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SULFUR DIOXIDE STRATEGIES IN JUICE/MUST AND WINE

IF YOU NEED MORE ASSISTANCE WITH UNDERSTANDING SULFUR DIOXIDE CHEMISTRY AND THE ROLE IT PLAYS IN WINEMAKING…

Make sure you review the previous webinar or printable notes, **“Demystifying Sulfur Dioxide.”** This previous webinar reviews several topics associated with sulfur dioxide including how sulfur dioxide works, the antimicrobial versus antioxidant properties of sulfur dioxide, and determining the molecular concentration for antimicrobial strength at a given wine pH.

PRE-FERMENTATION SULFUR DIOXIDE (SO_2) JUICE/MUST TREATMENTS

Pre-fermentation sulfur dioxide (SO_2) additions are made to the juice (whites, rosés) or must (rosés, reds). SO_2 addition strategies differ between different styles of wine.

White and Rosé Juice:

Remember one of SO_2’s properties is that it provides antioxidant protection. While there is a lot of focus on the antimicrobial properties of SO_2, part of what makes SO_2 unique is that it also provides antioxidant protection in both juice in wines. If you struggle with this concept, please make sure to refer to the **“Demystifying Sulfur Dioxide”** webinar and webinar notes.

In white wine production, many winemakers may debate the process of adding sulfur dioxide *prior* to fermentation.

When sulfur dioxide is not added to the juice, the juice becomes brown-tinted, hence the term **“brown juice.”** What is actually happening to the juice and how it will affect the wine after fermentation:

1. **Polyphenol oxidase (PPO, tyrosinase) is activated:** The browning enzyme, PPO, is natural to many fruits and vegetables, including grapes. Without a SO_2 addition to the juice, PPO is able to brown the grape juice. This is not a concern under normal, clean fruit conditions, as the brown pigments will fall out into the lees during primary fermentation. Furthermore, PPO is inactivated as alcoholic fermentation progresses.
    a. If the fruit has experienced substantial *Botrytis* rot, laccase can also cause juice *and* wine browning. Laccase is not inhibited by fermentation or alcohol accumulation. Therefore, this set of circumstances is different than what is described above, and alternative treatment to the juice should be considered.
2. **Flavor compounds are oxidized:** Without SO_2 to scalp oxygen, grape flavor compounds can oxidize and become lost. For neutral wine grape varieties or if the goal is to produce a neutral wine, this is not a detrimental effect.
3. **Juice tannins are oxidized:** Again, the lack of SO_2 allows for the oxidation of early-extracted tannins that can remain through fermentation and cause astringency in the wine.

In contrast, the addition of sulfur dioxide to white/rosé juice can lead to what's known as **"green juice."** (Of course, for rosés, this would likely result in a purer pink color and lack any brown hue.) What is actually happening to the juice and how it will affect the wine after fermentation:

1. **Polyphenol oxidase (PPO, tyrosinase) is inhibited:** According to past 'Oxidation Summary' by B.W. Zoecklein, K. Fugelsang, and B. Gump, it only takes 25 – 75 mg/L (ppm) of SO_2 to inhibit PPO by 75 – 97%. This inhibition minimizes the existence of visually observing any brown pigmentation to the juice prior to fermentation.
2. **Oxidation of flavor compounds are inhibited:** As SO_2 scalps oxygen, stopping oxidative chemical reactions, the grape flavor compounds are preserved to their fullest extent. This reductive winemaking technique is usually preferred for aromatic wine grape varieties or for those wines produced with intentional high aromatic intensity.
3. **Oxidation of juice tannins are inhibited:** Again, the presence of SO_2 scalps oxygen that would otherwise be available for oxidative chemical reactions. Therefore, tannins extracted in the juice are preserved in the later produced wine. The result of this is usually a higher perception of astringency, and occasionally bitterness, in the finished wine.

Understanding the purpose of sulfur dioxide additions pre-fermentation should highlight that different white/rosé wine styles may require a different strategy. Neither strategy (brown juice or green juice) is often necessary across the board of all wines made by a particular winery.

Brown juice or hyperoxidation strategies are often beneficial for:

- High astringency wines in which the winemaker would like to reduce the wine astringency and enhance the wine's juiciness.

- Rosés intended to have a soft, approachable mouthfeel and neutral aromatics or flavors.
- Neutral wine grape varieties (*e.g.*, Chardonnay, Pinot Grigio, Cayuga) or those wine varieties that are destined for a neutral wine style.
- White wine varieties in which the flavors produced from malolactic fermentation or from the flavors extracted from wood/barrel are desired in higher intensity than the fruit flavors.

