

ENARTIS NEWS

REPLACING SO₂ DURING FERMENTATION

Market demand for low SO₂ or SO₂-free wine is increasing as winemakers attempt to produce wines suitable for consumers suffering from food intolerances. For winemakers, embracing this philosophy means a greater commitment of time and responsibility in avoiding the risk of exposing an unprotected wine to chemical and microbiological modifications. With the recent approval of products such as chitosan and PVI/PVP, it is now easier to replace sulfur dioxide.

SO₂ ACTIVITIES

The three reasons for using SO₂ in the pre-fermentation stage are to:

- Protect juice from oxidation
- Minimize laccase activity in the case of Botrytis infected grapes
- Control the growth of microorganisms that can damage wine quality.

ALTERNATIVES TO SO₂ ANTIOXIDANT AND ANTILACCASE ACTIVITY

To better understand if and how SO₂ can be replaced, it is necessary to know the mechanism behind the oxidation of juice and how SO₂ can interfere with it.

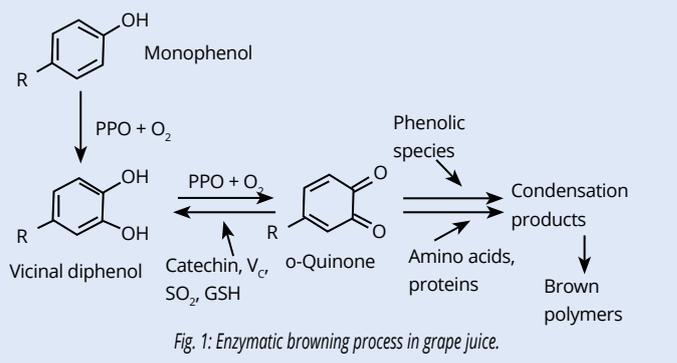
Juice Oxidation Mechanism

Oxidation is considered one of the main problems encountered during vinification as it adversely affects the sensory properties of wine causing browning, loss of flavor and aroma, and increased astringency.

Juice oxidation can be classified into enzymatic (Fig. 1) and non-enzymatic oxidation, with the former dominating on the latter. Many juice and wine compounds are susceptible to oxidation but phenolic compounds are most affected.

Enzymes responsible for phenolic compound oxidation at the juice stage are polyphenol oxidases (PPO): tyrosinase in healthy grapes and laccase in Botrytis infected grapes. PPOs turn phenolic compounds, mainly hydroxycinnamic acids and catechins, into quinones, strong oxidants responsible for juice browning.

This reaction is very fast and occurs within 10-15 minutes beginning from when a grape berry is damaged or crushed.



SO₂ alternatives for minimizing juice oxidation

For enzymatic oxidation to happen, oxidation enzymes, O₂ and the phenolic substrate must be present. Consequently, the antioxidant strategy can operate on 3 fronts:

Reducing O₂ solubilization in juice

Avoiding exposure to air, thus preventing the solubilization of oxygen in juice is the first step to prevent oxidation. In addition to using inert gas, chemical inertization is possible using compounds that can quickly react with oxygen before it can enter the enzymatic oxidation mechanism.

Contrary to common belief, SO₂ is very slow in reacting with oxygen. **Ascorbic acid** is 170 times faster in reacting with oxygen than SO₂. Its application (always in conjunction with SO₂ and tannins to block oxygen peroxide produced by the oxidation of ascorbic acid), is an effective and cost-effective alternative to inert gas and allows for reduced SO₂ additions.

Gallic and ellagic tannins also have a high capacity for O₂ consumption and can be used to replace SO₂.

Reducing oxidation enzyme activity

SO₂ antioxidant effects depend on its capability of inhibiting juice oxidation enzymes. Up to 90% decrease tyrosinase activity has been observed upon the addition of 50 mg/L SO₂, but higher dosages are necessary to effectively inhibit laccase, resulting in negative consequences for alcoholic and malolactic fermentations and wine quality.

Enological tannins inhibit PPO activity and are more effective than SO₂ in inactivating laccase (Fig. 2).

Recent trials have shown that the application of **PVI/PVP** in white juice settling produces wines with a fresher color, higher content of aromatics and less sensitivity to oxidation. The reason is related to PVI/PVP's ability to remove metals such as copper and iron. During the juice stage, copper is a catalyzer of PPO activity and, similarly in wine, in combination with iron, it can catalyze the non-enzymatic oxidation of phenols.

Activated chitosan application during the juice stage is able to reduce laccase activity. The mechanism is not yet clear, chitosan could reduce laccase activity either by its capability in removing copper or by the direct reaction of positively charged chitosan with negatively charged laccase.

Finally, SO₂ can reduce quinones produced by the enzymatic oxidation process back to a re-oxidizable form. This explains the SO₂ bleaching effect when added to brown juice. **Glutathione and cysteine** have a similar ability, when added during the juice stage, they react with quinones formed from the oxidation of caftaric acid (the most abundant hydroxycinnamic acid in grape juice) by tyrosinase activity forming the "Grape Reaction Product" (GRP). GRP is colorless and is no longer a potential substrate for further oxidation by tyrosinase.

