removing them from the stem, you may produce wine that has an undesirable "stemmy" taste. You should also avoid crushing the seeds. You can use a mechanized crusher or stemmer/crusher for speed, but for smaller lots, you can destem and crush manually.

You will need a press to properly dejuice the crushed grapes.

Juice Processing for White Wine. Once the juice is pressed, add 50 ppm SO_2 to control the growth of microorganisms (bacteria and yeast) and to reduce oxidation which causes browning. After thoroughly mixing SO_2, add pectic enzyme to help clarify the juice. The juice can be stored in a glass container (3 to 5 gallon carboy) with a fermentation lock to keep air out while allowing carbon dioxide to escape. Fill the container as full as possible.

Settling White Grape Juice. Let the juice settle overnight at a cool temperature between 40 and 50°F. A spare refrigerator will work for this purpose and will improve the chances of insoluble material settling out because the lower temperature reduces "wild" yeast activity and therefore the "turbulence" associated with it.

Wines made from settled juice tend to have a cleaner, fruitier aroma than wines made from unsettled juice. Rack the juice off of the sediment into a clean fermentation container with an airlock. For fermentation purposes, the container can be as full as 75 to 80% when using low foaming commercial yeast intended for winemaking. The exclusion of air is not as critical at this stage as it is in a finished wine because the wine yeast used in the controlled fermentation will utilize the oxygen.

White Wine Fermentation. Fermentation is the process where the yeast metabolize sugar and produce alcohol. The sugar content should be raised to between 20 and 22% (°Brix) if necessary. Brix levels are determined with a hydrometer or refractometer. Cane sugar from the grocery store can be used.

Warm the juice to 60°F before adding the yeast. The addition of a yeast nutrient to promote yeast growth is optional. Use commercially available dried yeast intended for wine production. Re-hydrate the yeast by suspending it in 10 times its weight of water (1 gram water = 1 milliliter water) at 104°F. Stir lightly, wait 15 minutes, and then stir again. Add the warm yeast/water mixture to an equal volume of juice to be fermented over a period of 5 minutes to reduce the chances of a cold temperature shock to the yeast (atemperation step). It is important to have a temperature difference of less than 18°F between the yeast starter mixture and the bulk must you are adding it to. This atemperation step can be repeated when working with a cooler must (temperature closer to 50 than 60°F).

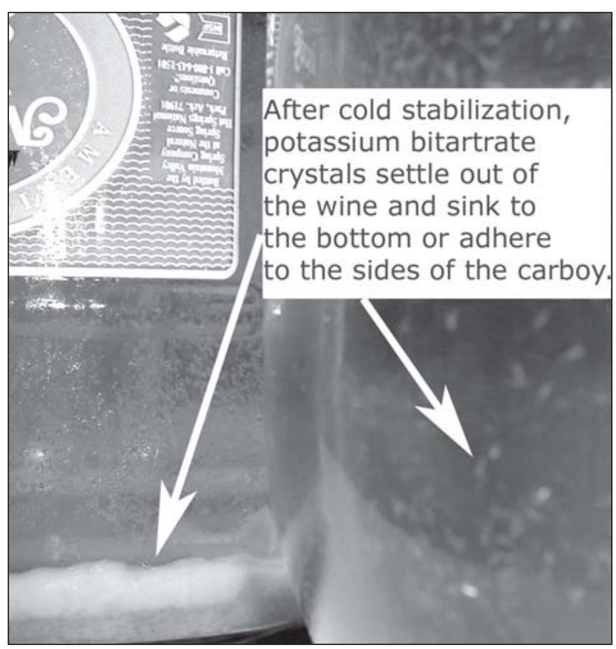
Allow the must (juice and yeast) to sit overnight at room temperature (68-76°F) before reducing the temperature to 55-60°F for the fermentation. A spare refrigerator will work well for this purpose. A special thermostat, available from home-brewing supply stores, may be necessary to control a refrigerator in the 55 to 60°F range. A cool temperature is necessary to control the fermentation and produce a fruity and delicate wine. Fermenting in a **cool** basement may give similar results.

Racking White Wine. Check the end of the fermentation by measuring residual sugar. A white wine should have a residual sugar level of 0.2% or less. Visual signs that the fermentation is over are a slowing in the release of carbon dioxide and a settling of the yeast.

The siphoning hose should be kept below the surface of the wine when racking to exclude oxygen as much as possible. Oxygen contact from this point on generally has a negative affect on white wine quality. Fifty parts per million (50 ppm) SO_2 should be added to the wine once it has finished fermenting (residual sugar of 0.2% or less) and has been racked.

Clarification and Stabilization of White Wine. Clarification can be achieved by the addition of bentonite at a rate of 1 to 2 grams/gallon. This will usually clear most white wines and provide a degree of protein stability.

