Inspiring innovation.

ENARTIS NEWS
SO_2 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 (SO_2). 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 SO_2****, 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 SO_2 use, offering alternative options and protocols for production of low or SO_2-free wines.

WHY IS IT IMPORTANT TO REDUCE SO_2?

The amount and timing of SO_2 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 SO_2 as soon as possible to protect wine from oxidation and microbial risk contamination can also create enological problems: appearance of reduction and increase of bound SO_2 content.

After alcoholic or malolactic fermentation, yeast and bacteria are still active for approximately 10-15 days. If SO_2 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 SO_2 to H_2S. This reduction of free SO_2 risks oxidation and microbial contamination. **Activated chitosan and tannins** are an effective alternative to the early addition of SO_2 post-fermentation (*see the suggested protocol at the end of the newsletter: Low or Zero SO_2 wine production*).

Enartis' SO_2-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 SO_2 (20-50ppm) 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: Comparasion of Enartis' SO_2-free and traditional protocol on white wine with initial pH 3.38.

SO_2 ALTERNATIVES

After several years of research and experience, Enartis has observed that quality wine can be obtained even when reducing or eliminating SO_2 additions. This is due to the use of different allergen-free products that have the antioxidant, antioxidasic, and antimicrobial activities of SO_2 (*Table 2*), regardless of wine pH.

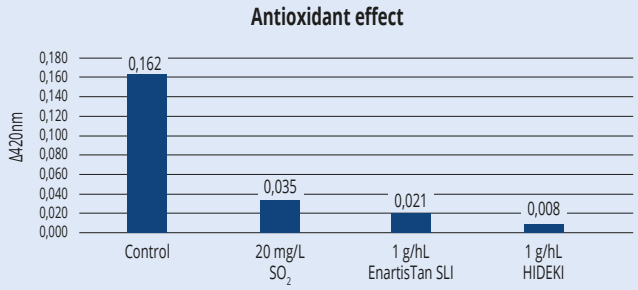
Tannins for Antioxidant and Antioxidasic Activity

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

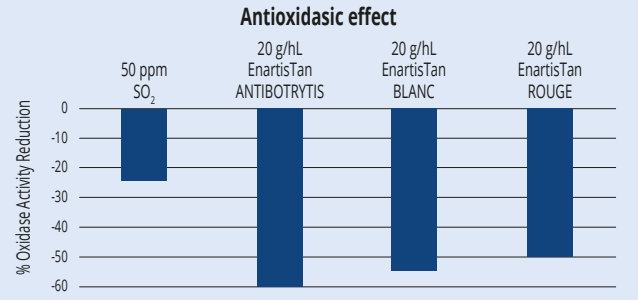
MOLECULE	ACTIVITY		
	Antimicrobial	Antioxidant	Antioxidasic
SO_2	highest	highest	highest
Tannin	medium	highest	highest
Chitosan	highest	medium	medium
PVI/PVP	no	highest	no
PVPP	no	highest	no

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*).



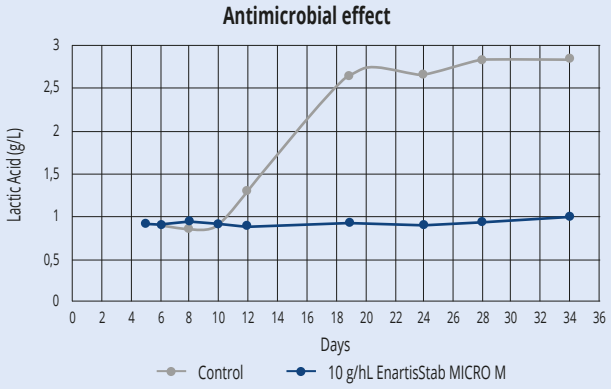
Graph 1: White wine with high catechin content and low SO_2 coverage exposed to air for 10 days at room temperature (25°C). Optical Density (O.D.) at 420 nm was measured before and after 10 days (Δ420 nm).



Graph 2: Inhibiting effect of tannins on laccase activity. To obtain the same antioxidasic effect of tannins large amounts of SO_2 are necessary.

Activated Chitosan *for Antimicrobial, Antioxidant and Antioxidasic 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.



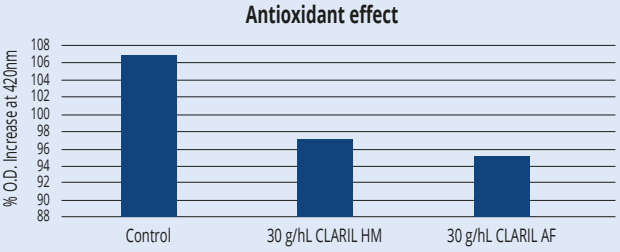
Graph 3. Difference of microbiological coverage between low SO_2 protection versus the addition of 10 g/hL Stab Micro M in a wine with a high pH (3,9). The wine was inoculated with 1 g/hL of malolactic bacteria O. oeni.

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 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 SO_2 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 SO_2 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; EnartisTan AROM	EnartisTan ROUGE; EnartisTan COLOR
	5-10 g/100 kg	EnartisStab MICRO M (recommendation: If malolactic fermentation - MLF has to take place, add EnartisStab MICRO M only after completion of MLF)	
PRESS/MACERATION	2 g/100 kg	EnartisZym AROM MP	EnartisZym COLOR PLUS
JUICE CLARIFICATION	2 g/hL	EnartisZym RS	
	15-20 g/hL	PLANTIS AF/PLANTIS AF-Q	
	20-40 g/hL	*Metal removal*: CLARIL HM	
	40-80 g/hL	*Polyphenols removal*: CLARIL AF	
TANK FILLING	5 g/hL	EnartisTan SLI	
YEAST INOCULATION (Select yeast with low SO_2 production)	20 g/hL	EnartisFerm ES181; EnartisFerm Q9	EnartisFerm ES454; EnartisFerm ES488
NUTRITION	20 g/hL	*Enhance aromas*: NUTRIFERM AROM PLUS *Respect varietal aroma*: NUTRIFERM ULTRA	
1/3 AF	20 g/hL (recommendation: divide the total dose in two parts: 10g/hL at 1/3 AF and 10g/hL at ½ AF)	NUTRIFERM SPECIAL	
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 SO_2 content to avoid H_2S and acetaldehyde formation.	
	1-3 g/hL	HIDEKI	
PRE-BOTTLING	**20-50 g/hL**	**Citrostab rH**	
	20-50 ppm	**SO_2**	

Protocol suitable for ZERO SO_2 wine production. Blue text is for LOW SO_2 production.

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