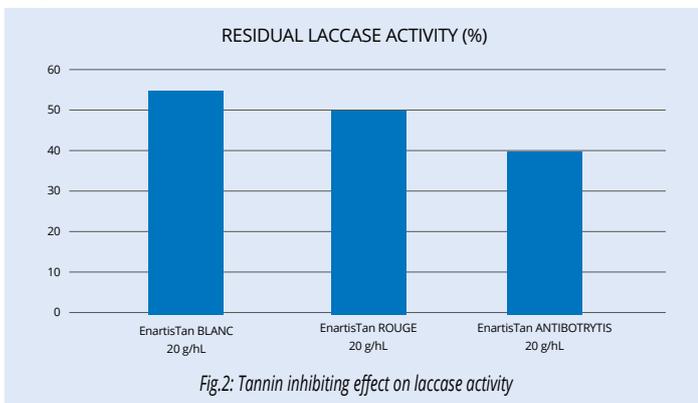
ALTERNATIVES TO SO₂ ANTIMICROBIAL ACTIVITY

The antimicrobial activity of sulfur dioxide is mainly due to the molecular form whose concentration depends on the free sulfur content, pH, temperature and alcohol content.

SO₂ is effective in controlling both yeast and bacteria. It is able to interfere with the microbes metabolism in different ways: alteration of cell membrane permeability; alteration of enzymatic activity; inhibition of glycolysis; lipid modification; interaction with coenzymes and vitamins; destruction of thiamine; DNA and RNA transformation; and damage to structural proteins.

Every microorganism has a different sensitivity to SO₂ therefore the quantity that is necessary to block the growth is specie dependent. Grape pH's tendency to increase makes microbiological control with SO₂ increasingly difficult.

Activated chitosan antimicrobial activity is much less dependent on juice pH and makes it a reliable alternative to SO₂. It works by contact: the positive charges present on its surface attract negatively charged microorganisms in the juice. Subsequently, it alters the permeability of the cell membrane and causes the microorganism to die from osmotic shock. Like SO₂, chitosan is a non-specific antimicrobial compound and can control both yeast and bacteria.



Removing phenolic compounds

Phenols are the main substrate of oxidation. Removing phenolic compounds with **fining agents** such as PVPP, animal or plant proteins and carbon is another way of minimizing the oxidation process.

VINIFICATION PHASE	TYPE OF WINE	PRODUCT	ACTIVE MOLECULES	REASONS TO USE IT
Grapes and must		AST	Ascorbic acid, gallic tannin and potassium metabisulfite	<ul style="list-style-type: none"> Reduction of dissolved oxygen Blocks radicals
		EnartisTan ANTIBOTRYTIS or EnartisTan AROM	EnartisTan ANTIBOTRYTIS: Mixture of gallic and ellagic tannins EnartisTan AROM: Gallic tannin, GSH and cysteine	<ul style="list-style-type: none"> Reduction of dissolved oxygen Blocks radicals Reduction of laccase and tyrosinase activity
		EnartisTan ANTIBOTRYTIS or EnartisTan ROUGE or EnartisTan COLOR	EnartisTan ANTIBOTRYTIS: Gallic and ellagic tannin EnartisTan ROUGE: Condensed, ellagic and gallic tannin EnartisTan COLOR: Grape seed tannin, ellagic tannin, GSH and cysteine	<ul style="list-style-type: none"> Reduction of dissolved oxygen Blocks radicals Reduction of laccase and tyrosinase activity
		PROTOMIX AF	Bentonite, PVPP, pea protein, cellulose	<ul style="list-style-type: none"> Removal of catechins Removal of iron
		EnartisStab MICRO M	Activated chitosan	<ul style="list-style-type: none"> Removal of spoilage microbes Removal of catechins Removal of iron and copper Reduction of laccase and tyrosinase activity
		EnartisPro FT or EnartisPro XP	EnartisPro FT: GSH and cysteine, free mannoproteins, PVI/PVP EnartisPro XP: Free mannoproteins, PVI/PVP	<ul style="list-style-type: none"> Removal of copper and iron Removal of catechins Reduction of laccase and tyrosinase activity
		EnartisPro BLANCO	EnartisPro BLANCO: GSH and cysteine, free mannoproteins	<ul style="list-style-type: none"> Reduction of quinones (reduction of browning)
Fermentation		EnartisFerm TOP ESSENCE or EnartisFerm ES181	EnartisFerm TOP ESSENCE: Yeast for increase in fruit aroma EnartisFerm ES181: The "never go wrong" yeast for all varieties	<ul style="list-style-type: none"> Low SO₂-producing strains
		EnartisFerm ES488 or EnartisFerm WS	EnartisFerm ES488: Yeast for blackberry aroma and "Ripen UP!" strategy EnartisFerm WS: Yeast for the fermentation of high-alcohol, big red wines	<ul style="list-style-type: none"> Low SO₂-producing strains

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