# Wine to Cellar: A guide to aging and cellaring wine – Part 1
# By John Gifford – Cellar Master

**History of wine cellaring**

The modern temperature controlled wine cellar can trace its origins back to a time long before there was refrigeration and cooling systems. There is archaeological evidence that ancient civilizations in Georgia and Iran were making and drinking wine as early as 6000 BC.
One of the main driving forces for the development of storing wine was the increasing production and its increasing geographic distribution. The earliest evidence of stored wine comes from 7000 year old pottery jugs that were buried in the dirt floor of a Neolithic kitchen in Iran. The Romans used catacombs, and subterranean cemeteries beneath their cities to store their wine.
Not until the sixteenth century was any semblance of modern wine management in evidence. Vintners were beginning to understand that wines exhibiting high levels of acidity and flavor components aged well, they also realised that a barrel needed to stay filled completely to fight destructive oxidation. Large casks of top-quality German Riesling were diligently preserved because these wines exhibited the correct balance of sweetness and acidity and were being kept in cool cellars, with constant topping up. Henry VIII of England imported wines from all over Europe particular Anjou, Gascony and Burgundy – but these came in barrels. Many sixteenth century wines did not keep well, and of those that did had an alcohol content of up to 17%. The King spent a fortune keeping his court in wines – up to 300 barrels a year. Not only was this volume required for his lavish entertaining, but as these barrels were emptied, resulting oxidation quickly deteriorated the wine, hence the need for so many barrels.
The seventeenth century development of storing wine in corked bottles was the real break-through in the aging of wine. Glass bottles are impervious to air and corks offer a good seal that allows very small amounts of air to enter the bottle over many years helping the aging process, and subsequently led to the actual shaping of today's cylindrical stackable bottle. The use of corked bottles quickly led to the re-application of drinking aged wine, as wine drinkers once did during the roman Empire, when the use of the amphora allowed extended aging.
The French began the practice of digging wine caves designed specially to store their wines.

**Why age wine?**

Wine is one food or beverage that has the potential to improve with age – though not all wines will get better. Of all the things that make wine wonderful and more alluring it is its potential to age. No other food product is expected to improve with age as is wine – no matter how good your crayfish thermidore is today, it will not be better in 20 years times – compare this to a bottle of Te Mata Coleraine 1998 or Chateau Petrus 1982 which will age for twenty or fifty years respectively.
The age-ability of a wine is what makes its reputation soar – but not every wine is made to age and not every wine is supposed to age.
That certain wines must be aged to achieve peak quality is perhaps so pervasive in the general public's consciousness that it can be considered common knowledge. Many people know that wine must be stored in a certain manner, though few can recite the details and fewer again understand the science behind aging, which in part explains why so many people underestimate the importance of proper wine storage.
Storage or aging wine is both a science and an art. The science of chemistry drives the aging process and some of the reactions are well understood. But cellaring wine is also an art as wine composition is diverse and complex and it is extremely difficult to predict the end result that aging will have on any particular wine. So

there is an element of mystery with many wines, especially those produced by the artisan winemakers, which in turn creates the allure of wine. There are no guarantees when it comes to aging wine. We have all been pleasantly surprised by wine that should never have improved with age (but did), and vice versa.
Although common knowledge and the science confirms the need for good storage conditions – many collectors or wine aficionados cut corners. Why do they do this?
Partially to blame is the fact that we have all enjoyed some pretty good wines brought up in "bad" neighborhoods. But we tend to only take note only when something is not as good as we would have liked or desired. Generally, this is moderately rare in our temperate climate for wines stored for less than 3-5 years. But the negative effects of improper storage can not be avoided – over time poor storage will always have an effect on the wine's flavor and bouquet. Sometimes the effect is subtle, and at other times it can be very pronounced. But even drastic changes may go unnoticed. Our taste buds have weak memories and unless you have a sample of properly stored wine on hand to compare, often it's a case of "you don't know what you are missing".
So what is proper storage?. First let us look at the basics. All wine is perishable. Unlike whiskey there is insufficient alcohol in wine to prevent it form going bad over time. Storage requirements are a function of the type of wine and its intended use. Fine wine destined for 2+ years of storage and eventual consumption by people with an interest in wine requires much stricter control that a bottle of table wine destined for the next months spaghetti sauce.
The wine aficionado is however looking for something different - wines that improve with age and that may only reach their potential after 5, 10 and up to 25 years and beyond in the bottle. Remember it is not to have an old bottle of wine, it is to have a wine that tastes and has an aroma (and if matched with food) that provides a unique and personal experience.

