

Wine 202: Adding a Bit of Scientific Rigor To the Art of Understanding and Appreciating Fine Wines

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Abstract

The murky history, local traditions, customs of wine making, and the lineage of vines and wines often confuse those who appreciate wines. One wine variety may have many different names. Conversely, the name of a wine may be the same in several locations, but the wine and vine may be totally different. A history of viniculture and why it is so convoluted are briefly discussed. The fickle characteristics of the vines explored; the diseases that almost destroyed the industry explained; several common misconceptions dismissed; and 20th Century efforts to rigorously identify vines and wines are briefly discussed. Rigorous efforts to understand the innumerable sensations of appreciating wines will be presented. Three individual experiments to better understand one's palate and food and wine combinations will be described.

History of Viticulture

Unlike beer, which is made from the invented process of brewing, and unlike distilled spirits, which are made from the invented process of distillation, wine is made from the natural process of fermentation. Since the advent of fruits, wild yeasts have attacked ripe fruits resulting in the conversion of the sugars into alcohol. Although the fruits and the yeasts may differ, and the process refined somewhat, this natural process of making wine is largely unchanged.

Man had no doubt observed apes, elephants, birds and other animals enjoying the natural fermentation of fruits. So one may conclude that man has also enjoyed the products of this natural process since his existence. Since grape juice ferments quickly, in a day or so, to make wine from wild grapes man did not need to discover agriculture. Although the evidence is not conclusive, based upon masses of skins and seeds and other evidence in Paleolithic sites, some archeologists have concluded the nomadic man probably made wine using leather bags for containers.

Of all the species of grapes, the most suitable for making wine is the species *Vitis vinifera*. Its thin skin and high sugar content permits rapid fermentation to an alcohol concentration that preserves the juice from readily spoiling. It is believed that this species originated in the Transcaucasia between the Black Sea and the Caspian Sea in what is now Georgia and Armenia about one million years ago. Since it takes three years for a vine to produce wine grapes of quality, viticulture requires a fully

sedentary way of life that is more complex than grain farming and stockbreeding. Like all fruit crops, viticulture requires planting, grafting and pruning. To achieve consistency, propagation of the plants is accomplished not by planting seeds or pollination in the wild, but by taking cuttings and planting them and by grafting cuttings onto existing rootstock. Clonal selection is important. Viticulture benefits from having consistency through generations of farmers. It is thought that by the Fourth Millennium BC viticulture was established in Transcaucasia in the area of present day Armenia and Georgia. The sub-species of grape that was cultivated and improved upon is *Vitis vinifera silvestris*, which is still found growing wild there. All major varieties of European wines are from this one species that has undergone six millennia of genetic modification by cultivation and selection. The remarkable consistency of leaf shape, the relatively large berries with high sugar concentrations and the fact that when abandoned vineyards revert back to the feral *Vitis vinifera silvestris* tend to verify this conclusion.

Physical evidence of viticulture is usually based upon archeological findings of masses of grape skins, various tools used in cultivation such as pruning knives, stone presses and crushers, drinking vessels, and the different shape of the stems and pips of cultivated vines vs. feral vines. The pips (seeds) of the feral vine tend to be more globular with a shorter stalk than the cultivated vine that has more oval pips with a longer stalk. There is physical evidence, in the form of cultivated grape skins and pips, that viticulture spread to Egypt and Mesopotamia in the 4th millennium BC and to Crete about 3000 BC. The earliest hard evidence of viticulture is an amphora discovered at Godin Tepe in the Zargros Mountains, near Kangavar in northwest Iran, dating to 3500 BC that appears to contain a red wine stain of tannins and tartaric acid. The Code of Hammurabi, King of Babylonia, (c. 1750 BC) contains the earliest references to the regulations of wine and wine shops. In Mesopotamia, in which Hammurabi became king, the name for wine was “liquor from the mountains” which tends to confirm that *Vitis vinifera* did not grow well in the hot, humid climate of Mesopotamia.

A major puzzle of the history of viticulture is evidence of viticulture on the Mediterranean Coast of Spain south of Valencia as early as the 4th millennium BC. Was this associated with the development of viticulture in Asia Minor? No one knows. What is known is that, first the Phoenicians, then the Greeks, helped spread viticulture throughout the Mediterranean and to the Rhone Valley of France. The Etruscans first established viticulture in northern Italy, then the Greeks established

it in southern Italy. The Romans adopted viticulture and when their legions marched through Europe, they literally carried vine cuttings on their backs. Viticulture was already established in the Rhone Valley, but the Romans help spread it to Germany and then to England in the 3rd Century where it flourished for a while, then receded during the cooling in the Dark Ages, once again flourishing during the Medieval Optimum as far north as 54° N Latitude, until the Little Ice Age killed off the vineyards in the 1300 and 1400's. The northernmost vineyards in Germany where it extended even to the Baltic States survived it bit longer but were also killed off by the Little Ice Age. Since then in Europe, until the advent of modern techniques to address harsh winters, the northern most reach of viticulture generally is 51° N Latitude. In 1980, based on old winery records in central Europe, C. Pfister has estimated that the growing season in the High Middle Ages was up to one month longer than in the 20th Century.

