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Commercial Winemaking Production Series

Wine Cold Stability Issues

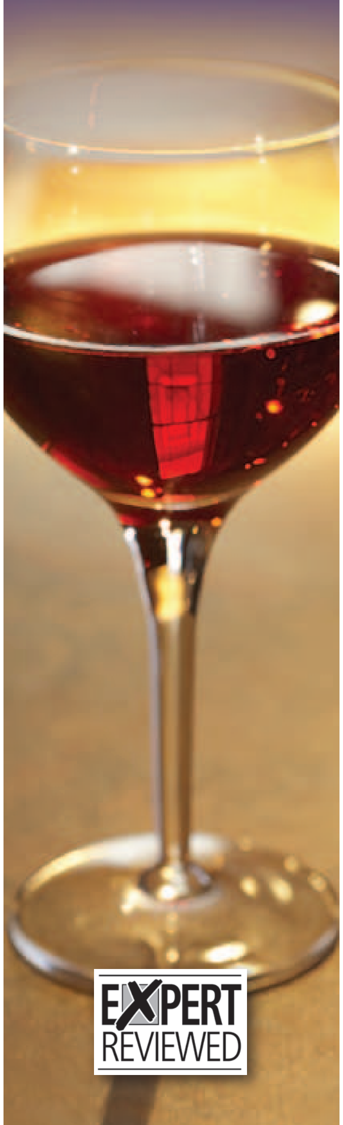
Chilling a wine can help remove 'wine diamonds'

By Christian Butzke

Enology Professor

Department of Food Science
Purdue University

butzke@purdue.edu



EXPERT REVIEWED

"Cold stabilizing" means to rid a wine of unstable potassium bitartrate ("cream of tartar"), the naturally occurring salt of the grape's tartaric acid, the major contributor to a wine's perceived tartness. Since potassium bitartrate is more soluble in water than in alcohol, the amount soluble in wine is smaller than that in grape juice. However, due to the presence of colloidal materials in wine, such as mannoproteins, pectins, and other polysaccharides, the unstable tartrate may not precipitate unless the wine is chilled or aged significantly in a tank or barrel. The deposit of harmless and tasteless potassium tartrate as visible crystals on the bottom of the bottle or wine glass may cause the consumer to mistake the "wine diamonds" for glass splinters. While only an aesthetical issue that requires wine consumer education more than winemaker intervention, it has raised concerns about potential frivolous lawsuits. Thus, the winemaker stabilizes the wine to simulate what would happen if a wine consumer placed a bottle of (white) wine into a very cold refrigerator to chill it down to, for example, 32°F. This cold stabilization is a giant waste of energy and a sad example of unnecessary over-processing of a natural product. However, because consumers expect a visually flawless product, and because more energy-efficient technology — such as a fluidized bed reactor — has not been developed far enough to allow for commercial application, traditional cold stabilization remains the practice of choice.

Potassium bitartrate crystals in a wine bottle

Since the solubility of potassium bitartrate is much reduced at lower temperatures, the winemaker usually chooses to "cold" stabilize a wine at a temperature just above the freezing point of the individual wine. The wine's freezing point is related most importantly to its alcohol content. The approximate freezing point of wine at 10 percent ethanol by volume is 25°F, at 12 percent it is 23°F, and at 14 percent it is 21°F. This means that the winemaker has a maximum stabilization window of 6 to 11 degrees, which translates into a solubility difference for potassium tartrate of between 200 and 300 mg/L, equal to 41 to 62 mg/L of potassium.

Impact of potassium additions

The time and efficacy of the cold stabilization depends on many factors, such as actual wine temperature reached, tank surface, use and size of seed crystals, etc. Assuming that the wine has reached maximum cold stabilizing at the temperature that was desired, how do further additions of sorbate, metabisulfite, or bicarbonate impact the post-bottling stability of this wine?

