Copper: friend or foe?

IS COPPER REALLY MUCH OF A PROBLEM IN WINEMAKING?

It can be. Copper instabilities are one of the most common metal instabilities, mainly because of the low concentrations required to cause instability. Copper is also a catalyst for oxidation and reduction reactions and again, low concentrations can have an impact. Furthermore, copper reacts with thiols, so it can affect the varietal aromas of wines, especially those where thiols play a major role, such as Sauvignon Blanc and Cabernet Sauvignon.

WHERE DOES THE COPPER IN GRAPE JUICE COME FROM?

A portion of the copper present in grape juice originates from the soil, but it is difficult to know how much given that copper-containing fungicides are commonly used in viticulture. In fact, copper-based agrochemicals are generally the major source of copper in grape juices.

WHAT IS A HIGH COPPER CONCENTRATION IN MUST OR JUICE?

If no copper-based vineyard sprays are used, then the level of copper in the juice is likely to be less than 0.5 mg/L. If copper-based sprays are used, then the level of copper can vary depending on the number of applications, total dose applied and the time between the last application and harvest. The copper content of the juice could therefore range from less than 1 mg/L to higher than 15 mg/L.

Tromp and de Klerk (1988) found that 10–15 mg/L of copper inhibited fermentation and the resulting wines were browner than controls due to increased oxidation. Investigations conducted at the AWRI have also shown that must copper concentrations below 10 mg/L have no effect on the rate of fermentation. However, if other inhibitory factors are also present (e.g. agrochemical residues, acetic acid or high ethanol) then it is possible that levels approaching 10 mg/L of copper might have an impact.

WHAT SHOULD I DO IF THE JUICE COPPER CONCENTRATION IS HIGH?

In general, most of the copper present in juice is removed during fermentation via the formation of sulfides and through binding to yeast and removal with the lees. However, when the copper concentration of a juice is high, steps should be taken to ensure optimal fermentation conditions to minimise the risk of a sluggish or stuck fermentation.

This can be done by choosing a robust yeast, ensuring good yeast preparation, measuring yeast assimilable nitrogen (YAN) and adding diammonium phosphate (DAP) if YAN is <150 mg/L for whites or <100 mg/L for reds, adding yeast hulls or proprietary inactivated yeast product, minimising sharp or large temperature fluctuations, and keeping yeast in suspension by warming and/or agitation. Note that in order to minimise the risk of oxidation, the juice should be protected as much as possible from oxygen exposure until fermentation commences.

SHOULD I ADD COPPER DURING FERMENTATION IF THE FERMENT GIVES OFF HYDROGEN SULFIDE?

Ferments are typically treated with copper sulfate or aerated (red ferments) to remove hydrogen sulfide (H_2S) odour. However, if mercaptans are also present, aeration can lead to their oxidation to disulfides. Using copper during fermentation is generally considered to be 'safe' because any residual copper tends to be removed with the yeast lees. However, copper can react with other wine constituents or mediate oxidation reactions that can decrease the intensity of wine aroma. For example, copper can react with the fruity thiols in Sauvignon Blanc leading to a loss of varietal characters.

Yeast strain is one of the most important factors in limiting H_2S production during fermentation. Choosing a low H_2S-producing yeast strain may reduce or eliminate the need for copper fining during fermentation. The depletion of YAN is a common cause of H_2S production, especially during the early stages of fermentation when yeast growth is active. H_2S produced during the early to mid-stages of fermentation can often be ameliorated by the addition of DAP or proprietary fermentation nutrient preparations that contain nitrogen. However, DAP additions are usually ineffective against H_2S produced during the late stages of fermentation. In this situation, it might be best to perform a copper trial towards the end of fermentation when most of the sugar has been utilised, but when sufficient yeast cells are still present to bind any excess copper.

SHOULD I ADD COPPER BEFORE BOTTLING?

The AWRI has always advised against adding copper just before bottling if a wine does not actually exhibit any reductive character. This advice was initially based on the risk of post-bottling copper haze formation and the fact that copper is a catalyst for oxidation reactions. Recent studies have also reported increased accumulation of H_2S and methane thiol during bottle ageing of wines treated with copper sulfate at bottling (Ugliano et al. 2001, Viviers et al., 2013, 2014), giving another reason to avoid this practice.

For more information about copper and winemaking, please contact the AWRI helpdesk.

P: 08 8313 6600

E: helpdesk@awri.com.au

References

Tromp, A., de Klerk, C.A. 1988. Effect of copperoxychloride on the fermentation of must and wine quality. S. Afr. J. Enol. Vitic. 9: 31–36.

Ugliano, M., Kwiatkowski, M., Vidal, S., Capone, D., Siebert, T., Dieval, J.B. Aagaard, O., Waters, E.J. 2011. Evolution of 3-mercaptohexanol, hydrogen sulfide, and methyl mercaptan during bottle storage of Sauvignon Blanc wines. Effect of glutathione, copper, oxygen exposure, and closure- derived oxygen. J. Agric. Food Chem. 59(6): 2564–2572.

Viviers, M.Z., Smith, M.E., Wilkes, E., Smith, P.A. 2014. Effects of metals on the evolution of volatile sulfur compounds in wine during bottle storage. Aust. N.Z. Grapegrower Winemaker. 600: 49–51.

Viviers, M. Z., Smith, M. E., Wilkes, E., Smith, P. 2013. Effects of five metals on the evolution of hydrogen sulfide, methanethiol, and dimethyl sulfide during anaerobic storage of Chardonnay and Shiraz Wines. J. Agric. Food Chem. 61(50): 12385–12396.