Amazingly, the vast varieties of major wine grapes considered native to Europe that are now planted elsewhere in the world stem from one parent plant -- the *Vitis vinifera silvestris*. I found no numeration of the number of varieties, but there are over several thousand. The National Institute for Agriculture Research, near Montpellier, France maintains a collection of more than 2,000 varieties. The government of Spain has classified over 650 with at least several hundred others remaining. Portugal must have several hundred. The number of varieties in Italy, Greece and the Balkans are unknown. And Georgia, alone, has over 500.

A Particular Variety -- Pinot Noir

With thousands of varieties of vines from one parent species, one would expect certain problem children. Certainly one problem child is Pinot Noir – the great red wine of Burgundy. It is a very old vine. It was probably the cultivated vine grown by the Allobroger tribe in the Burgundy area when the Romans came. Both Pliny and Columella described it in the first century (called *Vitis allobrogica*). This is a notoriously difficult vine to grow because it self-mutates. Among the more dramatic mutations are the Pinot Meunier (which is used in Champagne), the many Pinot Blancs, and many Pinot Gris (the latter two varieties are used to make white wine). Further, some experts estimate that there are over 1,000 types of Pinot Noir grown in Burgundy alone and perhaps 200 in Oregon alone.

No one has established generally acceptable taste and aromas for Pinot Noir. When it is planted in different climates and soils, the resulting wines are frequently dramatically different. They may vary from austere and complex, to heavy plum jam,

to little or nothing. To make matters worse, the vine dies young – usually within 40 years. When a vineyard owner must replant, he does so with trepidation, for the wine produced from the new plants may differ dramatically from the wine produced from the old plants. As may be expected, differences in this one variety are most dramatic in Burgundy. Most of the vineyards are small, one can throw a rock across many, yet the wines from one vineyard can vary so dramatically from the wines of its neighboring vineyard that one wonders if the wine is produced from the same grape variety.

Recent DNA research at the University of California, Davis, has shown that the Pinot Noir vine has spontaneously crossbred with the obscure Gouais Blanc, a mediocre variety, to produce 16 venerable wine-grape varieties, including the renown Chardonnay, Aligote (a white wine grape in Burgundy) and Gamay Noir used to make, among other wines, Beaujolais. The Gouais Blanc is considered so poor that no commercial vineyards plant it and several attempts were made as early as the Middle Ages to ban the planting of the vine.

A Particular Variety -- Cabernet Sauvignon

By contrast with Pinot Noir, most experts agree on distinctive tastes and aromas of Cabernet Sauvignon: a high concentration of black currants (cassis) and cedar wood. Cabernet Sauvignon has a remarkable concentration of phenolics (complex aromatic compounds made of benzene-OH units). The vine travels well and produces excellent wines with remarkable structure in a great variety of climatic conditions and soils. To add further interest, the wines have subtle changes in aroma and taste depending on the *terrier* and the wine makers skill. *Terrior* is a French term for which there is no appropriate English equivalent. It relates primarily to local soils, topography, direction of the slope to the sun, climate and microclimate. As the wine is properly aged, a large variety of subtle flavor compounds evolve yielding a wine of enormous complexity. Together with Merlot, Cabernet Sauvignon is the classic red wine vine of Bordeaux, and is especially noted as being the premier grape in M?doc and Graves.

Although many had believed it was the vine described by Pliny as *Biturica*, the earliest record of the planting of the vine in Bordeaux is in 1736 and it did not make much of an impact until the end of the 18th Century. In 1997, DNA research at the University of California at Davis, determined the Cabernet Sauvignon was a cross between Cabernet Franc and Sauvignon Blanc – most likely a natural crossing. Crossings, many spontaneous, are a characteristic of the tremendous variety of vines

stemming from one feral vine – the *Vitis vinifera silvestris*.

The Americas

Although many types of *Vitis* are indigenous to the Western Hemisphere, there is no record of the Indians making wine from them. The Vikings were so impressed by the abundance of grapes that they named the northeast area where they landed Vineland.

The Americas have a large number of species of vines that can be used to make wine. Table 1 gives some of the species of vines used to make wine. The vines of East Asia, which have not been comprehensively studied, are excluded from the table. There is only one species for Europe and Central Asia. *Vitis vinifera*, which accounts for over 99% of the recorded grape wine production in the world. With the exception of the sub-genus *Muscadiniae*, which is grown on the coastal plain of the southern and Gulf states of the United States, few commercial wines are produced directly from the American species. But the three American species in boldface are vital to the entire wine industry.

The earliest records of viticulture in the Americas date from 1521, when Cortez ordered cuttings from Spain one year after the invasion of Mexico by the Spanish conquistadors. Three years later Cortez issued an edict ordering all new Spanish settlers to plant vines on the land they had been granted. By the end of the century Mexico was self-sufficient in wine production and no longer needed to import wines from Spain. The first commercial winery was established in 1596 at the Mission of Santa Maria in the town of Parras. In the 1530s viticulture was introduced to Peru and within 20 years spread to Chile and Argentina. It appears that the vines were all imported from Europe, chiefly from Iberia.

The growth of viticulture came to an abrupt end in 1699 when the King of Spain issued an edict prohibiting secular wine making in Spain's new colonies in order to protect the Spanish wineries and make the colonies dependent upon Spain. However, the missions that were exempt from the ban greatly expanded their production. In Peru, the ban was not enforced and Peruvian producers soon were exporting wines throughout the region.

Early Eastern North America

The Eastern part of the United States and Canada had an abundance of native grapes. The first recorded crush in the United States occurred in Jamestown, Virginia in 1609. Most likely the *Muscadiniae* grape was used. It was quickly found that the native American grapes did not produce a wine suitable for the European palates.

