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Managing oxidative risk with biological tools

Part I – Pre-fermentation

Oxidation can occur throughout the life of the wine. The wine loses freshness and the bouquet becomes tired and dull with reminiscent notes of honey, faded flower, caramel, cardboard or straw, meat, wet wool or dog and tasting dull and flat on the palate. Failure to ensure that the wine remains in optimum condition and protected from oxidation can lead to consequences that range from loss of repeat sales, in the short term, to more detrimental and serious concerns over brand equity in the long term. In countries where consumers have a higher degree of involvement with the product they may be able to identify the negative impact of oxygen as a ubiquitous fault. For example, an analysis of 17,442 wines entered in Decanter World Wines Awards 2017 revealed that 5.8% were perceived as faulty. Almost 1% of the total entries were considered oxidized by the panels of experts.

Some wines are more sensitive to oxidation such as aromatic white wines like Riesling, Albarino, and Verdejo as well as rich in thiols varieties such as Sauvignon blanc. Red wines are less sensitive to oxidation because of the higher abundance of phenolic compounds, which are natural antioxidants.

Throughout winemaking, several steps are known as strategic key points where oxidation mechanisms can occur: transport of grapes, at pressing, stabulation, racking, at the beginning of AF, during cold stabilisation, storage and transport. This Winemaking Update will focus on biological tools available to winemakers to control oxidation prior to the onset of alcoholic fermentation.

❶ Transport/Pressing | ❷ Stabulation | ❸ Beginning of AF

Traditional oxidation management

The commonly used compounds used to protect must and wine from oxidation are sulfites (SO_2). However, SO_2 can have a negative impact on wine sensory properties, can delay the onset of malolactic fermentation, can cause some health concerns (e.g. high concentrations in the final wine) and consumers are looking for wines with reduced chemical input, like SO_2. That's why SO_2 levels in wine are regulated. On wine bottles, «contains sulfites» must be displayed on the label when found above 10 mg/L. Winemakers are trying to decrease the SO_2 concentrations during the winemaking processes, and the use of biological solutions is an excellent option.

Oxidation mechanisms

Understanding oxidation mechanisms is key in order to predict how biological tools can prevent it. Before fermentation, the main oxidative reaction **in the must** is an **enzymatic oxidation**. It involves polyphenol oxidase enzymes (laccase and tyrosinase) which converts monophenol into **quinone**, a strong oxidant. After fermentation and settling, **chemical oxidation** mainly occurs. Oxygen can react with transition metals like iron and copper to form radical oxygen species, a highly reactive oxidant which can then oxidize polyphenol to quinone.

Quinones are the convergence point of polyphenol oxidation, the result of either enzymatic or chemical oxidation. Such quinones are highly reactive (Figure 1) and lead to multiple reactions of quinones with phenolic compounds ❶ rapidly producing brown pigments which changes wine color (especially visible in white and rosé wines). Quinones can also produce aldehydes through the Strecker degradation ❷ which involves amino acids. These aldehydes, when produced in high concentration

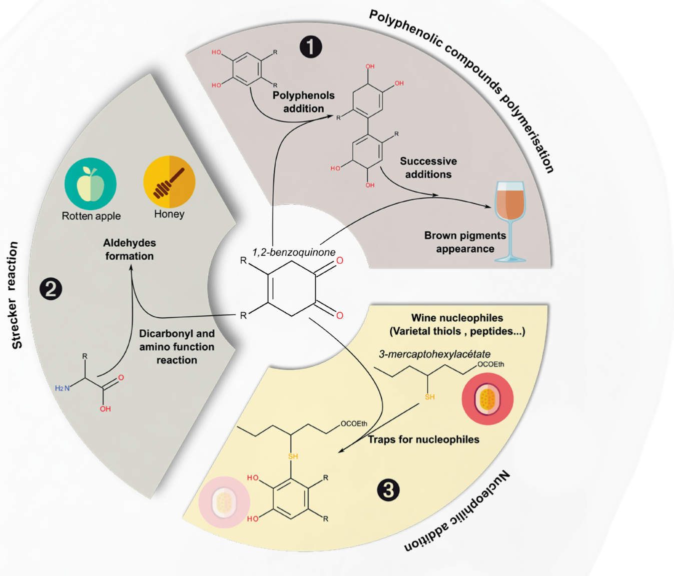

Figure 1. Potential pathways to reduce oxidant quinones leading to wine alteration

