What's in the bottle?

At its simplest; wine is just fermented grape juice. Left to itself a vat of grape juice will ferment, and may even turn into something resembling wine, but this is a rather hit and miss process and depends on exactly which micro-organisms happen to land in the sugary liquid. It won't stay drinkable for long either, as without some form of preservation wine rapidly turns into vinegar.

Since Pasteur discovered the role of yeast in fermentation, winemakers have learnt a lot about how to control the vinification process to ensure better and more consistent results. To understand exactly what you are getting when you open a bottle of wine, it's worth looking at the contents in two groups. First the components from the grape itself – alcohol, acid, tannins, flavours, colours, traces of minerals and enzymes, then second, the additives and processing aids. You will never see these on a label because EU law forbids ingredients to be declared on alcoholic drinks, but they have a role in preserving and stabilizing wine so it gets to the consumer in good condition.

Bugs and things

Yeast is the key to turning sugar in grape juice into alcohol. It gets its energy by feeding on the sugar and breaking it down into ethanol and carbon dioxide gas. It's a single-celled organism called *Saccharomyces cerevisiae* (literally sugar fungus) that carries out this tremendously useful transformation and it comes in many strains. Some varieties can be bought ready dried and are used all over the world, while others may be selected locally by an individual winery. Nowadays, there are plenty of bottles (especially upmarket New World wines) proudly proclaiming "Wild Ferment" on their labels. Many winemakers believe that using wild local yeast gives the wine more complexity and individuality than can be found in a bag of uniform commercial yeast. In reality, it's almost impossible to find *S. cerevisiae* in the vineyard, so most of these wild fermentations are started by different species of yeast (which tend to die around 5% alcohol) and then finished by wine yeast hanging around in the winery. Ed Flaherty at Errazuriz confirms that for his "Wild Ferment" Chardonnay, the yeast almost certainly arrives from other already fermenting vats. He feels that the extra complexity comes from the slower start to the fermentation – which allows other microorganisms to get stuck in.

The other important group of bugs is the lactic bacteria. Species like Lactobacillus and Leuconostoc use malic acid (the sharp acid in apples) as an energy source and break it down into lactic acid (the softer acid in milk). This process is called malolactic fermentation and helps to soften harsh acidic wines. It is also adds complexity, especially to neutral grapes like Chardonnay, as one of the by-products is a compound called diacetyl, which has a distinct buttery character.

Sugar

Sugar in wine comes from two sources - natural and added. A ripe grape contains 15 to 25 per cent sugars made up of glucose and fructose. The law in many winemaking areas, especially cool ones, allows winemakers to add sugar. The purpose is to increase alcohol in the finished wine, not to sweeten it, so it must be carried out before fermentation is complete. This sugar is usually sucrose from sugar beet or cane - just like common table sugar. However, in some countries like Italy, only concentrated grape must is allowed (a good way of subsidising some of the vast over-production of grapes in the south). This process is widely known as Chaptalization after Jean Louis Chaptal, one of Napoleon's ministers who first proposed it. Originally intended to make up for under ripe grapes in cold years, the problem is that it has become routine for many winemakers. For instance, Burgundy is often criticised for producing unbalanced wines with lots of alcohol but no real body or ripeness. The level of enrichment allowed is laid down by law, but there are always tales of supermarket shelves being emptied of bags of sugar around harvest time. It has not just a European practice either - adding sugar is banned in Australia, but permitted over the Tasman Sea in the cool damp climate of New Zealand.

Acid

Like sugar, the acid in wine may be natural or added during winemaking. It is essential in giving a fresh balanced flavour (t hink of crisp English Cox's apples, compared to flabby Golden Delicious). It also helps to stabilise colour and influence the growth of yeast and bacteria. The main acids found in grapes are tartaric acid, then malic acid (the same acid found in apples, with a crisp green taste) and traces of others. As grapes ripen and sugar levels increase, acid levels start to fall. Tartaric acid is a fairly stable acid, but malic acid is easily broken down, particularly in warm climates (warm nights are worst). The knack is for the winemaker to pick fruit with sufficient sugar, yet with enough acidity for freshness and balance. In hot areas, this is not always possible and many winemakers prefer to concentrate on ripe fruit flavours and then add acidity from a bag in the winery.

There are two ways of measuring acidity in wine. Total acidity is a measure of the actual quantity of acid present and gives an indication of how sharp a wine will taste. For the winemaker, the vital measurement is pH, which shows how stro ng the acid is (hydrochloric acid in your stomach is about pH 1, vinegar about pH 2.5 and tap water about pH 7). The pH affects colour stability, keeping potential and the flavour profile of wine, as well as the efficiency of preservatives like sulphur di oxide. For instance, Chilean reds often have a high pH (3.8 to 4.1) and taste very soft, even with lots of tannin. A typical Barolo may have a pH below 3.4 and taste much leaner and tougher at the same tannin level, but it should keep considerably longer .