Many efforts were made to introduce *vinifera* vines onto the East Coast. However, all these efforts failed – the plants succumbing to hard freezes, pests, and diseases. In the 1680s in Pennsylvania, a chance hybrid between a native American and a *vinifera* vine gave rise to a vine that produced suitable wines and that was resistant to temperature extremes and the yet unrecognized pests and diseases. This hybrid, Alexander, was not widely planted until the mid 18th Century but in 1973 it became the basis for the first commercially successful wine making effort in the United States. Once it was recognized as a hybrid in the early 1800s, many attempts to create hybrids were tried by crossing two different species of American vines or by crossing European varieties with various American species. The French, wishing to increase yields and develop winter hardiness, were particularly active in the latter – thus giving the name French-American hybrids. A number of these hybrids are in production today. With several exceptions, most early hybrids are more suitable for sweeter white wines rather than red wines and often have an aroma described as foxy (animal fur). Sweetness tends to mask the aroma. Norton, a notable red wine vine, was one of the most widely planted vines prior to Prohibition and the red wine received many awards in international competitions. The origin of the vine is debated – it may be a spontaneous crossing or a deliberate one – a web search failed to reveal any DNA analysis of this vine.

West Coast Wines

On the West Coast the experience was vastly different, Father Juan Ugarte is credited with spreading viticulture northward in mission after mission from Mexico into present day California. Around 1770, the first *vinifera* were planted near Los Angeles. Following the gold rush in California, many immigrants brought *vinifera* vines with them that were successfully planted in many areas of California that had a more temperate climate than the East Coast. A thriving wine industry was quickly established, but it was subsequently suppressed by Prohibition. After Prohibition the wine industry quickly expanded with the market demanding sweeter varieties of wines. It was not until the 1960s that a significant effort was made to produce wines that would compete with the finer European wines. In 1976 a highly publicized blind wine tasting was held in France pitting the best California Cabernet Sauvignons against the best French Bordeaux wines. In a blind tasting, the bottles are covered with paper bags so that the judges cannot know which wines they are judging. When the bags came off the bottles the French judges were surprised to find that they had

scored two American wines above all the French wines. Today, many world-class wines are produced in California as well as many varieties of *vinifera* and various hybrids. The state produces over 90% of the wine produced in the United States.

Table 1: European, Central Asian, and American Vine Species Used to Make Wine

SUB-GENUS <i>EUVITIS</i>	
AMERICAN SPECIES	
Temperate Regions: Eastern Zone	
<i>Vitis labrusca</i>	<i>Vitis aestivalis</i>
<i>Vitis linceunici</i>	<i>Vitis bicolor</i>
Temperate Regions: Central Zone	
<i>Vitis riparia</i>	<i>Vitis rebestris</i>
<i>Vitis rubra</i>	<i>Vitis monticola</i>
<i>Vitis berandieri</i>	<i>Vitis cordifolia</i>
<i>Vitis candicans</i>	<i>Vitis cineria</i>
Temperate Regions: Western Zone	
<i>Vitis californica</i>	<i>Vitis arizonica</i>
Torrid Regions: Florida and the Bahamas	
<i>Vitis coriacea</i>	<i>Vitis gigas</i>
Torrid Regions: Tropical and Equatorial Zones	
<i>Vitis bourgoeana</i>	<i>Vitis cariboca</i>
<i>Vitis vinifera</i>	
SUB-GENUS <i>MUSCANDINIAE</i>	
NORTH AMERICAN SPECIES	
<i>Vitis roundifolia</i>	<i>Vitis munsonian</i>
<i>Vitis popenoei</i>	

Modern East Coast Wines

In recent years, *vinifera* wines are finally being produced on the East Coast. After considerable research, in the 1960s Dr. Constantine Frank successfully grafted *vinifera* vines on Canadian rootstock, thus providing vines that could withstand the cold eastern winters and the indigenous pests and diseases. Since then, *vinifera* wines are being produced in many eastern states including New York and Virginia. Virginia has over 80 registered wineries and there are wineries now in every state of the Union.

Vine Pests and Diseases

To understand why three or more species of American vines that are not used to produce significant quantities of wines are critical to the entire wine industry, one must recognize the major economic diseases and pests of vineyards. Major vine pests include mammals, birds, insects and nematodes (small round worms that eat roots). Major diseases include those caused by bacteria, fungi, phytoplasma, viroids and viruses. While *vinifera* is indigenous to Eurasia, the most economically significant pests and diseases are indigenous to eastern and southeastern North America.

Beginning in the early 1800's, efforts on both continents to share viticulture practices, to expand knowledge, and to develop new varieties led to a sharing of the vines on both continents. This resulted in the vineyards of Europe being infected by a series of diseases and pests from North America. First, came the fungal disease Powdery Mildew (oidium), noticed in France in 1847, which caused widespread havoc to vineyards and wine quality. The effect on *vinifera* differs by variety. The fungus can infect all green parts of the vine that after a few weeks looks powdery, giving the disease its name. Dusting with sulfur can control it. Prior to the discovery of the treatment, the disease spread so quickly that by 1854 the crop in France was the smallest in 66 years.

