Optimising refrigeration usage for cold stabilisation of wines

Greg Howell and Marco Vallesi
Vintessential Laboratories

Introduction

The prevention of tartrate crystals in bottled wine is an important task for the winemaker. Although the crystals are harmless, the average consumer isn't likely to see it that way. With all the talk of contamination of foodstuffs, it is deemed necessary to ensure that wine is cold stable, i.e. that no tartrate crystals are present in the finished product.

Cold stabilisation of wines takes a considerable amount of refrigeration power, and can cost a considerable amount of money. Winemakers should always strive to use the minimum amount of refrigeration to make the wine cold stable. Not enough refrigeration and the wine won't be stable, although too much refrigeration will certainly make the wine stable but will waste refrigeration resources unnecessarily.

Several techniques are in use to check the cold stability (also known as tartrate stability) of a wine. The most commonly used techniques will be discussed in this article.

Chemistry

The chemistry of tartrate stability is quite simple in theory, but a number of factors exist that make it a bit more complex in practice.

The crystals in question that are formed in wine are potassium hydrogen tartrate (KHT), also known as potassium bitartrate. The crystals form when the wine is no longer able to keep them dissolved. Both potassium ions and tartaric acid are present in the grape at picking and so in the juice at crushing/pressing. However during winemaking changes occur, the major one being that alcohol is formed. Many ions such as hydrogen tartrate are less soluble in a water/ethanol mixture than in pure water itself and so can precipitate out as the composition of the wine changes.

Other changes such as pH, addition of more acid species, temperature changes and the presence of high moleculare weight materials such as proteins and polyphenolics, also affect the solubility of KHT.

Calcium tartrate crystals can also be formed in wine. This is much less common and will not be discussed in this article. Suffice to say that formation of calcium tartrate is time dependent and can take months to develop. Therefore calcium-based additives should be avoided.

Tests

Several different techniques are in use to check the cold stability of any particular wine. They range from simple non-laboratory checks to lab tests that require more sophisticated equipment. None of the tests are difficult to perform if carried out with some care. However, it is important to note that not all the tests discussed are recommended as reliable indicators of cold stability. They are simply discussed as they all still appear to be used in the Australian wine industry, sometimes with disastrous consequences, as we will see. Each one of the tests will be discussed below:

1. Conductivity Change
This test requires the most equipment of all tests discussed and therefore is the most costly to set. The major pieces needed are a refrigerated waterbath and a conductivity meter with a temperature probe. The test requires a wine sample to be cooled to 0^oC and its conductivity measured. Finely ground, pure KHT is then added to the sample and the conductivity measured again until a constant reading is produced. A change in conductivity over a set limit is regarded as unstable. A limit of between 3% and 5% is quoted as being generally accepted, however variation of this criteria between wineries is also noted[1].

An extensive study of cold stability methods by Leske et al[2] found several problems with this technique and stated; “the (conductivity) method is inappropriate for the prediction of cold stability”.

We have not used this technique in our own lab, but we have some clients who do. One client who previously used the conductivity method, stopped doing so after a container of their wine had to be recalled from English supermarket shelves after a tartrate deposit formed. A very expensive lesson indeed! Although we had performed the testing needed for Export Certificates for this winery, cold stability testing is not generally needed for these Certificates.

Needless to say, we do not recommend the conductivity method.

2. Concentration Product
This method uses the concentration of potassium, tartaric acid, alcohol and pH to compute a number that is then compared to published limits for different wine styles. Table 1 below shows a typical set of limits[1]:

Wine type	**CP values x 10^{-5}**
Dry white	9.4
Rose	8.8
Dry red	17.6
Sweet white	6.8
Port	10.6
Sherry	5.7

Obviously one major drawback of this technique is to do all the measurements first assuming the winery lab has the relevant equipment. This would only be so for a very small number of large winery labs. A further complication is that there is a range of published limits and that disagreement appears to exist as to which is the better set of limits to use. Due to these constraints, this technique does not appear to be very popular in the industry.

3. Freeze/thaw

This test is relatively simple and requires no special equipment. A sample of filtered wine is placed in a commercial freezer for a set period of time (usually at least overnight), and then allowed to thaw out to ambient temperature. Any crystals observed after thawing indicate that the wine is not cold stable.

In the Leske study, it was observed that this test tends to be more severe than others and so could lead to longer treatment times for the wine than is necessary, thereby using more refrigeration power than optimal. Other authors have also observed this [3,4]. It was also pointed out that conditions of this test are not standardised and so some variation of results would be expected. In fact, different freezer compartment temperatures were measured and found to vary from –10 to –27^{o}C.

4. Storage at –4^{o}C for 72 hours

This test is the one that appears to be the most commonly used. We use this method in our lab and the only major piece of equipment required is a small waterbath that is capable of holding a temperature of – 4^{o}C.

Samples are filtered, held at -4^{o}C for 72 hours and then inspected under bright light for any crystal formation. The samples are further examined after warming to ambient temperature, and if crystals are still present then the wine is deemed unstable.

As stated above this is quite an easy test to perform. It is important to ensure the bath temperature is accurately measured and that the wine is well filtered into clean containers. Obviously one drawback of this method is that it takes 3 days to perform.

The Leske study showed that the wines checked by this method compared best with long term storage stability of wines.

Conclusion

In order to achieve cold stable wine with the optimum use of refrigeration, a sample of the stabilised wine should be tested. Four different test methods have been reviewed. It is recommended that the “Storage at –4^{o}C for 72 hours” test be used as the best guide for cold stable wine.

References

1. Iland, P; Ewart, A; Sitters, J; Markides, A; Bruer, N.G.C; “Techniques for Chemical Analysis and Quality Monitoring During Winemaking”, 2000,

2. Leske, P.A; Bruer, N.G.C; Coulter, A.D; “Potassium tartrate – how stable is stable?” Proceedings of 9th Australian Wine Industry Technical Conference, Adelaide, South Australia, 1995, 39-45

3. Rankine, B.C; Pocock, K.F; “Wine stability tests for quality control”, Aust. Wine Brew. Spirit Rev; 96, 12, 1976, 24-25

4. Baldwin, G.E; “Tartrate instability; chemistry, testing and physical methods of removal”, Proceedings of ASVO Seminar, Reynella, SA, 1986, 5-14