

ENARTIS NEWS

SO₂ MANAGEMENT & ALTERNATIVES

The wine industry is experiencing increased awareness towards the impact that its practices are having on the environment. One of the most controversial additives currently used in wine is sulfur dioxide (SO₂). While it's easy to understand why sulfite additions are a useful tool in winemaking for its antioxidant, antioxidasic, and antimicrobial activities, winemakers are working towards limiting its use, both to respond to market demand and to expand their approaches in vinification.

Another important aspect to consider is climate change, which creates enological challenges to achieve the typical quality and shelf life of the wine. In recent vintages, there has been a trend towards higher pH levels in must and wine. This consistent **rise in pH comes with a lower effectiveness of SO₂**, requiring higher doses of sulfites.

Enartis is committed to finding innovative solutions and has been working in this direction by creating products to help reduce SO₂ use, offering alternative options and protocols for production of low or SO₂-free wines.

WHY IS IT IMPORTANT TO REDUCE SO₂?

The amount and timing of SO₂ additions play an important role during the winemaking process. Higher doses can cause problems with fermentation kinetics, lead to stuck fermentations and color loss, and give wine an unpleasant taste, thus, affecting the wine's quality and longevity. Adding SO₂ as soon as possible to protect wine from risk of oxidation and microbial contamination can also create enological problems: appearance of reduction and increase of bound SO₂ content.

After alcoholic or malolactic fermentation, yeast and bacteria are still active for approximately 10-15 days. If SO₂ is added before that period, it will react with these microorganisms, limiting its own ability to degrade acetaldehyde and consequently combining with it and other compounds such as pyruvic acid and α-ketoglutaric acid. The result is a wine with a higher risk of acetaldehyde and hydrogen sulfite formation because there are still active enzymes that will reduce SO₂ to H₂S. This reduction of free SO₂ risks oxidation and microbial contamination. **Activated chitosan and tannins** are an effective alternative to the early addition of SO₂ post-fermentation (*see the suggested protocol at the end of the newsletter: Low or Zero SO₂ wine production*).

Enartis' SO₂-free protocol showed better quality results after the fermentation was complete: more aromatic intensity and complexity, better mouthfeel and structure, and less faults (*Table 1*). It should be noted that a minimal addition of SO₂ (20-50 ppm) before bottling is recommended to increase the

shelf life of wines that are not going to be consumed within three months after bottling.

	Wine treated with SO ₂	Wine treated with Enartis' protocol without SO ₂ addition
Volatile Acidity (g/L)	0.39	0.28
Free SO ₂ (mg/L)	10	4
Total SO ₂ (mg/L)	50	10
Acetaldehyde (mg/L)	23	12
Blind Tasting	Reduced and citrus aromas. Dry and bitter on the palate.	Fruity, clean aroma, fresh and citrus on the nose. Good balance.

Table 1: Comparison of Enartis' SO₂-free and traditional protocol on white wine with initial pH 3.38.

SO₂ ALTERNATIVES

After several years of research and experience, Enartis has observed that quality wine can be obtained even when reducing or eliminating SO₂ additions. This is due to the use of different allergen-free products that have the antioxidant, antioxidasic, and antimicrobial activities of SO₂ (*Table 2*), regardless of wine pH.

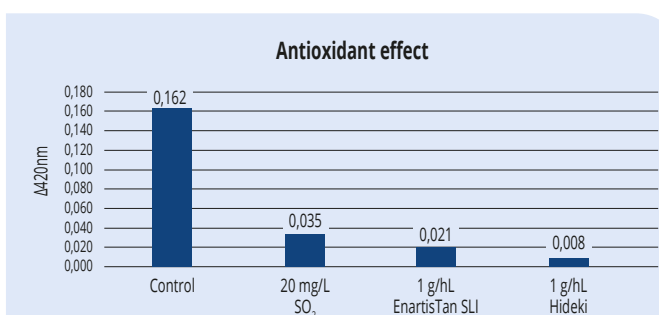
Tannins for Antioxidant and Antioxidasic Activity

Depending on the origin and chemical structure, tannins are capable of consuming oxygen, capturing free radicals, and limiting the activity of polyphenol oxidases (tyrosinase in healthy grapes and laccase in grapes affected by *Botrytis*). This helps prevent the

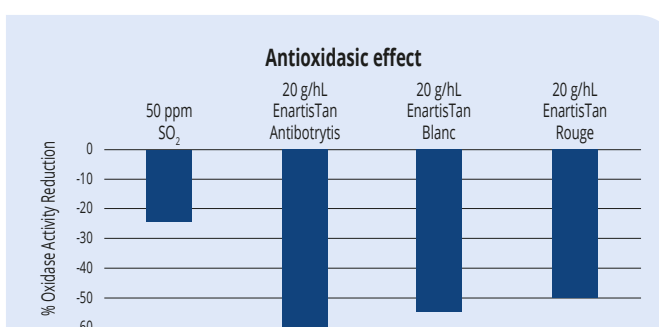
MOLECULE	ACTIVITY		
	Antimicrobial	Antioxidant	Antioxi-dasic
SO ₂			
Tannin			
Chitosan			
PVI/PVP			
PVPP			

Table 2: Efficacy of molecule according to the protective activity.
 highest protection; medium protection; no protection.

oxidation of phenolic compounds and, consequently, browning and loss of flavor and aroma. Enartis has isolated and developed the most useful tannins for specific applications to aid winemakers in handling these issues with precision (Graph 1; Graph 2).



Graph 1: White wine with high catechin content and low SO₂ coverage exposed to air for 10 days at room temperature (25°C). Optical Density (O.D.) at 420 nm was measured before and after 10 days (Δ420 nm).