In 1863, phylloxera arrived and almost wiped out the wine industry of Europe. It caused great social unrest as many vineyard owners, both rich and poor, saw their vineyards literally dying before their eyes. Phylloxera is a tiny aphid (about 1 mm) that attacks only vine roots. It feeds on the sap of the plant, at the same time injecting saliva that is poisonous to the roots. This poison causes infections on the root system permitting other microbes such as bacteria and fungi living in the soil to enter, killing the root system. Phylloxera is most commonly transported in rootlings (one year-old dormant plants). Once a vineyard is attacked, the infected vines die within several years. The use of carbon bisulfide or flooding the vineyards in the wintertime helped but was not enough. Phylloxera does not survive well on sandy

soil, so vines planted on such soil are immune from attack. The Great Plain of Hungary, parts of Chile, parts of Australia, a small part of the French Mediterranean coast including the site of the French National Institute of Agriculture at Montpellier, and the Sierra foothills of California are examples of areas without phylloxera. However, virtually all other major wine producing areas of the world are now infected.

In hopes of combating this infection, the French formed many private and government committees. Initially, few believed that a tiny aphid could cause such devastation. By 1889 wine production in France fell by a drastic 70% from its previous high in 1875. However, in the 1880s help was on its way. Scientists with the Institute of Agriculture Research at Montpellier began to suggest that American rootstock is resistance to the pest and that grafting French vines on American rootstock would yield a plant resistant to the pest, yet the fruit and wines would be unchanged. Missouri state entomologist C. V. Riley positively identified the French pest as identical to the American one and was among the first to advocate grafting. Riley, working with one of the founders of American viticulture, T.V. Munson of Texas, and nurserymen in Missouri, identified rootstock most resistant to the pest, *aestivalis*, *rapestris* and *riparia*, the three American species that are in boldface in Table 1. Munson also provided expertise in successful grafting techniques. The rootstock had to be carefully selected to adapt for local soil conditions in Europe, particularly the calcareous soils.

Initially, many of the French were skeptical and feared that grafting would result in wines that have the undesirable “foxy” aroma of American species. However, even that was better than the total destruction of the wine industry. Fortunately, the fears were misplaced. Now, all good Bordeaux wines are grown on American rootstock and the technique is used virtually throughout the world. Today, to better address varying soils and diseases and pests, most of the rootstock used is a hybrid of several American species.

In 1878, Downy Mildew first appeared in France, probably with in importation of massive amounts of rootstock from America to fight phylloxera. Caused by a fungus, Downy Mildew is a problem in areas with warm humid summers and the fungus has spread virtually throughout the world. As with Powdery Mildew, it attacks all green parts of the vine, with young leaves particularly susceptible. As its name implies, infected leaves show patches of dense, white cottony growth on the undersides. The leaves may die, causing a lack of photosynthesis, resulting low yields of fruit and wines that are puny and weak. The most severe epidemics occur with frequent rainstorms and warm weather. This fungus is generally fought with sprays based on copper that last only a few days.

Since the 1990s, curative fungicides that are longer lasting but more expensive are used as well.

In 1885, Black Rot first appeared in France, probably from rootstock imported from America to fight phylloxera. This fungal disease attacks young shoots, leaves, and berries and spreads in mild, wet weather. Crop losses can be as high as 80%. The only effective control is the use of fungicides from spring until fruit ripening.

Pierce's Disease is the only major vine disease or pest indigenous to the United States we have not managed to export to France, YET. It is caused by a bacterium, which also infects a wide variety of crops from almonds to alfalfa. It is particularly feared because it kills vineyards quickly and there is no known cure. Originating in the Gulf Coast, this disease was first identified in California and is found Central and South America. Small insects called sharpshooters that feed off vines spread it. *Vinifera* varieties have no resistance to this disease. However, North American *Muscadine* grows well where the disease is present and a variant of the species *aestivalis* appears to be totally resistant.

It appears modern genetic engineering techniques offer great promise in addressing most of the diseases and pests that originated in North America. Using these techniques it may be possible to incorporate into *vinifera* vines the characteristics found in American vines that are resistant to these diseases and pests. Such research is being conducted in viticulture centers such as the Geisenheim Viticultural Research Institute in Germany, the French National Institute of Agriculture at Montpellier, and the University of California at Davis. This research, coupled with more highly specialized hybrids, may reduce the economic impact of these diseases without heavy use of chemicals.

The vines of the *Muscandinae* sub-genus thrive in conditions that promote most of the major pests and diseases that have infected the sub-genus *Euvitis*, and more importantly, *Vitis vinifera* vines and grapes. Since the number of chromosomes of the *Muscandinae* and the *Euvitis* differ, hybrids have not been successful. Thus, an engineered vine that produces *vinifera* grapes but has the resistance of a *Muscandinae*, is a goal of research. However, consumer resistance to such research and its products may prevent its wide spread adoption. To my knowledge no commercial winery is using such genetically engineered vines. Another thrust of the genetic research is to better understand the diseases and pests with the hope of being able to develop less chemically dependent ways to control them.

Ampelography

When one considers that there are literally thousands of varieties of *vinifera*, all of them descendents of the one type of vine, *sylvestris*, and that many of the

varieties are capable of mutating or spontaneously crossing with other varieties, one might imagine that it is frequently difficult to know which species is in a particular vineyard. It is. The science of Ampeolgraphy deals with describing and identifying vine species *Vitis* and its cultivated vine varieties.