After bentonite is added, the wine can be held at approximately 32°F for about two weeks to cold stabilize. If both clarification and cold stabilization are done at the same time, the wine will only have to be racked once to remove both sediments. A spare refrigerator can be used to cold stabilize the wine. If the wine is not cold stabilized, it will be prone to the formation of potassium bitartrate crystals (cream of tartar) in the bottle. These crystals are more of a cosmetic problem than one of taste.



After cold stabilization, the wine should be allowed to come to room temperature (60 to 70°F) before racking off the sediment. Racking at a higher temperature reduces oxygen pickup at the expense of re-dissolving potassium bitartrate crystals. After each racking, add 15 to 25 ppm SO_2.

Sweetening of White Wine. White wines are often made into a sweet style. This is most readily done by the home winemaker by the addition of sugar to the finished wine. Wine bottled with sugar and not intended for immediate consumption will need to contain a preservative such as sorbic acid to prevent secondary fermentation by yeast. Secondary fermentation in a bottled wine can lead to cloudiness, gassiness, off odors and the explosion of the bottles. Sorbic acid, usually added as potassium sorbate, inactivates but does not kill yeast. The wine should have a relatively low population of yeast (brilliantly clear). The effectiveness of sorbate is enhanced by the presence of ethanol (greater than 10%) and free SO_2. If SO_2 and ethanol are at the proper levels, sorbate additions in the range of 200 to 250 ppm are suggested. Sorbate has some sensory properties and may be objectionable to some wine drinkers at the levels used in wines. Sorbate has little activity against bacteria. Lactic acid bacteria can degrade sorbate, producing a compound that has a strong off odor (geraniums) associated with it. Considering all the pros and cons of sorbate usage, home winemakers are best advised to sweeten their wines immediately prior to consumption if a non-dry wine is desired, rather than to store a sweet wine preserved with sorbate.

Bottling of White Wine. As long as clean, disease-free fruit is used and proper steps to minimize oxygen pickup are followed, most wines should contain enough free SO_2 at this point (50 ppm added after first racking and 15 to 25 ppm added after each additional racking) to protect the wine if it is carefully bottled. Just as in racking, the siphon hose should stay below the surface of the wine in the container receiving the wine. Bottles can be sealed with either corks or screw caps. Corks require special tools to insert and run the risk of causing cork taint in the wine, but they are traditional and pleasing to the eye. Plastic top corks that can be inserted and removed by hand are also available. Reusable screw caps can make a good seal and are easy to use, but give the connotation of cheap wine to some people. If corks are used, the bottles should be kept upright for a couple of days to allow the release of pressure from the headspace of the bottle caused by inserting the cork. The bottles should then be placed on their sides. If bottles are to be reused, they should be cleaned to remove any visible material and then soaked in 180°F hot water for 20 minutes. The key to reusing bottles is to immediately clean them after their use so no material dries on the inner surfaces.

Troubleshooting for White Wine.

Brown color - is a sign of oxidation, usually accompanied with a loss of fruitiness and varietal character. Oxidation is usually a result of excessive oxygen exposure and/or inadequate free SO_2 levels. Wine made from moldy fruit will often contain oxidative enzymes that are difficult to control with SO_2. Avoid browning and oxidation by using clean sound fruit, maintaining adequate free SO_2 levels, and avoiding aeration by keeping the racking hose below the liquid surface in the container you are racking into. Avoid racking excessively cold wine as the solubility of oxygen in wine increases as you lower the temperature. Keep containers of wine full to reduce headspace as much as possible and use air locks (fermentation locks) and keep them full of water.

Vinegar odor - The smell of vinegar or finger nail polish in association with a wine is a sign of spoilage by acetic acid bacteria. These bacteria can be controlled by the avoidance of excessive oxygen exposure and the adequate use of sulfur dioxide. This type of spoilage can also be caused by lactic acid bacteria and yeast. The use of clean fruit and the addition of SO_2 to the must prior to the fermentation helps to reduce this problem. Keep containers of wine full to reduce headspace as much as possible and use air locks (fermentation locks) and keep them full of water.

Rotten egg odor - is caused by hydrogen sulfide, produced by yeast. This is usually a sign of fermentation stress for the yeast during the primary fermentation, caused by a lack of must nutrients or a temperature shock to the fermenting must. This may also occur if elemental sulfur is present in the must. Some strains of yeast are more prone to excessive hydrogen sulfide production than others. With time, hydrogen sulfide and its related compounds tend to mask the fruitiness in wine. The problem can often be avoided by using yeast nutrients, using properly prepared commercial wine yeast, and keeping proper temperature control of the fermentation.

Cloudiness - The most common cause of a wine failing to clear is a protein haze which can be removed with a bentonite treatment. Sometimes bentonite fining needs to be followed by a sparkalloid treatment. If pectic enzyme was not used, then pectin may also be a cause of cloudiness. Sufficient growth of yeast or bacteria will cause haziness or cloudiness as well.