have a negative impact on wine aromas, leading to oxidation markers such as methional and phenylacetaldehyde. Finally, the oxidant quinones can be trapped by aromatic thiols ❸ which exert an antioxidant activity. This sacrificial addition leads to the neutralization of the quinones, but in the same time reduces the concentration of free thiols, which decreases the aromas of the wine. This last reaction is a **nucleophilic** addition of a sulfhydryl function (–SH); for example, the -SH on the aromatic thiol reacts with the electrophilic carbon of the quinone. Nucleophiles are compounds that are like wine antioxidants, such as sulfur dioxide or ascorbic acid, thiols, amino acids, and numerous polyphenols.

Preventing oxidation in the must /pre-fermentation

When sulfites are added to wine, a competition occurs between sulfites and thiols for the nucleophilic addition to the quinone. This competition leads to a decrease in the consumption of aromatic thiols, which in turn contributes to preservation of the wine aromas longer since the thiols are not trapped by the quinones. However, this reaction also naturally occurs with other compounds in the wine, notably others sulfhydryl containing compounds like glutathione (GSH). Consequently, compounds with free –SH function, such as glutathione preserve aromatic thiols of the wine. Increasing naturally the concentration of nucleophiles (such as GSH) in wine increases the wine oxidative stability by rendering the quinone ineffective to cause oxidation.

Through Lallemand research in yeast strains selection, growth medium and culture conditions, the production process of specific inactivated yeast (SIY) naturally rich in GSH has been optimized in order to provide innovative biotechnological tools for winemakers to naturally protect wines from oxidation by improving the natural antioxidant capacity of a wine. Recent reserach work led to the development of a new specific inactivated yeast with the highest amount of intracellular glutathione content : Glutastar™. In the frame of the research collaboration with the IUVV in Dijon, Florian Bahut's PhD work highlighted the uniqueness of this SIY and explained its superior performance. It was shown that not only GSH was accumulated in this SIY, but also numerous unique compounds in the inactivated biomass obtained from one specific wine yeast strain when compared to other inactivated yeast (Figure 2) .

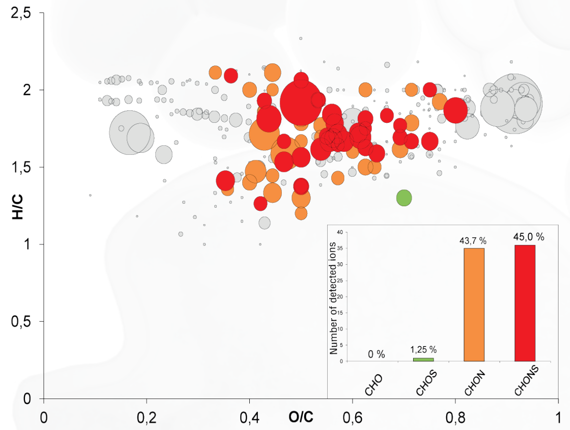

Figure 2. Through the use of ultra-high precision analysis, it is possible to determine the chemical composition of a solution and plot it according to their elemental formula. In this example, each circle corresponds to one chemical composition (which can correspond to several compounds). Grey circle represented compounds common to different SIY. Colored circles are compounds only present in Glutastar™, with a large abundance of compounds with C,H,O,N (orange) and C,H,O,N,S (red) chemical composition.