The Greeks were among the first to identify different wine grapevines. Starting with Pliny the Elder, the Romans identified numerous wine grapevines in the Empire. Modern classifications started about 1700 when Tournefort created the terms Genus *Vitis* and species *vinifera*. First studied by Linnaeus in 1735, these studies included certain characteristics of the plant such as leaves, shoots, grapes and clusters. However, the classifications contained many errors as may be expected with the wide variety of wine vines grown in various countries and regions, often given different names.

It was not until the great devastation caused by the diseases and pests from America that an intense effort was made to identify species – especially to those that were resistant to these imported diseases and pests. Early classification efforts had not established standardized criteria and the classification process was not systematic. In 1876, the Austrian ampelographer Herman Goethe proposed measuring the angle between the leaf veins, and a Frenchman, Louis Ravaz, in his publication, *Les Vignes Americaines* in 1902, adopted this use. Using this technique a number of regional compendiums were published in the early 20th century. However, one by Viala and Vermorel listed over 24,000 names of varieties, clearly classifying varieties with numerous regional names as being separate varieties.

Starting in the mid 1940s Professor Pierre Galet of Montpellier formalized the study of morphology of the growing shoot tips, leaves, and shoots, including qualitative descriptions of leaf hair types and quantitative descriptions of leaf shape. Galet's comprehensive quantitative leaf descriptions included measuring the lengths and angles of the veins, the ratio of length to width, and the depth of sinuses.

Galet established rigorous methods for identifying varieties that now include the color and hairiness of shoot, shoot tip, petiole, and young and mature leaves; the shape, color, texture and indentation of leaves; the sex of flowers; the shape and compactness of bunches; and the shape, colour, taste, and seed presence of the grapes.

The disadvantages of these methods include, one, characteristics such as leaf shape can vary even on one vine and, two, some of the characteristics can vary with environmental factors such as climate and soils, and with plant age, clone type, etc. There are only five characteristics that remain stable: sex of flower; grape skin color; pulp color; the taste of berries; and the presence of seeds. Although the criteria are partially subjective, well-trained ampelographers are surprising consistent in

identifying the numerous varieties of vines.

As a reward for his efforts Professor Galet spent a large part of the remainder of his professional life in court defending his techniques against vineyard owners who were outraged that the great wine they made was from a grape not quite as noble as they thought. For example, for decades Chilean producers claimed that pre-phylloxera Merlot vines produced their Merlot. Subsequently, it was determined that the vines were actually Carmenere (a vine once popular in Bordeaux).

But probably, most embarrassing is that the nursery of Department of Viticulture and Enology of the University of California, Davis, sent out many virus-free, high-health vines that were misidentified. These included: Petit Verdot (called Gros Manseng); a poor clone of Pinot Noir (called Gamay Beaujolais); Melon (called Pinot Blanc); Tempranillo (called Valdepenas) and Trousseau Gris (called Gray Riesling).

Great efforts are being made by the major research centers to correctly identify vines and as DNA techniques expand, many of the errors of the past will be corrected.

Wine Myths

Unblended wine is superior to blended wine. Many consider that wines identified by their variety are better than those that are not. In the United States for a wine to be labeled by variety, such as Cabernet Sauvignon, it must have at least 75% juice from that grape. It need not be 100%. Many whites and most red wines are blended. For example, most Champagnes (often products of two or more varieties) are blended across vintages. The famous French Bordeaux can be a blend of five or more different grapes. Other wines can be a blend of the same grape taken from different vineyards. Blending is truly an art of the wine maker. Repeated tests have demonstrated that the wines resulting from skilled blending are usually as good as, if not superior to, the best of the wines that went into the blend. Skillful blending has a synergistic effect on the wines.

Sulfites are not good. Many believe that Americans insist on putting sulfites (SO₂) in their wine while Europeans do not use it. The major difference in the sulfites between European wines and American wines are the labels. The U.S. government mandates that “Contains Sulfites” appear on wine labels if the content is over 10 parts sulfites per million. Some natural fermentations can produce levels of sulfites greater than this arbitrary level, therefore for convenience, and to be safe from prosecution, most US wineries put the warning on the label even if it is below the arbitrary standard. The European Union mandates that “Contains Sulfites” does not appear on the label. In certain European sweet wines the permitted maximum is 250 parts million – 25 times more than what will trigger the warning label in the United

States. Similarly, the U.S. Government required warning on the label that drinking wine may cause birth defects is also forbidden in Europe.

SO₂ naturally occurs in the wine making process. No wine is without it. As early as 700 BC, Armenians added SO₂ to wines by burning sulfur in the amphora jugs. Although they did not understand why, they learned that burning sulfur (adding SO₂) helped to preserve the wines from spoiling. The Greeks and others continued the practice. SO₂ is vital to wine making and is used in extremely small quantities – for red wines the concentration is usually less than 10 parts per million. SO₂ is used more in white wines than in red wines, and more in sweet wines than in dry wines. The use of SO₂ helps prevent wild yeasts that can change the quality of the wine; helps prevent the growth of fungi and bacteria that can infect the wine during aging, bottling and transportation; and helps control the aging of the wine.

Often those who claim an allergy to sulfites in the wine are actually allergic to histamines that are particularly concentrated in red wines. A clear test of an apparent sulfite allergy in wines can be conducted by drinking a given amount of white wine one evening and an equal amount of red wine on another evening. With very few exceptions the white wine will be higher in sulfites. If the red produces an allergic reaction and the white does not, it is probably a reaction from the higher level of histamines in red wine, rather than the more commonly accused sulfites.