Potassium sorbate

The proper (maximum allowable) addition of potassium sorbate to suppress refermentation by wine yeast in the bottle is 268 mg/L (equivalent to 200 mg/L of sorbic acid). The potassium fraction of such a sorbate addition equals 70 mg/L. Note that the potassium salt of sorbic acid is very soluble in water. However, if mixed directly into a small volume of wine, the wine's acidic pH will cause the sorbate anions to combine with hydrogen ions (protons) from the grape's tartaric and malic acids to form sorbic acid molecules. This effect can be observed as white flocks of insoluble sorbic acid floating inside and atop the mixture. The same holds true if potassium sorbate is added directly to a bucket of acidified water, in a situation where the winemaking goal is to make simultaneous sorbate and citric acid adjustments before bottling. In order to avoid the flocculation of sorbic acid, it is recommended to mix up the potassium sorbate separately in a bucket of clean water, then to slowly add the solution to a gently N2-stirred tank. Any acid adjustment should be performed separately from the sorbate addition. In case white flocks have formed, continue the stirring until they have resolved. Do not attempt to skim or filter them off, as this will result in an under-dosing of the required sorbic acid and will thereby increase the potential for a refermentation.

Potassium metabisulfite

Adjusting the sulfite concentration of the wine prior to bottling has to be done according to the individual pH of the wine. It also has to account for losses of SO_2 during the filtration/bottling process itself, as well as the reaction with possible oxygen residues in the bottle headspace. Without sparging the bottle or the headspace with an inert gas after filling, a 6 mL headspace between cork and wine would contain 1.7 mg oxygen, which in turn could bind 6.7 mg of free SO_2. As an example, an addition of 50 mg/L of free SO_2 (38 mg/750 mL bottle) would add another 30 mg/L potassium to the wine.

In the case of combining potassium sorbate and potassium metabisulfite treatments immediately prior to bottling, the extra 100 mg/L of potassium would clearly comprise the cold stability of the wine, which at best could only keep soluble 41 to 62 mg/L of the additional potassium. That means the wine might be cold stable only down to 37°F instead of 32°F. An issue can arise when the bottled wine is shipped during the wintertime to a cold region in a non-insulated truck.

Potassium bicarbonate

If the wine's acidity has to be adjusted chemically, the addition of potassium bicarbonate is recommended as it does not cause the stability problems associated with calcium salts that do not respond to cold stabilization. The recommended treatment limit for potassium bicarbonate is 1,000 mg/L, which neutralizes the equivalent of 1.5 g/L (0.15%) titratable acidity (T.A.). Deacidifying a wine with 1,000 mg/L $KHCO_3$ will add 386 mg/L of potassium. Even higher doses would make the wine taste salty. This substantial increase in potassium will require cold-stabilization after the treatment. While the reaction between the bicarbonate and the tartaric acid in the

wine is instantaneous given proper mixing, the ensuing release of carbon dioxide gas and thus possible foam formation require a tank headspace at least 25 percent of the wine volume. The wine will keep a full saturation with carbon dioxide, therefore a sparging with nitrogen is recommended to strip the wine of the majority of the CO_2. Otherwise, there will a significant increase in perceived crispness associated with higher concentrations of this acidic and very soluble gas. The saturation concentration of carbon dioxide at 50°F is about 2,000 mg/L (100 times that of nitrogen) or the equivalent of 3.6 g/L T.A. as tartaric acid. Recommendations for residual dissolved CO_2 for wines range from 200 to 800 mg/L for reds and from 700 to 1,800 mg/L for whites to avoid "flabby" tasting wines. In the United States, the legal limit for CO_2 in "still" wine is 3,920 mg/L, a concentration difficult to reach without carbonation or refermentation; in the OIV countries, it is 1,000 mg/L, about half the saturation at cellar temperature.

Reference

Principles and Practices of Winemaking. R. B. Boulton et al, p. 434, Springer 1996.

Reviewed by:

Richard Linton
Professor of Food Science and
Director of the Center for Food Safety Engineering
Department of Food Science, Purdue University

Bruce Bordelon
Viticulture Professor
Department of Horticulture & Landscape Architecture, Purdue University