Crystalline deposit - usually is a deposit of potassium bitartrate crystals. These can be removed by chilling the wine to around 32°F for several weeks.

Making Red Wine

The basic steps involved in making red wine are detailed in this section. Briefly, the process begins with grapes or concentrated juice. Follow the instructions for concentrate, or if using grapes, start with ripe, clean fruit. Remove the berries from the stems and crush. Treat the crushed berries with 30 ppm SO_2. You may also add pectic enzyme, but this is optional. Adjust the sugar level to 22 to 24 °Brix and add yeast to ferment. Ferment at room temperature and punch down the cap of skins at the top of the fermentation vat twice daily. Press the must after fermentation. Rack with aeration. Add malolactic bacteria if desired and rack at the end of malolactic fermentation. Cold stabilize and add 30 ppm SO_2. Age and add oak chips if desired. Rack 2 - 3 more times with aeration at 2 - 3 month intervals. Bottle and serve at 65°F.

The entire process from fruit to bottle should take about 9 to 12 months.

Red Wine Fruit/Must Processing. The fruit should be clean and free of rot. This is especially important as the juice will ferment in contact with the skins and mold is detrimental to red wine color stability. Discard any rotten or unripe fruit as needed.

The next step is to destem and crush the grapes. If you crush the grapes without removing them from the stem, you may produce wine that has an undesirable “stemmy” taste. You should also avoid crushing the seeds. You can use a mechanized crusher or stemmer/crusher for speed, but for smaller lots, you can destem and crush manually. Manual crushing will work as long as there is enough juice to get the fermentation going. As the must ferments and the cap (skins and seeds that float to the top) is punched down daily, the fruit will break down further.

Add 30 ppm SO_2 to the must using an estimated volume. Estimate that every 15 pounds of fruit will yield 1 gallon of liquid. Enzymes can be used to promote color extraction. Only enzymes suggested for use with red wines should be used.

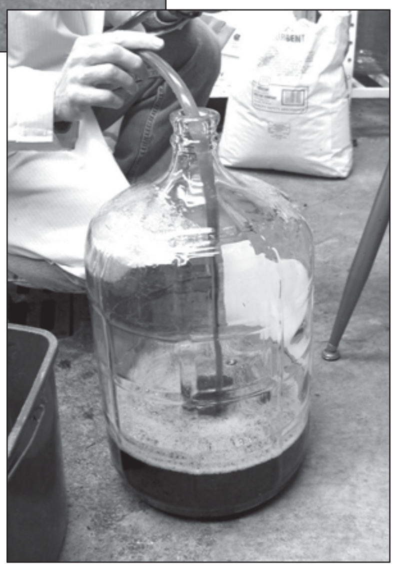
Red Wine Fermentation. The must is fermented in a wide necked container 1/2 to 2/3 full, preferably with a lid to reduce contact with fruit flies. Sugar content should be adjusted to 22 to 24°Brix if necessary. Sugar addition can be delayed until the must is fermenting and forming a cap of skins on top. When the cap forms, the actual amount of liquid can be more closely estimated. The sugar adjustment formula in the "Procedures and Discussion" section can be used to calculate sugar addition rates. Addition of a yeast nutrient (e.g., diammonium phosphate or DAP) is optional. Prepare yeast the same as for white wine, but note that the red must should be at around room temperature (around 70°F) so there is less danger of temperature shock to the yeast. Fermentation of the red must is best at temperatures in the range of 77 to 86°F. Temperature over 90°F should be avoided. As long as the room where the fermentor is located stays in the 70's, the fermentation should not get too hot (assuming the container is not too large). As the must ferments, skins and seeds will rise to the top. To keep the grape skins in contact with the liquid for color extraction and to release trapped heat, the cap should be broken up and pushed down below the level of the liquid in the container at least twice daily (photo below). The

fermentation should take from 5 to 7 days. When the cap no longer forms and the skins and seeds sink to the bottom of the container the fermentation is over. The must can be pressed prior to the end of fermentation (3 to 5 days and 0 to 5°Brix) to produce a red wine that requires less aging.

Pressing Red Wine Must. The must will not have to be squeezed too tightly since red musts tend to press rather easily. The pressed wine

should be placed in a glass carboy with an air lock. Unlike white wine, aerating by allowing the wine to splash while filling containers is desirable. Red wines are much more forgiving in their exposure to air and splashing allows for the release of off odors formed during the fermentation. Residual sugar values (Clinitest) for a dry red wine will be in the range of 0.2 to 0.4% (some of the coloring material in the wine will react during the sugar test).

Racking Red Wine. After the alcoholic fermentation has ended and the initial gross lees have settled, the wine should be racked (photo left) with splashing (photo right).



