JUICE AND WINE ACIDITY

The acidity of a juice or wine, in particular the pH, plays an important role in many aspects of winemaking and wine stability (see also Chapters 3, 8, and 12). The ability of most bacteria to grow, the solubility of the tartrate salts, the effectiveness of sulfur dioxide, ascorbic acid, and enzyme additions, the solubility of proteins and effectiveness of bentonite, the polymerization of the color pigments, as well as oxidative and browning reactions are all influenced by the juice or wine pH. The titratable acidity is an important parameter in the sensory evaluation of finished wines. It and the pH are also important in aging reactions.

In certain situations, the conditions of grape development and maturation or microbial and physical changes during winemaking can cause imbalance in the acidity of wines and corrections are required to ensure the desired values. It is for these reasons that a comprehensive consideration of both juice and wine acidity is presented.

The acidity has four main features, the acids themselves, the extent of their dissociation, the resultant titratable acidity, and pH. Although the titratable acidity and pH are easily measured quantities these values tell little about the nature of the underlying acid mixture. They are resultant or dependent measures and it is the acids themselves and their concentrations that actually determine the structure of the juice acidity. It is important to realize that the values of pH and titratable acidity are also not unique, there are various combinations of the different acids and neutralization that can give the same pH and titratable acidity values.

The final aspect of the acidity relates to the extent to which the equilibrium is altered as the concentrations of the acids change. This is referred to as the buffering or buffer capacity of the mixture. It will determine the change in pH accompanying carbonate deacidifications, the malolactic fermentation, or the addition or precipitation of tartaric acid during winemaking.

A. ACID CONCENTRATIONS

1. Tartaric Acid

Tartaric acid is present in grapes at levels of between 5 to 10 g/L and is usually the major...
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Acid in juices and wines. It is characteristic of grapes and is not found in other common fruits. Its concentration is primarily determined by synthesis, which is cultivar-dependent, and the final berry volume at harvest. The isomer found in grapes is the L(+)-form and appears to be synthesized from glucose via galacturonic, glucuronic, and ascorbic acids (Saito and Kasai 1978). Tartaric acid is partially converted to gluconic and other acids by Botrytis cinerea and is degraded at a pH above 4 by a few bacterial strains. It is not modified by microorganisms at wine pH levels. Its partially soluble salts of potassium bitartrate and calcium tartrate are involved in the physical stability of wines (refer to Chapter 8 for a more complete discussion of this). Slowly with time in wine a portion is esterified with ethanol to ethyl bitartrate (Edwards et al. 1985).

2. Malic Acid

Malic acid, the most widespread fruit acid, is present in grapes at concentrations in the range 2 to 4 g/L generally. It can be as high as 6 g/L in small berries in cool growing conditions and nearly absent in overripe grapes from hot growing regions. The levels vary considerably with cultivar and respiration due to temperature conditions during maturation. Its final concentration is also influenced by berry volume. The malic acid isomer found in grapes is the L(+)-form and it is synthesized from glucose via pyruvic acid.

Malic acid is converted almost completely into lactic acid by the malolactic fermentation. It has limited solubility as the calcium salt and can be partially removed during calcium carbonate treatment and by yeast fermentation.

3. Amino Acids

The amino acids of grape juice are generally in the range of 1 to 3 g/L depending on cultivar, the availability of nitrogen during maturation, the growing conditions, and the berry volume. The major acid is usually arginine at levels of 200 to 800 mg/L and most cultivars are also high in proline at the 750- to 1500-mg/L level. Nitrogen-rich acids such as glutamine, asparagine, glutamic, and aspartic acids are usually high when nitrogen is readily available during the growing season. The nitrogen content usually assimilated by yeast includes all of the amino acids other than proline, weighted according to the number of available amine groups per molecule, together with the ammonia content. It is the most relevant of several aggregate nitrogen measures for correlating yeast growth rates and fermentation rates. Most of the amino acids will be taken up and incorporated into yeast cell mass during fermentation and thus do not contribute significantly to the buffer capacity of wines.

4. Inorganic Acids

The basic inorganic species that are transported into the berries during maturation are involved to a lesser degree in the pH and buffer capacity of juices and wines. Components such as phosphate can be found at natural levels of 300 mg/L in wine depending on the cultivar and berry volume. The average natural sulfate content of wine is 775 mg/L (Ough and Amerine 1988), also depending on cultivar and berry volume. There are also known effects on the inorganic anion content due to the rootstock, but the form of the ions actually taken up (i.e., dihydrogen or monohydrogen phosphate, or hydrogen sulfate or sulfate) is not well resolved. There will be slight effects on the acidity and buffer capacity of juices due to large additions of diammonium phosphate and these will change due to their utilization during fermentation.

5. Lactic and Succinic Acids

The lactic acid in wines is primarily derived from malic acid during the malolactic fermentation. The concentrations in wines can range from 0 to 2.5 g/L and the form produced from malic acid is the L(+) isomer. The lactic acid salts are quite soluble under wine conditions, and once formed this acid undergoes little change in concentration.