Green juice strategies are often beneficial for:

- Aromatic wine grape varieties (*e.g.*, Riesling, Vidal Blanc, Sauvignon Blanc).
- Rosés in which the winemaker desires more aromatics or a more astringent mouthfeel.

When winemakers opt to use a green juice strategy, failing to pay particular attention to nutrient strategies during fermentation can result in losing the aromatics and flavors that the green juice was designed to preserve. For example, thiol-rich varieties (*e.g.*, Sauvignon Blanc, Vidal Blanc) that result in hydrogen sulfide aromas (H_2S, rotten egg, hardboiled egg) will ultimately get treated with copper sulfate. As copper sulfate reacts with many sulfur-containing volatile compounds, the addition of copper sulfate to the wine will also decrease the aromatics and flavors associated with the varietal character of those varieties.

The Article, **"Fermentation Nutrition: What to Know and Why to Know It"** reviews basic concepts associated with fermentation. More detailed information about yeast nutrition can be found in the webinars and printable notes for **"YAN: Part 1,"** **"YAN: Part 2,"** and **"YAN: Part 3."** Each webinar focuses on a different aspect of yeast nutrition. Finally, winemakers that need additional guidance for creating a yeast nutritional strategy can reference the Production Guide, **Fermentation Nutrition Strategies** or contact info@dgwinemaking.com for further consultation.

Rosé and Red Must (Juice with Skins):

In red grape varieties, assuming the influence of rot or disease is minimal, I do not recommend a pre-fermentation SO_2 addition.

An exception would include those musts destined for **cold soak**. Cold soak is the application of holding musts at low temperatures (≤10°C or ≤50°F), pre-fermentation, to enhance anthocyanin extraction. Make sure the cold soak process makes sense for the wine grape variety. For example, many hybrid wine grape varieties do not require a cold soak because they naturally produce deep, red wines.

During the cold soak process, grape oxidation will also proceed. The ways to minimize oxidation of the fruit during the cold soak process is to minimize oxygen, keep the fruit cold (hence the term "cold soak"), and add an antioxidant (*e.g.*, sulfur dioxide) to scalp oxygen.

For best practices, I suggest using dry ice during a cold soak as opposed to using a chilled storage room. The reason for this is because dry ice rapidly chills the fruit and removes oxygen by carbon dioxide generation from the dry ice presence. If you are going to put a must through the cold soak process, remember to monitor must temperature to ensure it stays cold, and to only use this process on clean fruit.

POST-FERMENTATION SULFUR DIOXIDE (SO_2) WINE TREATMENTS

Recent Winemaking Research Exchange (WRE) articles made two very valid points about sulfur dioxide additions to wine:

- When a sulfur dioxide addition is made, only about one-third to one-half of the addition contributes to the free sulfur dioxide concentration (assuming normal wine circumstances like the wine was produced from clean fruit). That means, if the winemaker makes a 50 mg/L (ppm) free sulfur dioxide addition, about 25 – 33 mg/L will result as the free sulfur dioxide concentration.
- Sulfur dioxide additions are a balancing act between maintaining an adequate free sulfur dioxide concentration (either 0.5 mg/L molecular for reds or 0.85 mg/L molecular for whites/rosés) while minimizing the total sulfur dioxide concentration, which is regulated.

With that in mind, a common sulfur dioxide strategy is to **make larger, fewer doses of SO_2** over the wine's production period. This usually ends up benefiting wine quality more than making frequent smaller doses over time. The reason for this is because smaller additions do not maintain the adequate molecular concentration required to inhibit chemical processes or microbial growth. When the free SO_2 dips below the appropriate molecular concentration, components produced through chemical processes or microbial growth can later bind future SO_2 additions. What this means is: less of the addition goes towards the free and more goes to the total. Over time, this results in a free SO_2 concentration that is not adequate, but a high total SO_2 that may approach legal limits.

In contrast, adding larger additions keeps the free SO_2 above the molecular free concentration. This practice inhibits any chemical oxidation or microbial growth from occurring. Instead, the free sulfur dioxide concentrate slowly decreases as the wine is "moved" (*i.e.*, pumping, racking, filtering, etc.). Future SO_2 additions only need made as the molecular level is approached.