The wine should be kept in full containers with air locks.

Oak chips may be added at this time (4 to 7 grams per gallon) to provide oak aroma and flavor and to facilitate aging. The use of barrels for the storage and aging of wine is not practical for most home winemakers.

The wine can be inoculated for malolactic fermentation (MLF) at this time if desired. Malolactic cultures that allow for direct inoculation are the easiest to use for the home winemaker. The wine should be kept at a temperature of 64°F or above during the MLF. Under optimum conditions and with a direct inoculation culture, the MLF should be complete in about two weeks. Paper chromatography kits can be used to track the MLF and determine when it has finished.

Cold Stabilization of Red Wine. After completion of the malolactic fermentation, the wine should be racked with aeration. Add 30 ppm SO_2.

The wine can be cold stabilized at this point. Hold the wine at 32 to 40°F for two or more weeks. A spare refrigerator can be used for this purpose. (Photo above - Potassium bitartrate crystals settle to bottom of carboy after cold stabilization.)

Racking three to four more times after cold stabilization, over a period of nine to twelve months, should be enough to produce a clear and stable red wine.

Aging Red Wine. For aging red wines, the free sulfur dioxide levels should be kept at 15 to 20 ppm (you can use a free SO_2 test kit to measure SO_2 levels). If you cannot analyze for free SO_2 levels, 15 to 20 ppm can be added at each racking. Adding at this level is just an estimate.

If your wines tend to oxidize (turn brown), you may need to add more SO_2 in the future. If your wines tend to have an objectionable SO_2 aroma (prickly, burnt match) you may need to reduce the amount of SO_2 added to your wines in the future.

Bottling Red Wine. Rack the wine into bottles. Bottles can be sealed with either corks or screw caps. Corks require special tools to insert and run the risk of causing cork taint in the wine, but they are traditional and pleasing to the eye. Plastic top corks that can be inserted and removed by hand are also available. Reusable screw caps can make a good seal and are easy to use, but give the connotation of cheap wine to some people. If corks are used, the bottles should be kept upright for a couple of days to allow the release of pressure from the headspace of the bottle (caused by inserting the cork), the bottles should then be placed on their sides. If used bottles are to be refilled, they should be cleaned to remove any visible material and then soaked in 180°F hot water for 20 minutes. The key to reusing bottles is to immediately clean them after their use so no material dries on their inner surfaces.

Troubleshooting for Red Wine.

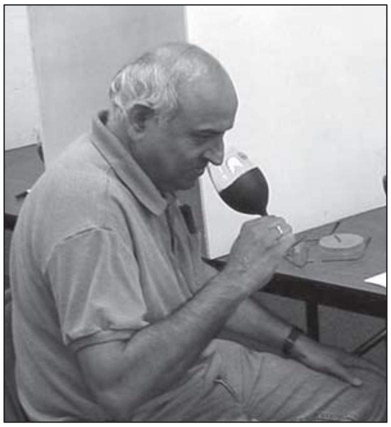
Brown color - is a sign of oxidation and is usually accompanied by a loss of fruitiness and varietal character. This usually results from excessive oxygen exposure and/or inadequate free SO_2 levels. Wine made from moldy fruit will often contain oxidative enzymes that are difficult to control with SO_2. To avoid oxidative browning, use clean, sound fruit, maintain adequate free SO_2 levels, keep containers of wine full to reduce headspace as much as possible, and use air locks (fermentation locks) and keep them full of water.

Vinegar odor - The smell of vinegar or finger nail polish in association with a wine is a sign of spoilage by acetic acid bacteria. These bacteria can be controlled by the avoidance of excessive oxygen exposure and the adequate use of SO_2. This type of spoilage can also be caused by lactic acid bacteria and yeast. The use of clean fruit and the addition of SO_2 to the must prior to the fermentation helps to reduce this problem. Keep containers of wine full to reduce headspace as much as possible and use air locks (fermentation locks) and keep them full of water.

Rotten egg odor - is caused by hydrogen sulfide, produced by yeast. This is usually a sign of fermentation stress for the yeast during the primary fermentation, caused by a lack of must nutrients or a temperature shock to the fermenting must. This may also occur if elemental sulfur is present in the must. Some strains of yeast are more prone to excessive hydrogen sulfide production than others. Hydrogen sulfide and its related compounds tend to mask the fruitiness in wine. The problem can often be avoided by using yeast nutrients, using properly prepared commercial wine yeast, and keeping proper temperature control of the fermentation.

Crystalline deposit - usually is a deposit of potassium bitartrate crystals. These can be removed by chilling the wine to around 32°F for several weeks.