Phenolics - Colours and Tannins

Most people are familiar with tannin in a cup of stewed tea - with its mouth-puckering effect on the inside of the cheek (it's actually starting to cross link protein in your mouth just as in leather-making). In wine, tan nins are part of a complex group of compounds called phenolics, which are found in the skins, pips and stems of grapes. These phenolics also include anthocyanins, which are the red, blue and purple pigments in black grapes.

The phenolics accumulate in th e skin of the berries as they ripen and, with very few exceptions, the grape juice itself is colourless. The key to making red wine is to extract the pigments from the skins and, at the same time, the tannins and other phenolics dissolve. Both acids and alcohol help to extract these compounds, so keeping the skins well mixed with the fermenting juice is vital for good colour and structure.

The anthocyanins quickly start to react with the tannins forming compounds called "pigmented tannins" which give red wine its colour. These "pigmented tannins" also contribute to mouth-feel, giving roundness and softness in mature red wines. Young tannins are typically bitter and astringent, but with time and encouraged by gentle exposure to air, these polymerise and drop out of the wine, thus softening the flavour. Provided there is sufficient fruit intensity, a good level of tannin gives wine ageing potential and allows it to keep long enough to develop the fascinating array of flavours so admired in mature bottles.

Wood

Wood has been used in winemaking for centuries and in spite of the arrival of concrete, fibreglass and stainless steel (via the dairy industry Down Under) it's still used today. When wood is mentioned, it's usually oak, though other timbers are occasionally seen, such as cherry in Valpolicella, chestnut in Portugal and an evergreen beach called Rauli in Chile.

Wood is used for two main reasons in winemaking. First, it allows gentle oxidation and this helps to stabilise and clarify the wine. This also helps to soften the tannins and develop complexity and mouth-feel. Secondly, for the first two-to-three years of their life, oak barrels give flavour to wine. Vanillin, with its obvious vanilla character, is easily extracted from oak, along with other compounds giving aromas ranging from coconut to toasty smoky tones.

Oak barrels are expensive, costing from £150 to £400 each, depending on the type of wood, and the standard size - a barrique - holds just 225 litres. This has led to the development of cheaper solutions to satisfy the perceived demand for oak flavours. Oak chips (still strictly illegal in the EU) are widely used and the word "oaked" on the label is a giveaway. A giant mesh "teabag" of oak chips is dropped into the vat, giving oak flavour quickly and cheaply, but without the benefit of gentle oxidation. Another development is the use of inner staves, where whole planks are lowered into the vat and the quality of the oak is more controllable. Barrels are still regarded as the ideal by those top wineries that can afford them, but increasingly skilful use of these other techniques is making oak flavours widespread in inexpensive wines.

Flavour

Many drinkers wonder why wine doesn't just taste of grapes and why florid descriptions like "barrow loads of Ugli fruit" are used by certain TV wine personalities. To understand the flavour of wine, it's also important to realise that that most of what we taste is actually smell (think how boring food is with a heavy cold and a blocked nose). The process of winemaking transforms the simple grape flavours found under the skin, into an array of several hundred chemicals, and each grape variety has its own unique combination. Many of these chemicals are identical to those found in other fruit and foods, so it seems perfectly reasonable to use these terms to describe wine. For instance, raspberry ketone and zingerone are found in Shiraz (raspberries and ginger) and methoxypyrazines give green pepper, asparagus and gooseberry notes to Sauvignon Blanc and Cabernet Sauvignon (and are also found at the greengrocer). Monoterpenes give floral aromas and appear in Muscat, Riesling and Gewurztraminer. Flavour and aroma can also come from the winemaking itself. Beaujolais Nouveau gets its personality from the short-lived bubblegum-like esters produced during fermentation, while bottle-fermented "fizz" gets much of its character from the breakdown (or autolysis) of dead yeast.

Maturing wine alters flavours too - simple berry characters and fermentation notes give way to what is often described as complexity. This is shorthand for a huge array of flavours needing many descriptions. The actual chemical reactions are complex and unpredictable, but depend on the starting material, method of winemaking, maturation in wood or bottle and storage conditions. An imprecise science, but a fascinating one to follow.