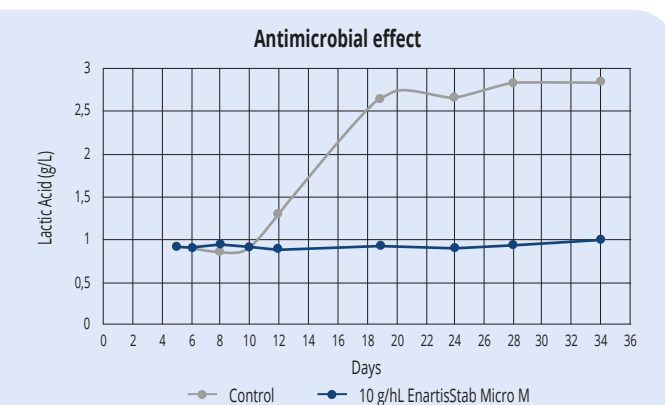


Graph 2: Inhibiting effect of tannins on laccase activity. To obtain the same antioxi-dasic effect of tannins large amounts of SO₂ are necessary.

Activated Chitosan for Antimicrobial, Antioxidant and Antioxi-dasic Activity

Activated chitosan (**EnartisStab Micro M**) is an antimicrobial fining agent that can be used at any stage during the winemaking process to control spoilage microorganisms. In addition to being allergen-free and vegan-friendly, these bioregulators' antimicrobial activity is not influenced by wine or

juice pH (Graph 3). Activated chitosan can be used to control non-*Saccharomyces* yeast, bacteria, and molds (including *Botrytis cinerea*). Furthermore, it can limit oxidation reactions by chelating metals such as copper and iron, which are catalysts of enzymatic and non-enzymatic oxidation reactions.



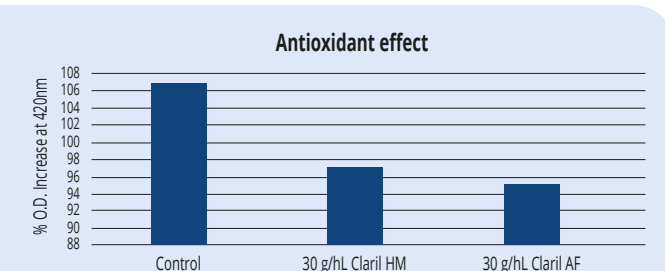
Graph 3: Difference of microbiological coverage between low SO₂ protection versus the addition of 10 g/hL EnartisStab Micro M in a wine with a high pH (3,9). The wine was inoculated with 1 g/hL of Enartis bacteria (EnartisML Silver).

PVI/PVP for Antioxidant Activity

Copolymers of polyvinylimidazole and polyvinylpyrrolidone (PVI/PVP) are used in enology to remove metals, mainly iron and copper, which are the main co-factors in the oxidation reactions of juice and wine. The synergy between PVI/PVP and activated chitosan (**Claril HM**) can significantly reduce the metal content and, consequently, limit possible oxidation problems (Graph 4).

Complex Fining Agents for Antioxidant Activity

Complex fining agents containing PVPP and pea protein are highly effective in the prevention of oxidation and pinking, as well as the reduction of bitterness. **Claril AF** uses synergy to reduce easily oxidable or oxidized polyphenols, which can cause browning (Graph 4).



Graph 4: White wine with high catechin and metal content and low SO₂ coverage exposed to air for 5 days at room temperature (25°C). Optical Density (O.D.) increase at 420 nm was measured after completing the oxidative test.

LOW OR ZERO SO₂ WINE PRODUCTION PROTOCOL

WINEMAKING PHASE	RECOMMENDED DOSE	WHITE & ROSÉ WINE	RED WINE
GRAPE RECEPTION/CRUSHER	10-20 g/100 kg	AST	
	15 g/100 kg	EnartisTan Blanc; Tan Arom	EnartisTan Rouge; Tan FT; Tan Color
	5-10 g/100 kg	EnartisStab Micro M	
PRESS/MACERATION	2 g/100 kg	EnartisZym Arom MP	EnartisZym Color Plus
JUICE CLARIFICATION	2 g/hL	EnartisZym RS	
	15-20 g/hL 40-60 mL/hL	Plantis AF or Plantis AF-Q Plantis AF-L	
	20-40 g/hL	Metal removal: Claril HM	
	40-80 g/hL	Polyphenols removal: Claril AF	
TANK FILLING	5 g/hL	EnartisTan SLI or Hideki	
YEAST INOCULATION (Select yeast with low SO ₂ production)	20 g/hL	EnartisFerm ES181 or EnartisFerm Q9	EnartisFerm ES488 or EnartisFerm WS
NUTRITION	20 g/hL	Enhance aromas: Nutriferm Arom Plus Respect varietal aroma: Nutriferm Ultra	
1/3 AF	20 g/hL*	Nutriferm Advance	
POST AF		Rack off gross lees	
	1-2 g/hL	EnartisTan SLI	
	10-20 g/hL	EnartisStab Micro M	
		After 15 days of alcoholic fermentation completion, adjust the SO₂ content to avoid H₂S and acetaldehyde formation.	
	1-3 g/hL	Hideki	
PRE-BOTTLING	20-50 g/hL	Citrostab rH	
	20-50 ppm	SO₂	

Protocol suitable for ZERO SO₂ wine production. Blue text is for LOW SO₂ production.

*recommendation: divide the total dose in two parts: 10 g/hL at 1/3 AF and 10 g/hL at 1/2 AF

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