Wine Tasting, Evaluation, and Storage



Wine Tasting. A 12 - 15 ounce tulip shaped glass is useful for the tasting and drinking of table wines. Red wine should be served at about 65°F and white wine should be served from 50 - 60°F. To taste the wine, fill the glass 1/3 or less full and swirl the wine around to get the molecules up in the air. Sniff the wine and savor the aroma and bouquet. To help you describe what you smell, you may want to obtain the wine aroma wheel developed at the University of California at Davis (Appendix 5). Taste the wine by taking some in your mouth and rolling it around your tongue. Note the sweet, sour and bitter tastes and the balance and body of the wine.

If you decide to grow grapes or make wine from those locally grown, the best way to learn what you like is to visit Missouri wineries and taste the wines in their tasting rooms. Sample, ask questions, and take note of what you like.

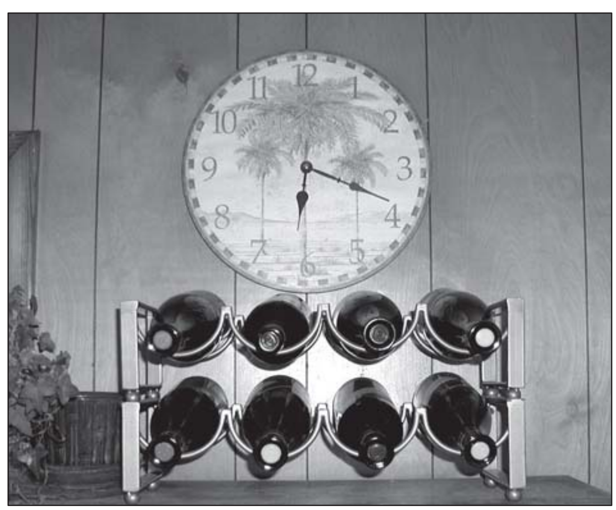
Wine Evaluation. The more you learn about tasting wine, the better you will be in evaluating your finished product. Whatever your level of ability, you need to spend some time critically evaluating your wine. As your skills in sensory evaluation evolve, you may devise a score pad or evaluation table that you can fill out for each wine you make.

First, evaluate appearance. Is the wine clear or cloudy. Is the color appropriate? A color of dark amber for a white wine indicates oxidation and is not appropriate. Brown color in red wines is also inappropriate.

Second, evaluate the odor or "nose" (aroma and bouquet) of the wine. Do you detect a nice, fruity nose. Do you detect any off-odors?

Third, evaluate the taste. Does the wine taste good? Are the major components in the wine balanced? Is the taste of the wine consistent with its style? A dry, red wine, for example, should not taste overly sweet.

Storing Wine. Home wine cellars can be quite elaborate or very simple. An area with a cool (about 60°F) and even temperature, out of direct sunlight, with relatively high humidity and away from strong odors and vibrations is ideal. Available now are small wine temperature controlled storage units, either freestanding or integrated into kitchen cabinetry. Wine cellars can be large rooms with temperature and humidity controls, a tasting area, and an extensive wine library. Most of us are content to find a cool spot in the home, out of direct sun, to store our wine. Be careful not to put your wine rack on top of a refrigerator or freezer that may vibrate and produce heat. Corked bottles should be stored horizontally so that the cork is kept moist. Screw capped bottles can be stored upright.



Appendix 1 TTB Regulations Sec. 24.75
Wine for personal or family use

(a) General. Any adult may, without payment of tax, produce wine for personal or family use and not for sale.

(b) Quantity. The aggregate amount of wine that may be produced exempt from tax with respect to any household may not exceed:

(1) 200 gallons per calendar year for a household in which two or more adults reside, or

(2) 100 gallons per calendar year if there is only one adult residing in the household.

(c) Definition of an adult. For the purposes of this section, an adult is any individual who is 18 years of age or older. However, if the locality in which the household is located has established by law a greater minimum age at which wine may be sold to individuals, the term “adult” will mean an individual who has attained that age.

(d) Proprietors of bonded wine premises. Any adult, defined in Sec. 24.75(c), who operates a bonded wine premises as an individual owner or in partnership with others, may produce wine and remove it from the bonded wine premises free of tax for personal or family use, subject to the limitations in Sec. 24.75(b).