Wine always benefits from aging. Some reds and many whites do not benefit from any aging. Many are ready to be consumed when they are released. Generally wines aged in oak barrels will benefit from bottle aging.

French wines will age well and American wines will not. Many American wines benefit from aging.

Aging is a consistent process. Particularly Bordeaux reds, but also Burgundy reds, will taste excellent when very young, but then will close up – the fruit will disappear -- and tannins and acids dominate. Only after considerable aging will the fruit once again appear. The closed state is called the “dumb” stage in the life of wine, or the teen-age years. After the fruit once again opens, a properly aged wine may be eminently drinkable for a period of five, ten, or twenty or more years without any appreciable change in quality. This period, which changes from vineyard to vineyard and vintage to vintage, is called the “plateau of maturity.”

One needs an expensive cellar to age wines. The most important variables in aging wine are to keep it cool and away from areas that have frequent temperature changes. Keep the wine away from drafts, preferably in a space that resists temperature changes. Do not keep it exposed in the kitchen.

One bottle will taste the same as the next. Try as they might, wine makers have not yet been able to achieve perfect consistency in wines. Just because one

bottle in a case is bad that does not mean the next is.

California is phollexarea free. Many in California believed this until the 1980s and 90s when a variant of phollexarea attacked many vineyards, forcing a very expensive replanting of these vineyards. Some claim that this was the best thing to happen to California because thousands of acres of second-rate vines were ripped out and replaced with first-rate vines.

High yield results in low quality. The French fervently believe this and tightly regulate the maximum permitted yields of the premier vineyards. Starting with Georg Frohlich in the 1870s the Germans have been producing clones of their premier grape Riesling with higher yields and greater resistance to freezing and diseases. Since the 1930s yields have increased by at least four-fold without any apparent drop in quality.

White wines should be served well chilled. Frequently white wines are served too cold. For a white wine a temperature between 50 to 60° F is appropriate; for red wine a cool room temperature of 60 to 72° F is appropriate. Light red wines can be served cooler or chilled.

Sensory perceptions are linear. With wines the most powerful sense is the sense of smell, the nose. However if the wine is sniffed constantly, the sense shuts down. Take a sniff, than move the wine glass away. With taste, a significant increase of, say sugar, may not be perceived, but a small amount more may be perceived as significant.

Spicy foods need spicy wines. Many spicy foods such as curry do better with fruity wines and especially with semi-sweet wines that bring out the complexity of flavors in the food.

Wine Generalizations

Climate: Generally, the warmer the climate, the fruitier and sweeter the grape, thus the wine is usually fruitier and higher in alcohol. The cooler the climate, the slower the ripening process and the more complex and intense the flavors and aromas.

Soils: Generally, the more difficult the soils, the more the vine will struggle to search out nutrients and thus will develop more complex and intense flavors and aromas in the grape.

Malolatic fermentation: Almost all barrel-aged red wine undergoes a process called malolatic fermentation in which the malic acids are changed into lactic acids. Wine makers also can induce this process in white wines by adding bacteria while aging wines – usually in the barrels. This conversion has two effects. One, the actual acid level in the wine remains the same but the perceived acids are less. This change can be very noticeable in the whites and is very subtle in reds. In the red

wines the perceived acids are not as harsh and the wine may be more approachable when young. Two, with this conversion, the fruitiness is reduced, it is not as pronounced, and other tastes and aromas come to the fore. The wine tends to be more complex after malolactic fermentation.

Aroma

The multitude of varieties, growing regions, and wine producing methods yield a vast spectrum of aromas in wines. Illustration 1 is a “Wine Aroma Wheel” designed by Professor A.C. Noble of the University of California at Davis. It is the finest effort to systematically identify the spectrum of aromas that may appear in a glass of wine and to provide an analytically descriptive lexicon of these aromas. Usually only a few of these aromas may be perceived in a given wine. The wheel is read from the center to the circumference with increasing specificity as one goes through the three tiers. For example, an aroma from a wine may be identified first as fruity, then classified as berry, and then further refined as black current (cassis). Some aromas such as chemical aromas are undesirable. And some aromas are desirable in one type of wine but not in another. For example, an earthy aroma is frequently desirable in a red Burgundy, but not in a white Burgundy. To better identify the aromas in wine, one can add the appropriate ingredients into a glass of well made but non-descript bulk wine. For example, to identify a oak aroma just add a few oak chips in a glass of red or white wine and cover it with plastic wrap, and after an hour or so sniff the wine. The pronounced aroma will help in identifying a more subtle aroma in wine. This method can be repeated for most of the aromas identified on the wheel and most aroma producing ingredients are available in grocery stores. For further information on the aroma wheel consult the web page of A.C. Nobel: <http://wineserver.ucdavis.edu/Acnoble/waw.html>.