Sulphur Dioxide and Other Preservatives

Sulphur Dioxide has been the winemaker's friend since Roman times. It's easily produced by burning a piece of ye llow sulphur, but has a bad reputation, as it has been associated with breathing problems in asthmatics. It is present in all wine as it forms naturally as a by - product of fermentation, but only in small amounts. Almost all winemakers add it – it's virtually impossible to make wine without it - or at least one that stays drinkable for very long. Wine turns to vinegar very quickly without protection and sulphur dioxide (usually added as a sulphite for ease of handling) is almost a magic cure all. It acts as an antioxidant and mops up stray oxygen before it can damage the wine; it kills stray bacteria and wild yeast; it also inhibits enzymes from rotten grapes that can destroy colour and flavour and it can even freshen wine already damaged by exposure to a ir. The problem comes when it is used to excess because it has an unpleasant aroma of struck matches that catches in the throat and spoils the bouquet. There are legal limits to the total amount of sulphur dioxide permitted, but the real knack is to use just enough to keep the wine fresh until the consumer gets it.

A couple of other preservatives are sometimes found in wine. Vitamin C (Ascorbic acid) sounds quite benign. It acts as an antioxidant, but must be used with sulphur dioxide or it will turn brown itself and actually make oxidation worse. Sorbic acid (and Potassium Sorbate) inhibits yeast, but properly handled wine should not contain any live yeast, so it is just an excuse for sloppy winemaking.

Fining

Most wine drinkers expect a glass of wine to be bright and clear, but just after fermentation, there's often a lot of cloudy suspension in a vat of young wine. With patience, much of this settles out naturally, but most wines nowadays are fined and filtered to speed this process up. Filtration is literally a process of "sieving" small particles out of the wine, usually via a membrane filter with tiny pores (as small as 0.45 microns). Some particles are too small to physically remove (like the cloudiness in milk), so fining is used. This depends on the fact that the tiny particles or colloids usually have positive or negative charge, so a fining agent with the opposite charge is selected. The opposite charges attract each other and the colloids clump together and become heavy enough to sink and remove. Typical fining agents include egg white (they eat a lot of omelettes in Bordeaux), casein (a milk protein), isinglass (from fish swim bladders) and bentonite (a special clay). Often vegetarians and vegans are concerned about consuming animal products in their wine, but the point about fining agents is that they do not remain the wine once they have been used – they are just a processing aid. However the trick is to look out for wines fined with bentonite to avoid any animal products altogether.

Organic wine

"Organic" is the buzz word nowadays and so called "organic wine" is jumping on the bandwagon. Strictly, there is actually no such thing as organic wine, but only the cumbersome description "wine made from organically grown grapes" is allowed. As yet there is no organic standard for winemaking itself - though numerous organisations have their own set of rules.

Organic farming was defined in 1981 in France as "farming that uses no synthetic chemical products." Grape growers must therefore rely on good cultivation, cover crops, manure, compost and encouraging natural predators. Some naturally occurring chemicals are allowed, such as sulphur powder and Bordeaux mixture (a fungicide based on copper sulphate and lime).

It's much easier to grow grapes organically in warm dry climates such as the Rhone Valley, Languedoc and California. In Chile, dry air and natural mountain barriers mean there are very few pests and diseases, so many producers are planning to move to organic production. Carmen is leading the way (winemaker Alvaro Espinoza keeps a herd of alpacas for manure and makes his own compost and herbal brews). Nearby Veramonte also has an organic plot and use composted tea-leaves from an instant tea factory as part of their armoury.

Biodynamic viticulture is an extreme development of the natural approach and uses ideas like following lunar phases and homeopathic "remedies" for vines. This is too much for most grape growers, but there's definitely a widespread move towards a more sustainable approach - after all this is just a return to tradition.

Residues

Today's consumer is ever more aware of green issues and agrochemical residues are a significant concern. Some pesticides have been linked to increased occurrence of cancer while others can mimic female hormones. For most grape growers, the use of pesticides, fungicides and herbicides in the vineyards has become virtually an essential practice.

All synthetic products approved for vineyard use have been tested for residues left in the environment, and on the fruit, and a withholding period is specified between the last treatment and harvest. In theory, this should prevent pesticide residues reaching the wine – though it may depend on enough rain to wash the berries clean. Pesticide levels will also fall during pressing, settling and clarifying of the juice.

A major concern to the winemaker is the effect any agrochemical residue may have on the fermentation. Yeast is particularly sensitive to fungicide and recent research in Canada has shown that fungicides in the juice can delay or prevent fermentation. In these experiments, the presence of pesticides also caused unpleasant chemical taints to develop during winemaking. The next stage of this research will look at the actual occurrence of pesticide residues in more than 3,000 juices and young wines, and should be very revealing about the true occurrence of contamination in the real world.

A poet once said, "the whole universe is in a glass of wine". He may not have been strictly accurate, but wine is much more than alcoholic grape juice. The secret behind great wine is not just its ingredients, but getting the balance between all of them just right.

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