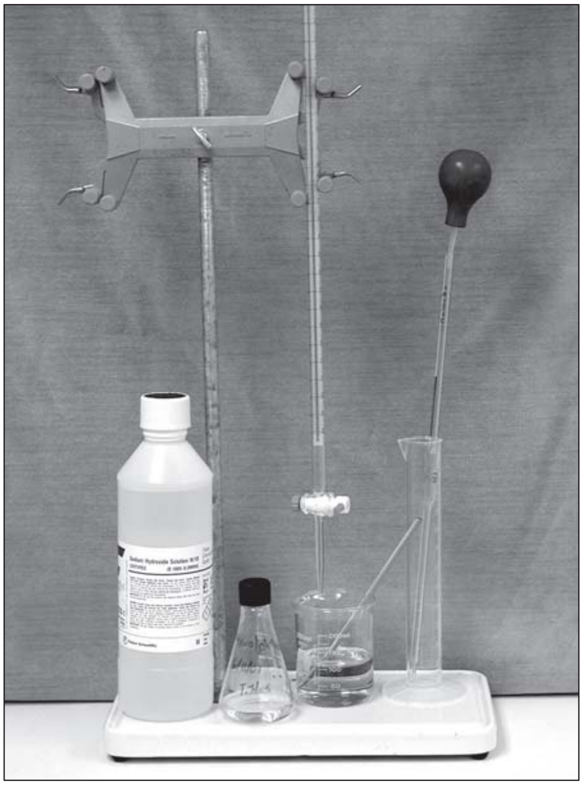
(e) Limitation. This exemption should not in any manner be construed as authorizing the production of wine in violation of applicable State or local law. Except as provided in Sec. 24.75(d), this exemption does not otherwise apply to partnerships, corporations, or associations.

(f) Removal. Wine produced under this section may be removed from the premises where made for personal or family use including use at organized affairs, exhibitions or competitions, such as home winemaker’s contests, tastings or judgings, but may not under any circumstances be sold or offered for sale. The proprietor of a bonded wine premises shall pay the tax on any wine removed for personal or family use in excess of the limitations provided in this section and shall also enter all quantities removed for personal or family use on ATF F 5120.17, Report of Bonded Wine Premises Operations.

(Sec. 201, Pub. L. 85-859, 72 Stat. 1331, as amended (26 U.S.C. 5042))
(Approved by the Office of Management and Budget under control number 1512-0216)

[T.D. ATF-299, 55 FR 24989, June 19, 1991, as amended by T.D. ATF-338, 58 FR 19064, Apr. 12, 1993; T.D. ATF-344, 58 FR 40354, July 28, 1993]

Appendix 2 Determination of Titratable Acidity



Equipment (can be purchased together in a titration kit from winemaking supplier):
300 ml beaker or large baby food jar
5 ml volumetric pipette
25 ml buret calibrated by 1/10 milliliters.
1% phenophthalein indicator solution
0.1 Normal (0.1N or N/10) sodium hydroxide (NaOH) solution
Rectangular base and clamp or buret support
Glass rod for stirring

Procedure

1. Fill the buret with 0.1 N NaOH solution.

2. Place 100 to 200 ml of recently boiled distilled water in 300 ml beaker or other suitable glass container.

3. Add about 3 drops of 1% phenophthalein indicator solution*.

4. Add in increments (titrate) 0.1N NaOH from the buret to the distilled water until you see a faint pink color. Stir after each addition.

5. Once the faint pink color remains after stirring, note the level of the NaOH in the buret and record this value (read the NaOH level in the buret at the bottom of the meniscus) or refill the buret to 25ml.

6. Add 5 ml of room temperature juice or wine to the distilled water using a 5 ml pipette.

7. Add in increments (titrate) 0.1N NaOH from the buret to the distilled water, stirring after each addition, until you see a faint pink end point in a white wine sample. A red wine sample will change several shades of green before it reaches the gray or otherwise murky colored (non-green, pinkish-brown) end point*.

Note the volume of 0.1N NaOH you used to reach the end point (subtract the end reading on the buret scale from the beginning amount that you recorded just before running the juice sample).

* If you have a pH meter, you can set the end point to 8.2 and then titrate to the pH of 8.2 instead of using phenolphthalein indicator.

Calculation

Tartaric acid is the main acid in grapes so the total acidity is expressed as percent tartaric acid.

The formula used to calculate % Total Acidity is as follows:

$$\text{Tartaric acid, g/100ml} = \frac{(V)\,(N)\,(75)\,(100)}{(1000)\,(v)} = \%\ \text{T. A.}$$

Where **V** = volume of sodium hydroxide used to titrate to the endpoint

N = normality of the sodium hydroxide (0.1 is recommended)

v = the volume of the juice or wine sample (5 ml is recommended)

If you use 0.1N NaOH and use a 5 ml sample of juice or wine as recommended, the formula is simply %T.A. = (V)(0.15) or literally the volume of 0.1N NaOH used to titrate to the end point multiplied by 0.15.