Glutastar™ was shown to contain not only a high amount of reduced glutathione but also a large pool of peptides containing sulfhydryl group (-SH). When the antioxidant activity is compared between SIY with similar glutathione concentration, Glutastar™ shows better antioxidant capacity. This can be attributed to the synergistic activity of this unique pool of nucleophiles which also helps to preserve glutathione longer, and contributes to preserve the quality of the wine longer (Bahut et al, 2020).

The impact of Glutastar™ in wine

Several winery trials have shown that the use of Glutastar™ resulted in significantly more preservation of thiols. Figure 3 shows this action in a trial in Sauvignon blanc (IFV Val de Loire, France) where Glutastar™ was added to the free-run juice after pressing.

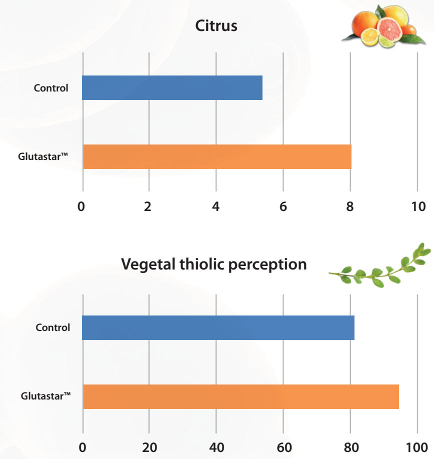

Figure 3. Aromas index based on Odor Activity Value (OAV) in Sauvignon Blanc (Val de Loire, 2019) with 30 g/hL of Glutastar™ added to the free run juice after pressing compared to a control with no addition.

Glutastar™ can also be used during prefermentative maceration as shown with the results of a winery trial (Figure 4) in Sauvignon Blanc from Val de Loire. The thiols concentration was significantly higher even at least up to 5 months after bottling thus indicating a greater oxidative stability and aroma preservation throughout the ageing.

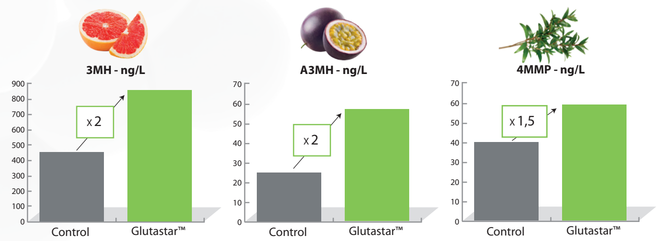

Figure 4. Thiols in Sauvignon Blanc (Val de Loire, 2019) with 30 g/hL of Glutastar™ added on must before a prefermentative maceration (8 days at 4°C) compared to a control with no addition.

The color of wines is also protected when Glutastar™ is used as demontrated by this trial conducted in Provence (Figure 5).

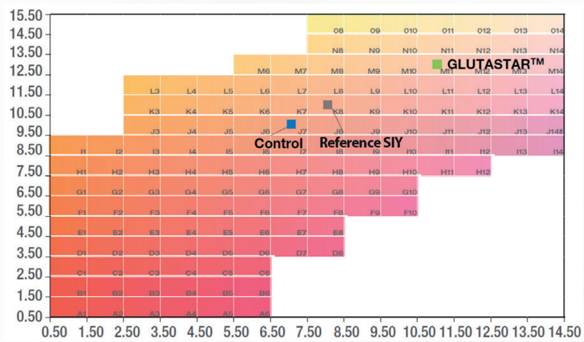

Figure 5. Rosé Syrah / Grenache (Provence, 2018). Addition of 30 g/hL of Glutastar™ to the free run juice in the press tray in comparison with a reference SIY, and a control with no addition.

Summary

The use of biological tools during the winemaking processes to prevent oxidation is being adopted by producers who wish to maintain the sensory integrity of their wines all the way to the consumers. It is also part of an overall strategy of bioprotection to reduce the use of SO_2. Using Glutastar™ in the pre-fermentation steps can insure that the wine is protected from oxidation and retain its full sensory profile.

In Part II of this Winemaking Update series, will take a look at post-fermentation protection up to the later stages leading to bottling with Pure-Lees™ Longevity.