Dangers of Oxidation in Table Wines*

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Missouri vintners produce some of the finest white table wines from French hybrid cultivars. Vignoles, Seyval, Vidal, and Cayuga White are the leading grape varieties used in premium white wine production. In 1992, Missouri wines received 240 awards in 17 wine competitions. Over 55 percent of these awards were given to white wines. Premium white wines are, therefore, very important to the growth of Missouri's wine industry. One of the quality features of these white wines is the presence of typical varietal character. Maintaining this quality attribute is crucial to the production of premium white table wines in Missouri. Loss of fruity varietal character can occur if the wine is exposed to excess aeration. White wines are particularly vulnerable immediately following the fermentation. For this reason, premium white wines should be reasonably protected from air during the course of processing.

Wine Oxidation

In must and wine oxidation, phenolic compounds serve as the primary substrates. The oxygen reacts with phenols and produces a compound known as quinone. The quinone can react with other phenols, and thus continue the oxidative reactions. The oxidation can be enzymic or nonenzymic, which is also called auto-oxidation.

In the case of enzymic oxidation, enzymes such as polyphenol oxidase and (in botrytis-infected must) laccase catalyze the reaction. This kind of oxidation mostly occurs in must. In wines, the oxidation usually occurs without the mediation of enzymes. This type of reaction is called chemical oxidation. In one of the chemical oxidation reactions involving phenol, a strong oxidyzing compound such as hydrogen peroxide is produced. The hydrogen peroxide thus formed can react with ethanol and produce acetaldehyde. Oxidation of wine causes browning, loss of fruity aroma, and formation of aldehydic odor.

Solubility of Oxygen

When a wine is exposed to air, the oxygen from the air dissolves into the wine. This step is a physical process. Generally, about 6 ml of oxygen per liter is dissolved. The amount of dissolved oxygen in wine changes over time because the oxygen is used in oxidative reactions. The solubility of oxygen is markedly influenced by temperature. Table 1 shows the data regarding the solubility of oxygen in water at different temperatures.

Table 1. Solubility of oxygen in water.

Temperature	Oxygen dissolved in mg/L
0ºC (32ºF)	15.0
10ºC (50ºF)	11.4
20ºC (68ºF)	9.1
30ºC (86ºF)	7.7

The solubility figures for wine are lower, depending on composition. Alcohol and the dissolved solids are among other factors that influence the solubility of oxygen in wine. The former increases and the latter reduces the amount of oxygen that can be held by the wine.

Since temperature greatly affects oxygen solubility in wine, it is important to protect wine from aeration during filtration after cold stabilization

Means of Preventing Oxidation Problems

Once a wine is oxidized, its quality is permanently impaired. Certain measures such as "yeast fining", refermenting the oxidized wine, and fining with casein may bring some small improvement. But these measures cannot be relied upon to completely restore the wine quality. For this reason, it is better to adopt processing techniques which will prevent oxidation. Some of the important techniques are discussed below.

Condition of Grapes at Harvest

Use only healthy grapes for winemaking. Moldy grapes, such as those infected by botrytis, are very susceptible to oxidation. This is due to the enzyme laccase. This enzyme (laccase) is relatively more stable in must and wine. It can also oxidize a wider range of phenolic compounds. As compared to the other enzyme polyphenol-oxidase, laccase is relatively resistant to sulfite. For this reason, sulfiting a rotten must

does not give sufficient protection from the adverse effect of this enzyme.

Judicious Use of Sulfur Dioxide (S02)
Sulfur dioxide is widely used in the wine industry as a germicide and as an antioxidant. It exists in wine in "free" and "bound" forms. The "free" form of $S0_2$ is useful to the winemaker. Free $S0_2$ is strongly influenced by pH; therefore, $S0_2$ addition to a wine should be based on wine pH. The $S0_2$ level in wine should be periodically tested and adjusted to the desired level. Over-sulfiting the wine to prevent oxidation should be avoided.

Keep Wine Containers Full
Wine containers, such as barrels and tanks, should be completely filled with wine. In partially filled containers, the wine is exposed to the oxygen present in the headspace. To minimize the danger of oxidation, the 0_2 level in the headspace should be reduced to less than 1 percent. This can be achieved by blanketing the headspace with $C0_2$.

Use of Inert Gas
Inert gas such as nitrogen and carbon dioxide should be used to protect wine from oxygen pickup during transfer and storage. This is accomplished by sparging and blanketing the wine with inert gas.

Use an Oxygen Meter
The oxygen present in the air (headspace) and dissolved in the wine can be measured by an oxygen meter. Some winemakers use this instrument to monitor oxygen levels in wine during processing and bottling. The use of the oxygen meter for producing premium white wine is strongly recommended.
By following the measures discussed above, one can minimize the problem of oxidation. This is important for producing high quality wines with fruity varietal aromas.

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