Juice for wine should have acid levels between 0.6 - 0.9 grams/100 ml tartaric (0.6 - 0.9% Total Acidity)

Appendix 3 Weights, Measures, Conversions and Other Information

Volume/Capacity

U. S. System
1 Gallon = 4 Quarts = 8 Pints = 16 cups = 128 Fluid Ounces

Metric System
1 Liter (l) = 10 Deciliters (dl) = 100 Centiliters (cl) = 1,000 milliliters (ml)

U.S./Metric Equivalents
1 Gallon = 3.785 Liters
1 Fluid Ounce = 29.6 Milliliters

Conversion Factors

To convert:	Multiply by:
gallons to liters	X 3.785
ounces to milliliters	X 29.57
liters to gallons	X 0.264
liters to fluid ounces	X 33.81

Weight

U.S. System
1 Pound = 16 Ounces

Metric System
1 Kilogram (kg) = 1,000 Grams (g) = 1,000,000 Milligrams (mg)

Conversion Factors

To convert:	Multiply by:
pounds to kilograms	X 0.453
pounds to grams	X 453.592
ounces to grams	X 28.349
kilograms to pounds	X 2.204
kilograms to ounces	X 35.273

Temperature Conversion

°Fahrenheit to °Centigrade - subtract 32, multiply by 5, divide by 9

°Centigrade to °Fahrenheit - multiply by 9, divide by 5, and add 32

Chemical Measuring Spoon to Gram Conversion Chart (subject to +/- 20% error)

Chemical	**1/4 teaspoon weighs:**	**1/2 teaspoon weighs:**	**1 teaspoon weighs:**	**1 Tablespoon weighs:**
Potassium Metabisulfite (powder)	1.5 grams	2.9 grams	5.8 grams	17.4 grams
Bentonite (powder)	1.0 gram	1.8 grams	3.5 grams	10.4 grams
Sparkalloid (powder)	0.3 gram	0.6 gram	1.3 grams	3.5 grams
Diammonium Phosphate (DAP)	1.2 grams	2.1 grams	4.4 grams	12.5 grams

Other

Parts per million (ppm) = milligrams per liter (mg/L)

To calculate ppm of SO_2 when using potassium metabisulfite powder (58% SO_2):

1 gram potassium metabisilfite = 30 ppm SO_2 in 5 gallons

1.5 grams (1/4 teaspoon) potassium metabisulfite= 45 ppm SO_2 in 5 gallons

Percent (%) = milliliters per 100 milliliters (ml/100ml) or grams per 100 milliliters (g/ml)

% sugar multiplied by 0.55 estimates the % alcohol you can expect after yeast fermentation

1 degree Brix = 1 degree Balling = 1% sugar

Water has a direct metric volume/weight relationship

1 gram water = 1 milliliter water

1 kilogram water = 1 liter water

15 pounds of grapes will yield about 1 gallon of juice

One bushels holds about 45 pounds of grapes and one lug holds about 15 - 20 pounds of grapes

One mature grapevine will yield about 10 to 15 pounds of fruit

Appendix 4 Terminology

Term	Definition
Alcoholic fermentation	The conversion of sugar to alcohol and carbon dioxide through the action of yeast. It is a heat producing reaction.
Amelioration	The addition of sugar and/or water to must or wine. This can also refer to adjusting the acid level.
Aroma	Grape derived odors in wine.
Balance	A term that describes how the parts of a wine blend together so that no one particular flavor or characteristic dominates, but all complement each other.
Body	This refers to the texture and "mouth feel" of a wine, light or heavy.
Bouquet	Odors in wine derived from processing and aging.
Brix	Term that expresses the percent sugar concentration in juice.
Buret	A graduated glass tube with a small aperture and a stopcock delivering measured amounts of liquid, used in acid base titrations.
Cap	Layer of grape solids that float on the surface during red wine fermentation "on the skins".
Carboy	A glass container with a narrow neck that comes in 3, 5 and 7 gallon sizes, used for making wine.
Citric acid	One of the acids found in grapes and wine.
Cold stabilization	Chilling wine before bottling to remove excess potassium bitartrate in order to prevent its precipitation in bottled wine.
Chromatography	An analytical procedure used to determine the levels of malic and lactic acid during malolactic fermentation.
Crushing	Breaking the skin of the berry to release the juice.
Dry	Wine without a noticeable sweet taste.
Enology	The science of winemaking.

Fining	A process to clarify, stabilize and/or modify wine quality by addition of agents such as bentonite clay, egg white, PVPP, gelatin and others.
Flavor	A term to describe the smell and taste of a wine.
Foxy	Musty, earthy flavor characteristics of native American wines made from *Vitis labrusca* grapes.
Free run	Juice or wine that drains without pressing.
Free SO_2	Sulfur dioxide ions in solution not bound to other chemicals and so are free to prevent oxidation, etc.
French-American hybrid	Hybrids or crosses between American cultivars of grapes and European cultivars of grapes. Also called French Hybrids.
Head space	The air space above wine in a closed container.
Heat stabilization	Removal of heat unstable protein.
Hydrometer	An instrument that measures the specific gravity of a liquid at room temperature. A sacchrometer is a hydrometer that is calibrated to read °Brix or % sugar.
Lactic acid	One of the acids found in grapes and wine.
Lees	Sediment.
Malic acid	One of the acids found in grapes and wine.
Malolactic fermentation	Conversion of malic acid to lactic acid by lactic acid bacteria.
Must	The term for crushed grapes and juice until the end of fermentation.
Nose	The odor of a wine composed of aroma, bouquet and other factors.
Oxidation	A wine disorder resulting from excessive exposure to oxygen. Browning of the wine is a result of oxidation.
pH	Measurement of H+ (hydrogen) ion activity.
Pipette	A narrow tube into which fluid is drawn by suction and retained by closing the upper end. A 5 ml pipette is designed to draw 5 ml liquid at room temperature.
Potassium metabisulfite	A source of sulfur dioxide (58% SO_2) for use in winemaking.
Pomace	Material remaining after pressing the must.
ppm	Parts Per Million. Milligrams/liter = ppm for example. One milligram is 1/1000th of a gram. One liter equals 1,000 milliliters (which in turn is equal to 1,000 milligrams of water by weight).