**The science of aging**

Throughout time many factors have been attributed to the age ability of wine. Sugar obviously has something to do with the amazing life expectancy of sweet-style German and French Rieslings and Saturnes. Also acidity has a role in extending the life of wine. High alcohol contributes to stablising wine so that their hidden charms can surface.
But wine science over the last two decades has zeroed in on the role of phenolic components as some of the most important agents which assist with aging, at least for red wines. With the key players being complex polymeric combinations of anthocyanins and tannins that develop over the first few years of aging which in turn contribute an anti-oxidant role for the years following. Apparently, it is not so much that pigmented polymers prevent oxidation, rather they promote and are in part a result of good oxidation, combining with oxygen in a way that controls aging rather than encouraging deterioration.
These same polymerized tannins also contribute to mouth feel. From firmer and more astringent to softer and rounder. Even though bigger, long-chain tannins are generally more astringent than shorter forms, the polymeric phenols somehow find a way to become less obvious (ie as the degree of polymerization continues).
Researchers, Andy Waterhouse of the University of California at Davis and Jim Kennedy of Oregan State University admit they don't know exactly what the role of polymerization of tannins is – but where the total phenolic concentration is greater than 2.5 grams per litre this tends to indicate the wine has potential to age.
As said before, acidity and its counterpart, pH, also play a role in age ability. The benefits of high acidity or low pH are creating an environment not favourable for spoiling microorganisms, thus preventing the wine

going bad before it turns good. For white wines that are not fermented on their skins, acidity and pH are critical. Volatile (fruity flavoured compounds) can be lost due aging which gives the wine less emphasis on fruit flavours and more on the secondary compounds that usually add complexity and subtlness.
This to a certain extent explains why some high acid Rieslings live for ever and why higher acid Chardonnays from Burgundy may age better than lower-acid Chardonnays from California. However, this contrasts to the observation that Semillon tends to age better than its common higher-acid blending mate Sauvignon Blanc and similarly, relatively low-acid , high pH Marsanne which ages better than high acid, low pH Roussanne among the Rhone whites.
Ask a winemaker – "what makes wines age well" - and you will not get a citation on phenolics – but you will hear about balance – which means no one characteristic of the wine sticks out – with the underlying theory being that if a wine is out of balance now – then it will still be out of balance in 10 years time. A perfectly aged wine will have an optimal combination of three things: fruit flavours, fermentation flavours and aging flavours. Whether this takes a year and a half or more than 10 years depends on the bottle and the condition is it kept in. Understanding the science behind wine aging can't provide a magic formula that tell us when to open that particular wine but it does help us understand why it needs to be kept under controlled conditions – if it was good enough for the Romans 5000 years ago, then it is likely to be the right thing to do today.
There is more to the science of aging however, than meets the eye as knowing or at least knowing something about the age ability of wine may assist in preserving a wine - but this is not the same as knowing how it will taste in ten to fifteen years down the track. It is possible to make a reasonable wine – to find that it is still reasonable a decade down the line – though perfectly preserved. It is also possible to have a promising wine get less interesting over time – we do not like old wines because they are old – we like them because their aroma and taste is something quite extraordinary. So there must be something else in a wine, some stuffing, some great fruit, something that is hard to quantify but worth preserving. It is one of those things you know when you taste it, but can't produce the formula for.
Sue Ebeler, flavor chemist at UC Davis, says we aren't at the point where we can predict tomorrows sensory profiles from todays chemical composition – there are just too many complex interactions that affect perceptions. A lot of things we like in older wines develop from precursor compounds in the young wine – and these precursors may not have any volatile sensory properties that we can pick up on. When we age wine we hope for change that causes the wine to mature well by gaining a complex mix of complimentary flavours. As the chemical reactions that take place during aging vary between grape varietals, regions and even crops from year to year, they are not easily quantifiable.
It is theorized that grapes evolved aromatic compounds as a means to entice pollinating insects, and it is lucky for us that they did, for without the primary aromas from the grapes, the chemical reactions that take place during aging would have no materials to work on and we would never end up with tertiary flavours like leather, earth, nuts that give aged wine its complexity.

**Aging to correct the characteristics of wine**

Aging of wine can also assist in correcting wine problems or specific conditions. Under some circumstances it may be desirable for some of the volatile esters to be lost through aging as they are to dominating of the wines character and therefore are masking other desirable flavours, or they are simply not desired to give the final required flavor. Such ester flavours are largely of microbial origin and not

derived from the grapes and are therefore not components of the varietal character. Where the goal is to produce a true to type varietal wine, esters may detract from the perceived quality of the wine.
Allowing aging or time to loose fermentation or microbial characters so that the varietal character is more dominant is also an example of aging to achieve a certain style.