Taste

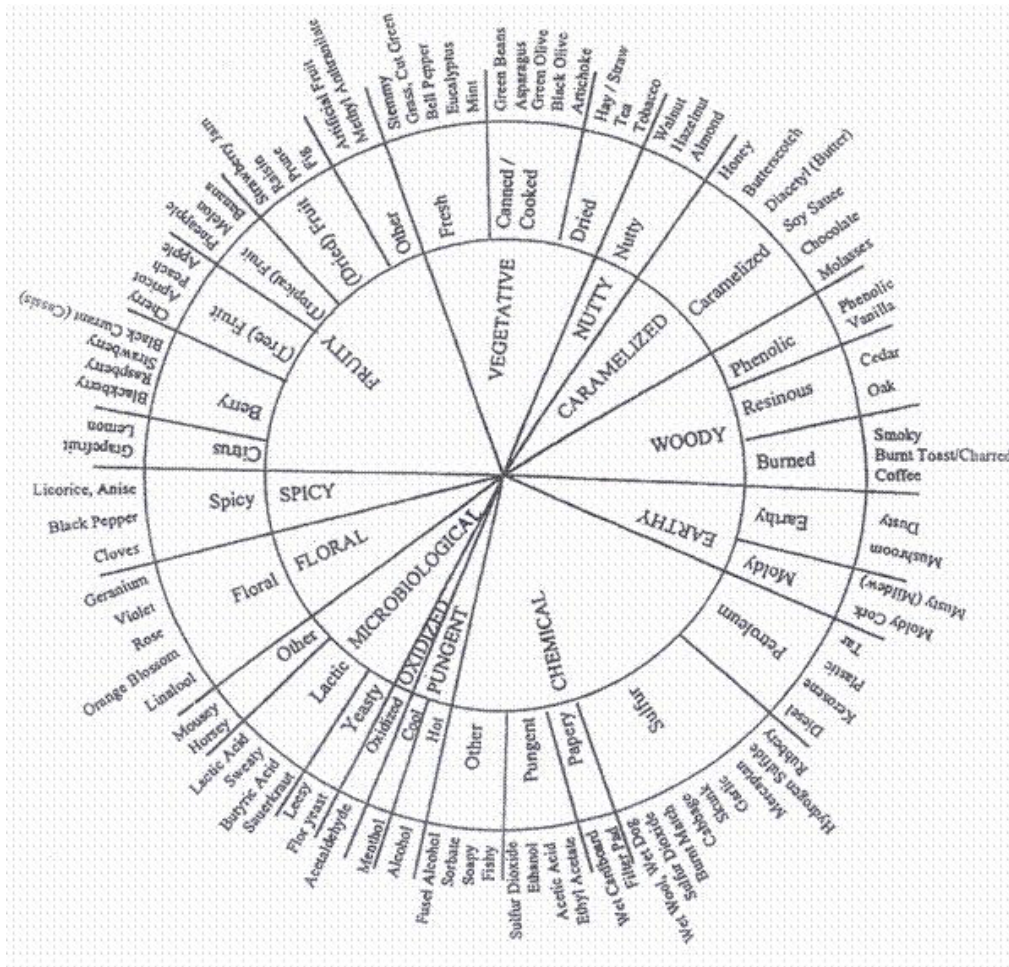
There are four well established tastes: sweet, salty, acid and bitter. Of these, salty does not apply to the wine itself. The taste receptors are principally located on different parts of the tongue. The tip tastes sweetness, the sides taste acid, and the back tastes bitterness. The overall mouth feel of the wine pertains to different properties in the wine such as viscosity and astringency.

There is a common misunderstanding about the acid-sugar balance in wine. The term “dry” in wines means the lack of perceived sweetness – residual sugar – sugar remaining after fermentation, mainly glucose and fructose. This is measured in g/l, with 1g/l equaling 0.1%. Both red wines and many white wines may be described as dry – with no perceived residual sugar. However the perceived sweetness in wines varies significantly with acidity. For a given level of sugar, the greater the acidity the less the perceived sweetness. A high acid wine may be

perceived as dry even though there is a significant amount of sugar in the wine. German wine quality laws recognize this balance and permit the use of the term “trocken,” meaning dry, for wines on a sliding scale with a maximum of 4g/liter (0.4%) of residual sugar on the lower end and a maximum of 9g/l on the higher end, as long as the total acidity is not less than 2g/l less than the residual sugar. If the wine has a total acidity of 2g/l the permitted residual sugar for a trocken wine can be as high as 4g/l. It may be less. If the wine has a total acidity of 7g/l the permitted sugar for a trocken wine may be as high as 9g/l. Tannins also reduce the perceived sugar in red wines.

Illustration 1: Wine Aroma Wheel

Wine aroma wheel. Copyright 1990 A C Noble, Colored copies may be obtained



from A C Noble (Box 72239, Davis, CA 95616) www.winearomawheel.com. The wheel may not be posted on a web site

Sweet dessert wines have high residual sugar. A Hungarian sweet wine, Tokaji, must have 250g/l, and one reached 488g/l. After fermentation most high-sugar wines must be stabilized, usually with SO₂, so that they will not ferment in the bottle. Dessert wines produced by natural botrytis need not be stabilized because its trace materials inhibit fermentation. Often these wines have very low alcohol levels.

To better comprehend one's own palate on the types of wines preferred and to express this when buying wines, one can conduct a simple taste experiment at home over several evenings, using ingredients readily available in food stores. Needed for the experiment are: 1) at least 7 glasses, preferably 12 or more, with three ounces of a non-descript wine in each (white one evening and red another evening), 2) powdered sugar for sweetness, 3) Cream of Tartar for acid, which is a byproduct from the fermentation of grape juice, 4) strong tea for tannins (bitterness), 5) Alum for astringency and 6) a stirrer.

Keep one glass of wine unaltered to use as a standard. In the next three glasses put successively 1/8, 1/4, and 3/8 of a teaspoon of sugar and stir. In order, taste all four glasses of wine to perceive increasing levels of sweetness. Many Americans state they prefer dry wines without any perceived sweetness, but actually prefer to drink wines with a perceived sweetness. There is no right or wrong level of sweetness except for that which your palate prefers.

