Class 2 - Vinification

Must Adjustments

Enrichment

In cooler climates, there may be insufficient natural sugar in the grapes to give the wine a satisfactory level of alcohol. In such circumstances, must enrichment (generally referred to as chaptalisation, after the Comte Jean-Antoine Chaptal, the Napoleonic Minister of the Interior who proposed it to support the French beet industry as he developed the technique for extracting sugar from beets) may be carried out.

The sugar is added to the must either before fermentation (to increase the end degree of alcohol) or during fermentation (to increase the end degree of alcohol to the desired level).

The process is forbidden in many warmer parts of the wine world and is strictly controlled where it is permitted.

If carried out well, chaptalisation may give a better wine.

If abused, it can ruin the wine by creating a wine that tastes hot and thin, because there is insufficient fruit to balance the artificially elevated alcohol.

Sulphur Dioxide (SO^2)

Sulphur dioxide is almost indispensable in the winery; it acts as an anti-oxidant and an antiseptic. It is a widespread practice to kill off the wild yeasts and the bacteria that the grapes bring with them on their skins before fermentation is started with cultivated yeasts. This minimizes the risk of off-flavours due to bacterial or fungal infections.

Sulphur dioxide may also be used to kill off the yeasts before they have consumed all of the sugars (generally this is employed in the making of cheaper sweet wines).

Sulphur is also useful after fermentation to prevent oxidation, stabilize the wine by killing off yeasts or bacteria.

Too much sulphur used can result in an unpleasant smell and flavour to the wine.

Most countries legislate the use of sulphur both in production and in the final product.

Acidification

The addition of acid where wines lack it, primarily in hotter wine regions is quite common with the addition of tartaric acid in powder form. Acidification generally occurs during or post fermentation.

De-acidification

De-acidification is more common in cooler climates; here excess acid may be neutralized by the addition of potassium bicarbonate or calcium carbonate (chalk).

pH and Total Acidity

pH is a scale (0 to 14) of measurement of the concentration of the active acidity in a solution (technically, pH is the negative logarithm of the all-important hydrogen ion activity or concentration). Low values of pH indicate high-acid, values near 7 are basically neutral, and values between 7 and 14 indicate basic or alkaline solutions.

Wines whose pH is between 3.2 and 3.5 not only taste more refreshing, but are more resistant to bacteria, age better, and have a clearer, brighter colour.

While possible to manipulate pH values, with grapes and wine it can be impractical because of wines high buffer capacity, which is a resistance to dramatic change in total acidity.

Total acidity (TA or Titratable acidity) is the measure of both fixed acids and volatile acids present in either grape juice or wine.

The total acidity of wines expressed as tartaric acid normally varies between 4.5 g/L and 8 g/L, although in practice it can vary between 3 g/L and 16 g/L.

Tannin

Tannin may be added if tannin levels are insufficient. Increased tannin levels can aid in the ageing potential of the wine, and help with colour pigmentation stability.

Yeast

Yeast are single-celled organisms that are integral to the fermentation process.

Within the yeast species are several hundred different strains or selections, each with real or fancied minor differences.

Yeasts metabolise sugars and creates alcohol and carbon dioxide as by-products of their function.

The waxy bloom on the outside of a grape skin may contain wild yeasts that can start the fermentation process.

If uncontrolled, the more abundant wild yeasts will start fermentation, but most generally die off above 4% abv.

Saccharomyces cerevisiae is the most common yeast responsible for the alcohol fermentation.

The winemaker may use wild yeast as part of the fermentation process (some believe it adds more complexity to the wine), but most use cultured yeast because the results are more predictable.

Among the many genera of yeast, there are an astounding variation in terms of the production and tolerance of:

Alcohol
Aroma and flavour
Rate of fermentation
Temperature tolerance
Flocculation characteristics
Sulphur dioxide tolerance
Reducing potential
Micro-nutrient requirements

Fermentation

Fermentation is the conversion of sugar into alcohol, with carbon dioxide gas and heat as the principle by-products.

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

In theory, the higher the sugar content of the must, the higher the resulting alcohol will be of the finished wine. However, yeasts generally die off when the alcohol content reaches 15%abv even if unfermented sugars remain, but some strains of yeast can ferment up to 18% abv.

High levels of sugar or alcohol can be toxic to yeast, as are some compounds fond in botrytis affected grapes, therefore some sweet wines may cease naturally at low levels of alcohol.

A winemaker may choose to have a sweet or medium-sweet wine by stopping fermentation via filtration or the use of sulphur.

The fermentation may also stop if temperatures become too high or too low or if the yeasts run out of essential nutrients.

A fermentation that stops unintentionally early is called a ‘stuck fermentation’.

Actual Alcohol (volume of ethanol) + Potential Alcohol (residual sugar) = Total Alcohol

Heat is generated during fermentation and will need to be controlled, especially for white wines.

White Wine Vinification

White wines have to be treated with more care in respect to oxidation. The grapes are pressed on arrival at the winery as colour and tannin are not required. Although sometimes a 3-6 hour contact with the skins is employed to impart more flavour and fruit character.

