Acidity in all its various aspects

THE AWRI often receives queries relating to various aspects of acidity. Given the importance of pH to the stability and development of wine and the importance of titratable acidity (TA) to wine's sensory properties, this article answers some of the more common acidity-related questions.

What is the relationship between pH and titratable acidity?

The pH of a wine or juice is a measure of the concentration of free hydrogen ions in solution, whilst the TA is a measure of the total amount of hydrogen ions. Based on these definitions, one might be tempted to think there is a relationship between the pH and the TA in juices and wines. Unfortunately, there is no direct or predictable relationship between pH and TA, and the same titratable acidity can be measured in different juices with either low pH or high pH. The pH is not correlated with the concentration of acids present, but is influenced by their ability to dissociate.

Is it best to adjust acidity to a pH or titratable acidity value?

Of course, one would hope that the pH can be adjusted to the desired value and at the same time achieve the desired TA value. However, if the desired values of both parameters cannot be achieved, then preference should be given to the pH, particularly with musts. This is because pH plays an important role in many aspects of winemaking and wine stability. The pH influences microbiological stability, affects the equilibrium of the tartrate salts, determines the effectiveness of sulfur dioxide and enzyme additions, influences the solubility of proteins and effectiveness of bentonite and affects red wine colour and oxidative and browning reactions (Boulton et al. 1996).

It is best to adjust the acid as early as possible as juice and wine are more stable at lower pH. In the case of red musts, it is advisable to adjust the pH to pH 3.4 or lower. If the desirable TA cannot be achieved, then the must should be adjusted to pH 3.4 regardless of the amount of tartaric acid required to do so. Note that a large amount of the added acid will precipitate later as KHT, resulting in a decrease in the TA. Given that the pH of red wines is likely to rise during fermentation, due to the leaching of potassium ions from the skins, it is recommended that the pH be measured during fermentation on skins and that additions be made to maintain the pH in the range 3.4 – 3.5.

Why is the titratable acidity less than the sum of the individual acids?

If all the individual acids in a wine are expressed as tartaric acid equivalents and summed, the value for the total acid concentration will be greater than the value for the titratable acidity concentration. This is because the total acidity is the sum of all the organic acid anions in solution, while the titratable acidity measures the total available hydrogen ions in solution. The titratable acidity will always be less than would be expected from the organic acid concentration (Boulton et al. 1996). This is because total acidity analysis measures both the dissociated and undissociated forms of each individual acid. As an example, if a solution of 1 g/L tartrate, as KHT, is analysed for titratable acidity, the result will be 0.5 g/L expressed as tartaric acid. However, if the solution is analysed for total acidity, using HPLC for example, the result will be 1 g/L as tartrate.

What could cause the titratable acidity to increase during fermentation?

Winemakers are generally used to observing TA decreases during fermentation due to the precipitation of potassium bitartrate (KHT), which becomes less soluble with increasing ethanol concentration. When the KHT precipitates, it removes a proton from solution that would otherwise have contributed to the TA concentration. Winemakers are generally less used, however, to increases in TA during fermentation.

When TA increases are observed, they are almost always associated with red wine ferments. Given it is difficult to obtain a homogeneous sample of red must immediately after crushing, inaccurate must titratable acidity results can sometimes explain TA discrepancies. Analytical error might also explain TA variations in some cases, whilst errors in tartaric acid additions due to inaccurate weighing might explain the results in others. If analytical error and other factors, such as a high acetic acid concentration can be ruled out, then increases in TA can often be attributed to increased concentrations of succinic acid.

Succinic acid is a normal by-product of alcoholic fermentation and its mean concentration in red and white Australian wines is in the order of 1.2 g/L and 0.6 g/L, respectively. However, concentrations as high as 3.0 g/L have been recorded in red wines for which TA increases have been observed (AWRI publication #817).

Yeast strain appears to be an important variable affecting the amount of succinic acid produced. However, a number of other factors might also influence the production of succinic acid, including fermentation temperature, aeration, must clarity and composition (e.g. sugar concentration, nutrient content, pH, titratable acidity, presence of excess SO^{2}), and other environmental factors (AWRI publication #817). It is not currently possible to predict with certainty whether a fermentation will produce a higher than usual amount of succinic acid. However, selection of a known high succinic acid producing yeast strain, used in combination with several of the factors mentioned above, will increase the chance of increased TA.

REFERENCES

1. Boulton, R.B.; Singleton, V.L.; Bisson, L.F.; Kunkee, R.E. (1996) Principles and practices of winemaking. New York: Chapman & Hall: 521–253.

2. AWRI publication #817 Coulter, A.D.; Godden, P.W.; Pretorius, I.S. (2004) Succinic acid—How it is formed, what is its effect on titratable acidity, and what factors influence its concentration in wine? Aust. N.Z. Wine Ind. J. 19(6); 16–20, 22–25.

GW