The next step is adding 1/8 of a teaspoon of Cream of Tartar to the fifth glass and stirring. Taste this, then compare it to the unaltered wine. The acid will be obvious. If there are sufficient glasses, then prepare another set of three with the graduated sugar levels and add 1/8 of a teaspoon of Cream of Tartar to each. Taste these comparing them with the glasses with only sugar added. This gives an appreciation of the acid-sugar balance.

A next step is to add strong tea to an unaltered wine. Since the tannins in white wines are generally not perceived, this step is usually for red wines only. Then taste this and compare it with the standard wine and the wine that has only acid added. This will assist in discerning the difference between acidity and tannins (bitterness) that relatively few understand. If sufficient glasses of wine are available, another flight can be prepared with tannins and sugar and compared with the flight of acid and sugar.

The final step is to add 1/8 teaspoon of Alum to an unaltered wine to perceive astringency. Compare this with the unaltered wine, the sugar-only wine, the acid-only wine, and the tannin-only wine. If sufficient glasses of wine are available, other

flights can be added using astringency with, separately, sweetness, acid, and tannin. Generally, high acid reinforces astringency. Creating various combinations can lead to several evenings of entertainment. One need not drink the altered wines but merely experience them on their palette to better understand and express personal preferences when buying wine.

Two taste concepts that are difficult to communicate, yet are important and depend to a significant part on individual preferences, are balance and body. Balance refers to the sweetness, acidity, tannins, astringency, and alcoholic strength in a wine. This is often an individual preference. But as long as one of these characteristics does not dominate the others, the wine is said to be in balance. Body refers to the fullness of the wine -- the combination of viscosity and fullness of the fruit. Wines may be appropriately classified as light, medium, or full bodied. When combined with appropriate balance, particularly in red wines, a full-bodied wine lays flat on the tongue filling all sensory receptors.

How Food Affects the Taste of Wine

Another experiment that can be easily conducted at home helps one understand how food affects the taste of wine. Again this experiment can be performed with mild white wine and a solid red wine – well made bulk wines are appropriate. The only ingredients needed are a slice of a sweet apple, a slice of lemon, and salt. First, taste the white wine, second, taste the apple wedge (sweet) then taste the wine again. The sweet apple makes the wine taste stronger. Third, lick the lemon slice and taste the wine again. The acid in the lemon makes the wine taste milder. Fourth, taste the salt and taste the wine again. The salt will subdue any bitterness in the wine. This is particularly noticeable in red wines that have more tannins. Then repeat the experiment with red wine. To clearly understand the effect of salt, mix some salt in a small amount of tonic water (quinine water). The salt will make the tonic water appear to be almost sweet.

The Japanese have identified a taste called umami. However, this is not generally accepted in the literature and possibly has more to do with altering taste of wine rather than being a separate taste. Foods containing umami – mushrooms, tomatoes, meats, green tea and aged cheeses, etc. – produce subtle changes. The salts of glutamic acid or nucleotides (small proteins) tend to make the tannins taste somewhat stronger. This change does not affect white wines but will affect red wines.

Suggested Wine and Food Pairings

The pairing of wine and food can be a controversial subject and depends, in part, on one's palate. Rather than listing generally accepted pairings, stated here are some pairings that may be considered controversial and frowned upon by some

authorities. The general rule of thumb: “white wines with white meat and seafood, and red wines with red meats and heavily sauced pasta,” is useful but as with most rules of thumb it is a guide and need not be strictly followed. Taste, complexity and the body of the wine are as important as the color.

In general, the more complex the course, the more complex the wine and the heavier the course the more heavily-bodied the wine. Grilled meats and fish are complex and benefit from a complex wine. For example, a California style Chardonnay would overwhelm a poached fish, but may go well with a grilled fatty fish such as salmon or tuna and a spicy seafood dish such as Cioppino. A lighter bodied, spicy red wine may also go well with both grilled fish and the Cioppino. Usually pork is paired with white wine, but spicy stuffed pork chops may go well with a vibrant, lighter-bodied red such as Sangiovese. Traditionally, duck is served with medium to heavy-bodied red wine. But Oriental duck breast prepared with five spice seasoning, ginger and soy sauce, all considered category killers for wine, may go well with a light fruity red such as Beaujolais or especially with a semi-sweet white such as the French-American hybrid Vidal Blanc. As stated previously, semi-sweet wines tend to bring out the complexity of foods with heavy oriental or curry spices. Generally red Burgundy is served with red meats, but, very controversial, it may go well with sushi, perhaps the only wine to do so. The key is to experiment with one’s own palate and try a variety of wines with a variety of foods.

Conclusion

Wine is a wholesome and natural beverage created through the natural process of fermentation. For perhaps six millennia man has cultivated vines to produce wine. In so doing he has created a massive number of different varieties, most of which are based on one naturally occurring vine, *Vitis vinifera silvestris*. Wine is now produced in every continent except the Antarctic. During the last one hundred and fifty years significant strides in science have provided techniques that increase production without any reduction in quality, greatly increase the quality of affordable wines, made vines more resistant to pests and diseases, and permitted the planting of vines in areas where harsh winters have previously killed the vines. In addition, significant efforts have provided means of better understanding and communicating the taste and aroma components in wine and how different foods affect the taste of wine. Given the large body of on-going research, high quality wines will be available far into the future.

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