Punch down	Manually breaking and submerging the cap during red wine fermentation.
Racking	Separating clear wine from sediment or lees during production.
Reducing sugar	Fermenting sugars that will reduce copper upon chemical analysis.
Refractometer	Simple optical instrument that measures the amount a given solution bends light and so determines the amount of soluble solids in solution (sugars) by measuring the amount of bend on the Brix scale (distilled water = 0°Brix).
Residual sugar	Sugar left in the wine after alcoholic fermentation.
Stuck fermentation	Premature cessation of fermentation.
Sucrose	Table sugar added to wine that is not a reducing sugar. It is converted to glucose and fructose by grape and yeast enzymes and by low pH conditions.
Sulfur dioxide	An antiseptic that prevents spoilage and oxidation in wines when the concentration in the juice and wine is managed properly.
Tannins	Compounds in grapes and wine that impart astringent (pucker) and/or bitter flavor. Tannins are extracted from grape skins, seeds and stems. Oak tannins are extracted from aging in oak barrels or from oak additives.
Tartaric acid	The primary acid found in grapes.
Titratable acidity	Acid content determined by titrating must/wine with sodium hydroxide and following a formula. The term is commonly expressed as grams of tartaric acid per 100 ml or % total acid.
TTB	United States Bureau of Alcohol and Tobacco Tax and Trade Bureau. The Federal agency that regulates the production and sale of alcoholic beverages in the U.S.A.
Volatile acidity	Acetic acid content of a wine that is used as an indicator of spoilage. Vinegar.
Vitis aestivalis	A native American grape cultivar or variety.
Vitis labrusca	A native American grape cultivar or variety, with “foxy” character.
Vitis vinifera	A European grape cultivar or variety.
Wine library	A collection of wines where the location of the bottle in storage is cross referenced to information about the particular wine.
Wine thief	A hollow tube with tapered openings at both ends, that is used to extract samples of juice or wine from larger containers for analysis.
Yeast	Fungi that can carry out alcoholic fermentation.

Appendix 5 Resources

Gusmer*Cellulo*
Filtration, clarification and processing materials for the wine industry
Midwest
1401 Ware Street
Waupaca, WI 54981
(715) 528-5525
www.gusmerenterprises.com

Missouri Winemaking Society
To promote winemaking as a hobby and to develop an appreciation for wine
John Merkle
P. O. Box 158
Glencoe, MO 63038
http://www.mowinemakers.org/

Presque Isle Wine Cellars
Winemaking supplies and equipment
9440 West Main Rd.
North East PA 16428
(800) 488-7492
http://www.piwine.com

Prospero Equipment
123 Casteton St.
Pleasantville, NY
(800) 310-4305
www.prosperoequipment.com

Scott Laboratories
Products and services for producers of valuable liquids
2220 Pine View Way
P.O. Box 4559
Petaluma, CA 94954-5687
(707) 765-6666
www.scottlab.com

St. Louis Wine and Beermaking
Wine and beer making supplies
251 Lamp and Lantern Village
Chesterfield, MO 63017
(636) 230-8277
www.wineandbeermaking.com

The Home Brewery
Home brewing and winemaking supplies
1967 W. Boat Street
Ozark, MO 65721
(800) 321-BREW (2739)
www.homebrewery.com

The Wine Aroma Wheel
by Ann C. Noble
http://winearomawheel.com

Enartis (Vinquiry)
Analytical services, consulting & supplies for the wine industry
7795 Bell Road
Windsor, CA 95492-8519
(707) 838-6312
www.enartis.com

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Oakland, CA 94608-1239
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Cellar Notes:

Cellar Notes:

Cellar Notes:

Darr School of Agriculture

Missouri State Fruit Experiment Station • 1899

Missouri State

UNIVERSITY

MSU-Winery and Distillery

9740 Red Spring Road

Mountain Grove, Missouri 65711-2999

http://mtngrv.missouristate.edu