The juice is then drawn off the press and is sent to a vat or barrel; or a chilling tank for clarification.

Fermentation will normally take place at a temperature between 15C and 20C, but sometimes as low as 9C. The lower temperature is used to slow down the rate of fermentation to enhance fruit flavours and maintain a freshness to the wine.

Fermentation at temperatures that are too low can result in off-flavours, notably hydrogen sulphide (H_2S)

When fermentation is complete, the wine is racked off its lees and into another tank/vat or barrel.

Wines can also be aged ‘sur lie’ to add complexity and character.

Extended ageing on the lees can lead to yeast autolysis contributing a buttery, toasty, yeasty, brioche character.

Malolactic fermentation can soften further the acids in the wine.

Rosé Wine Vinification

There are a few ways to make a rosé (or pink) coloured wine.

Vin Gris: Black grapes are pressed directly and the juice is then fermented.

Abbreviated red wine vinification: Black grapes are crushed, macerated for 12 to 72 hours before the pale-coloured juice is run off/pressed and the fermentation is left to continue.

Saignée Method: A portion of the juice is run off at 12-24 hours, the lesser the contact, the paler the resulting wine. The remainder will be used to make a more concentrated red wine.

Blush: A blend of red and white wines. Note: This is forbidden in the EU for the use of quality rosé wine, with the exception of Champagne.

Red Wine Vinification

Red wines are almost solely made from black grapes, though it is popular is some regions to blend a small portion of white grapes in for acidity or aromatics (Viognier is commonly added to Syrah/Shiraz in Côtes-Rôtie and Australian Shiraz.

It is important that black grapes are picked in good condition and not affected by rot as this would impact the flavour and colour of the wine.

Classically, the grapes are destemmed and crushed, the resulting mass which includes skins and seeds is then put into a vat to ferment.

Some wines (notably Red Burgundy) are left to macerate for a period at a low temperature (4-8C) for a period before setting off the fermentation.

Fermentations should begin around 20C, but higher can be more common, temperatures in excess of 35C will cause the yeast to cease and die.

Ideal temperature for fermentation depends on grape variety and region.

Sometimes cooler-climate grapes are heated before fermentation, this encourages the skins to release their colouring matter and flavours to the maximum. The potential danger of this thermo-vinification is that it can lead to ‘cooked’ or ‘jammy’ wines.

Fermenting red wine will produces sufficient CO_2 to cause the mass of pulp and skins to float to the surface. If nothing is done about this, the juice will take on little colour and the objective is to extract as much colour and flavour from the skins as possible.

Pumping over (*remontage*) involves drawing wine off the bottom of the tank and pumping it over the top, this is normally practised at least twice a day.

Punching down (*pigeage*) traditionally meant getting into the vat and trampling the crust down which posed dangers of people overcome with by carbon dioxide. Now the same effect can be achieved with paddles or rakes (either manual or mechanical).

Rotary fermenters are modern devices where the red wines are fermented in horizontal tanks, which rotate, bringing the juice into regular contact with the skins.

The presence of skins makes fermentation in oak barriques impractical for red wines.

Length of maceration vary widely depending on grape variety and the desired style of wine. The longer the maceration, the more colour and tannin are extracted up to a point.

Colour extraction occurs most rapidly at the beginning of maceration and slows near the end. By contrast, tannin is released more slowly, so wines that are meant to be aged need longer maceration.

Extremely long macerations (30+ days) can result in wines with softer tannins as the tannin molecules are large and if in abundance will bind and precipitate out. But only red wines that are not prone to oxidation can handle the rigours of extended maceration.

After maceration, the wines are drawn off (free-run) and then the mass is pressed. Depending on the wine, sometimes the free-run only wine is used. Sometimes a portion of the pressed wine is added to the free-run to add tannin.

Malolactic fermentation (Malo or MLF)

Malolactic fermentation converts stronger malic acid into weaker lactic acid (and carbon dioxide), it is accomplished by lactobacillus bacteria which can be naturally present or can be cultured and introduced. It is often called secondary fermentation.

$COOH\text{-}CHOH\text{-}CH_2\text{-}COOH \rightarrow COOH\text{-}CHOH\text{-}CH_3 + CO_2$

Lactic acid, also known as milk acid, can impart a distinct dairy character to food and drink, and the malolactic process spins off chemical components that can have even more strange effects. Diacetyl, for instance, brings the strong "buttery" flavor to Chardonnay that some love and others despise.

Lactobacillus bacteria are also the key player in the fermentation process that turns fresh cucumbers into pickles and fresh cabbage into sauerkraut. It's not surprising, then, that excessive malolactic can add pickle or sauerkraut aromas to the wine.

Brettanomyces (Brett)

Member of yeast genera, naturally occurring on bloom of grapes.

Lends, earthy, farmyard, manure aromas to a wine

Can be considered a wine fault.

Sensitive to sulphur, so presence may indicate hygiene problems.