Oxidation and Reduction in Wine
Oxidation and reduction reactions are important components of wine aging. Oxidation is where there is an increase in the oxidation number and an apparent loss of electrons by an atom, molecule, compound or ion. Reduction is the opposite, the apparent gain of an electron. Chemically oxidation and reduction must be balanced, so for one compound to be oxidized another must be reduced. Oxidation is important in some wine styles such as Sherries and Ports. It is considered a defect in many other styles, particularly white wines. For most wine styles there is an optimum level of oxidation and then further oxidation detracts from the wine's quality. This may be due to simple loss of complexity or to the appearance of undesired compounds. It is difficult to predict the optimum oxygen exposure for a specific wine. How a wine responds to oxygen is dependent upon the wine composition.
When oxygen reacts with alcohol, it creates acetic acid or vinegar. Oxidation also affects the colour of wine with wines turning brown when in contact with air. Aged red wine is naturally brick-coloured and aged whites tend to be golden brown - but too brown colours is undesirable. Wines with high acid tend to brown less so are better wines to store or cellar.
In addition to having a range of adverse effects on wine, oxidation also helps the fruity flavours of a young wine to fade and combine with tannin derived flavours from barrels. Age wine more and it will develop earthy, nutty flavours alongside the fruity ones.
The oxidation of tartaric acid creates some of the tertiary aromas that eventually form the kind of bouquet that wine connoisseurs will pay top dollar for. Decanting wines into a wine decanter encourages oxidation and can improve a young wine's flavour profile.
Esters
Esters are one kind of compound that contributes to the wine's aroma. Esters are created when the alcohol in wine reacts with the acids. The type of yeast used during fermentation plays the major role in determining what kinds of esters are produced during the process of esterification. Hydrogen, which is more abundant in wines with greater acidity, encourages this reaction to take place. Interestingly, the presence of hydrogen can also make the reaction reverse, turning esters into alcohol and acid. This complex reaction is one of the ways in which wine could be called a living, breathing organism: the give-and-take between esters and their primary compounds means that the flavours in wine are constantly changing. The ester in a Chardonnay opened after 2 years might taste of pears. After 5 years, it may have developed into a distinct buttery flavour.

**Tannins and Other Phenolic Compounds**

Phenolic compounds are the chemicals responsible for many of the tastes and aroma we perceive in all foods. At this point, it is important to clarify that since your taste buds can only detect the five basic flavours of salty, sweet, bitter, sour and umami, the oaky notes you are tasting in your wine are really aromas picked up by your olfactory receptors. The phenolic compounds present in a bottle of wine slowly change as it ages.
There is more than one type of phenolic compound, but most important to wine aging is tannins.
Have you ever opened a bold, rich wine, such as a Cabernet Sauvignon, and taken a sip, only to be rewarded with a dry bitter taste than makes your mouth pucker? For that unpleasant sensation, you can thank the wines

tannins. Tannins like to bind to proteins (which is why red wines go well with red meats). When we drink wine that contains tannins, these compounds bind to the proteins in your saliva, inhibiting the saliva's ability to lubricate the mouth, and causing that puckering, astringent feeling. As the wine ages, the tannins polymerise - reactions that allow the tannins to bind together to produce longer molecular chains. Once bound together, the tannins may fall out and create a sediment, lose their ability to bind with other compounds, and the aged wine loses it astringent qualities and starts to taste softer and more mellow.

If tannins cause astringency, then why put tannins in a wine to start with and start with a wine that is more mellow? Winemakers do often take care to do just that by crushing grapes gently to limit the amount of tannins released from the skins, seeds and stems - these tend to be the not so good tannins which to not readily polymerise. However, more desirable tannins come from oak barrels, once aged and bound together give wine the qualities of smoothness and suppleness. Tannins not only bind to one another, but also to other compounds which reduces their evaporation and so helping the wine to hold its old flavours as it gains new ones which in turns build a wine's complexity. The tannins also assist in avoiding oxidation therefore preserving the wine.

Sotolon is a lactone and an extremely powerful aroma compound with the typical smell of fenugreek or curry at high concentrations and maple syrup, caramel or burn't sugar at lower concentrations. In wine it is known to be responsible for premature-aging flavor in dry whites. Sotolon generally results from mild oxygenation during bottle aging and until now its formation pathways has not been elucidated. Sotolon was found to be produced by the oxidative degradation of ascorbic acid.