High Wine pH SO_2 Strategies

Wines with high pH (>3.70) are difficult to treat with SO_2. This is due to the fact that as the pH increases, the amount of sulfur dioxide to reach molecular concentration also increases. The Australian Wine Research Institute (AWRI) has previously posted free sulfur dioxide levels that are optimal for wines in bottle at certain pH's. For wines that have really high pH's, the antimicrobial molecular concentration cannot be reached. Thus, the wine is always at risk for spoilage, and additional production practices should be considered to preserve the wine.

Molecular SO_2 Targets for Wine in Bottle

In bottle, most white and rosé wines should be at 0.85 mg/L (ppm) molecular free SO_2 concentration a month or two post-bottling.

For most red wines, a 0.50 mg/L (ppm) molecular free SO_2 concentration a month or two post-bottling is desirable. There is an assumption that red wines will receive additional antimicrobial protection from other components (*e.g.*, tannins) that are natural to those varieties.

Occasionally, I recommend certain red wines should maintain a 0.85 mg/L (ppm) molecular free SO_2 concentration in the bottle. This may be due to the fact the wine is prone to spoilage, has significant sugar in the wine, or may have been problematic during production (*i.e.*, harbored a spoilage issue). For any red wine that would receive such concentration of sulfur dioxide, I recommend doing some bench trials at those sulfur dioxide concentrations. Allow the wines to sit overnight, and evaluate visually for how they look. Since the 0.85 mg/L (ppm) molecular free SO_2 concentration can bleach red wine color, it's important to understand how the wine will act with these higher SO_2 additions.

SO_2 Strategies for Bottling Wine

Keep in mind that if the wine is at the 0.85 mg/L (ppm) molecular free SO_2 concentration in the tank before bottling, there is a strong likelihood that molecular concentration will not be maintained post-bottling. This is because some of the free SO_2 will get depleted as the wine moves from tank to filter to bottle with the ingress of oxygen.

What can a winemaker do to compensate for this loss?

1. Make larger free SO_2 additions in tank so that by the time the wine reaches the bottle, it will exist at the molecular SO_2 concentration.
2. Wineries can learn their average loss of free SO_2 from the sterile filter to the bottle by sampling pre- and post-bottling for several lots of wine over time.
3. Dissolved oxygen (DO) in the wine is another important component to SO_2 consumption post-bottling. Measuring DO prior to bottling can help wineries make a decision to sparge out any unnecessary DO or compensate with extra SO_2 additions. More information on DO can be found in the webinar, **"Dissolved Oxygen."**

Bottling is the one time where double checking free and total SO_2 concentrations are quite important. Follow these guidelines to ensure the free and total SO_2 is where it is meant to be in the wine:

- Check the free and total SO_2 prior to plate-and-frame or lenticular filtration.
- Check the free and total SO_2 after plate-and-frame or lenticular filtration is complete. This is also a really good place to check the DO and adjust with nitrogen sparging, if needed.
- Adjust the SO_2, if needed.
- Confirm the free SO_2 level of the wine in tank prior to sterile filtration and bottling. Ensure it is at the level that was intended.

- Test the free SO_2 concentration in the wine after it has been in bottle 1 – 2 weeks and after 1 – 2 months to evaluate free SO_2 loss.

SULFUR DIOXIDE STRATEGIES: ACTION STEPS

1. **Implement a plan to measure SO_2 monthly.**
    a. It takes time to get comfortable with SO_2 analysis and to get consistent results.
    b. Purchase an AO system to do both free and total SO_2 (this is important, as extra parts are required for total SO_2), or a Vinmetrica 100A unit to start measuring SO_2 regularly.
    c. Take time to figure out if the results you get match the results of the same wine when it is tested by an ISO-accredited lab.
2. **If you are not using higher SO_2 additions post-fermentation (or post-MLF), start now.**
    a. For those wines in which it is appropriate, start making higher SO_2 additions.
    b. If you need help adjusting your SO_2 strategy, please contact Denise today!
3. **If you are making high pH wines, write down your SO_2 strategy.**
    a. High pH wines will not receive a 0.85 mg/L (ppm) molecular free SO_2 concentration, so it is up to the winemaker to determine what the target free and total SO_2 levels are for those wines that have a high pH. What are the targets?
    b. What other production steps can the winery take to protect high pH wines?
        i. What is the tank storage temperature? What is the appropriate temperature barrels are set at?
        ii. What is the topping up protocol for barrels?
        iii. How can the winery minimize headspace in tanks with high pH wines?

NEED MORE HELP?

If you find yourself needing further assistance or would like more access to the services that *DG Winemaking* provides, please contact Denise at info@dgwinemaking.com. See how other winemakers like you are benefiting from *DGWinemaking's* consulting services.