Once in cooperage, very difficult to eliminate.

Low-levels of Brett can provide complexity to a wine, and can be quite pleasant to some tasters.

Aeration

Must be carefully controlled during winemaking. (Oxidation can lead to acetic acid).

Part of barrel maturation.

Micro-oxygenation can benefit (soften) high-tannin wines (example: Tannat in Madiran.

Can remove unwanted compounds (hydrogen sulphide, mercaptans, etc…)

Often same benefits as decanting.

Oak Ageing

Oak is hard, supple and a watertight wood; that and its affinity for combining with wine, gives it a major advantage over other types of wood.

Oak is of the botanical genus of *Quercus:*

Quercus alba: American white oak. More obvious flavour, vanillin in character. Can be more astringent.

Quercus robur: variously known as French, English or Russian oak. Smoother, more subtle in character.

Top 5 oak producers:

1. United States (693.8 cu m)
2. France (422.7)
3. Croatia (178.0)
4. Hungary (104.6)
5. Bulgaria (79.4)

Barrique bordelaise: 225 litres. (most famous and most widely used type)
Burgundy: 228 litre
Hogshead: 300 litre (widely used in New Zealand and Australia)
Tonneau: 900 litre (equivalent to 4 barriques or 100 cases of wine)
Fuder: 1000 litre (used in Germany)

Fining

In winemaking, fining is the process where a substance (fining agent) is added to the wine to create an absorbent enzymatic or ionic bond with the suspended

particles, making them a larger molecule that can precipitate out of the wine easier and quicker. Unlike filtration, which can only remove particulates (such as dead yeast cells and grape fragments), fining is effective in removing soluble substances such as polymerized tannins, coloring phenols and proteins. Given enough time in a stable environment, many of these suspended particles would gradually precipitate out on their own. The use of fining agents speeds up the process at lower cost. White wines are fined to remove particles that may cause the wine to brown or lose color as well as removing heat-unstable proteins that could cause the wine to appear hazy or cloudy should it be exposed to high temperatures after bottling. Red wines are fined for the same reason but also for the added benefit of reducing the amount of bitter, astringent tannins which makes these wines smoother and more approachable sooner after bottling and release. Throughout history a wide range of substances have been used as fining agents, such as dried blood powder, but today there are two general types of fining agents — organic compounds and solid/mineral materials.

Winemakers can use the whites of eggs (discarding the yolk) as a fining agent

Organic compounds used as fining agents are generally animal based, which may bring concerns for a vegan diet. The most common organic compounds used include egg whites, casein derived from milk, gelatin and isinglass obtained from the swim bladders of fish. Pulverized minerals and solid materials can also be used as fining agents with bentonite clay being one of the most common fining agent used due to its effectiveness in absorbing proteins and some bacteria. Activated carbon derived from charcoal is used to remove some phenols that contribute to browning colors as well as some particles that produce "off-odours" in the wine.

As with filtration, there is the risk of some loss of flavor with fining due to desirable flavor molecules being precipitated out along with the more undesirable particles. Some producers of premium wine will do less fining or do it much later in the production process in order to leach as much flavor and aromatics from the phenols before they are removed. Still, fining is considered a less harsh process than filtration, with its advocates believing that it better mimics the natural clarification and stabilization process.

Filtration

While fining clarifies wine by binding to suspended particles and precipitating out as larger particles, filtration works by passing the wine through a filter medium that captures particles that are larger than the hole size of the medium. Complete filtration may require a series of filtering through progressively finer filters which can be expensive but will be considerably quicker than letting gravity naturally settle the wine and using racking to siphon the clear wine out. Most filtration in a winery can be classified as either depth filtration or surface filtration.

Depth filtration is often the first type of filtration a wine sees after fermentation when the wine is pushed through a thick layer of pads made from cellulose fibers or diatomaceous earth which traps the particles and can be removed from the wine. If the producers wish to further filter the wine, they may go to surface filtration. Surface filtration involves running the wine along a thin film of polymer material filled with holes tinier than the particles that are being filtered out. Running the wine parallel to filter surface (known as "Cross-flow" surface filtration) will minimizing the amount of potential clogging of the filter. Most membranes are made from plastic or ceramic. Another step in surface filtration, usually taking place right before bottling, is microfiltration where the fine is passed through a membrane with holes small enough to trap yeast and bacteria cells. An alternative to filtration is centrifugation where wine is put through a centrifuge decanter and gravity separates the particles from the wine.

The use of filtration is a controversial subject in winemaking with some producers feeling that the technique strips the wine of too much of its natural flavors and characteristics. Some producers will add the phrase "unfiltered" to their wine label as a marketing tool. Wine can go through a natural clarification and stabilization process by aging in a wood barrel where the subtle oxidative effects can aid in the precipitation of larger particles (particularly proteins and tartrates). This process takes time, however, and producers who bottle their wine too early, and without the assurance of sterile bottling equipment, can risk microbial contamination and instability. Wines that have not been filtered are much more likely to develop sediment as the wine ages.