Acidity – Frequently asked questions PART 1

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Basic Wine

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Acidity's importance to wine cannot be understated, as it contributes **freshness**, acts as **a preserving agent**, and helps, notably, with microbial **stability**. Knowing the acid level of a wine is, is a huge consideration for a winemaker and will influence many winemaking decisions. 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 blog post addresses some of the more common acidity-related questions and misconceptions.

What are total acidity, titratable acidity and pH in wine?

Titratable acidity (TA):

Titratable acidity is a measure of the **total amount of available hydrogen ions** (protons) in solution. This is determined by titration with a strong base to a specified endpoint. Titratable acidity is typically quantified in terms of g/L of tartaric acid, as if it were a quantification of only tartaric acid. However, titratable acidity is not a single acid measurement and is made up of contributions from tartaric, malic, succinic, lactic, acetic and citric acids, with minor contributions from a range of other acids.

Total acidity:

Total acidity is the **sum of all the organic acids** in solution. It, therefore, measures both the dissociated and undissociated forms of each individual acid. Measuring total acidity is difficult as it requires the ability to directly quantify organic acids.

pH:

The pH of juice or wine is a **measure of the strength and concentration of the dissociated acids** present in that medium. It is calculated using the concentration of hydrogen ions in the formula $pH = -\log_{10}[H^+]$. For example, the difference between a wine with pH 4.0 and a wine with pH 3.0 is that the wine with a pH of 3.0 has 10 times the number of hydrogen ions compared to a wine of pH 4.0.

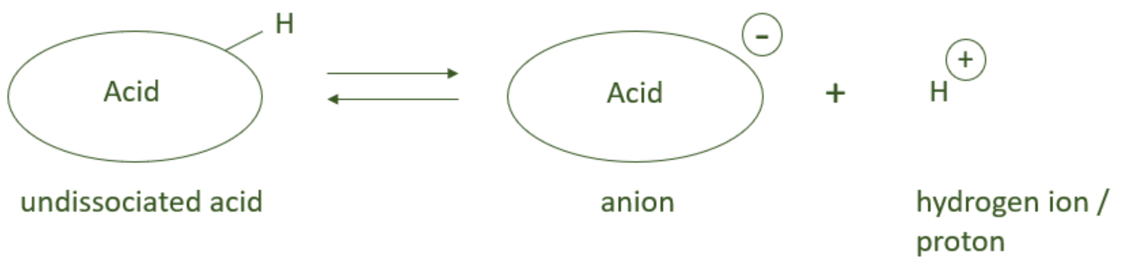

Figure 1. Oversimplified demonstration of acid dissociation

Why is pH important?

Often referred to as real acidity, **pH affects all aspects of winemaking**. The pH of a wine influences the microbiological stability, affects the equilibrium of tartrate salts, determines the effectiveness of sulfur dioxide and enzyme additions, influences the solubility of proteins and the effectiveness of bentonite and affects wine colour and oxidative and browning reactions. Higher pHs in musts and wines generate microbiological instabilities and organoleptic alterations such as colour changes and lead to poor ageing capacity.

What is the difference between total acidity and titratable acidity?

Many use titratable acidity and total acidity interchangeably, but **it is not the same**. If all the individual acids in wine were expressed as tartaric acid equivalents and summed, the total acid concentration would be greater than the value for the titratable acidity concentration.

The titratable acidity is always less than the total acidity because **not all of the hydrogen ions expected from the acids are found dissociated during the determination of titratable acidity**. Total acidity is the sum of all the organic acids in solution (dissociated and undissociated), while titratable acidity measures the total available (dissociated) hydrogen ions in solution.

In the winery, **titratable acidity is the best practical expression of the organic acid concentration** within must or wine and is considered to be the **better way to measure perceivable acidity**. Another reason we use titratable acidity more frequently is that it is **easier to measure** (titration) with most wine producers having some ability to measure it, either by simple titration with a pH meter or by more sophisticated equipment such as auto-titrators or FTIR spectrophotometers. Measuring total acidity requires the ability to directly quantify organic acids which is a much more complex process.

What is the relationship between pH and titratable acidity?

While acid content affects pH, there is **no direct or predictable relationship between pH and titratable acidity**. The same titratable acidity can be measured in different juices with very different pH values. This non-direct correlation is partially due to pH "buffering" caused by a number of compounds in wines, such as sugars, acids, and phenolic compounds. The pH is not correlated with the concentration of acids present, but rather the **strength of the acids** (the acid's ability to dissociate).

What is the difference between volatile and fixed acids?

Traditionally total acidity is divided into two groups, namely the volatile acids and the nonvolatile or fixed acids. **Fixed acidity** corresponds to the set of **low-volatility organic acids** such as malic, lactic, tartaric or citric acids while **volatile acidity** corresponds to the set of short-chain organic acids that can be **extracted from the sample using a distillation** process: formic acid, acetic acid, propionic acid and butyric acid.

What are the most important fixed acids in wine?

The predominant fixed acids found in wines are tartaric, malic, citric, lactic and succinic acid. The Australian Wine Research Institute (AWRI) completed an analysis of the organic acid profile of 277 red and white wines during 2010 to 2015[1]. The **relative proportions of these acids in wine can have a significant impact on flavour as well as the outcomes of winemaking interventions** such as acid adjustments and cold stabilisation. The relative proportions of organic acids in red and white wine are shown below[1]:

Acid	Proportion of acid (%)	
	Red wine	White wine
Acetic acid	7.4	5.8
Citric acid	1.5	2.3
Lactic acid	15.6	7.3
Malic acid	14.8	30.8
Succinic acid	21.4	13.6
Tartaric acid	39.2	40.2

Tartaric, malic and citric acids are derived from grapes while succinic, lactic and acetic acid are formed through yeast and bacterial activity.

How do you increase the acidity of musts or wines?

Chemical acidification (the addition of organic acids especially tartaric acid) has been the traditional method for adjusting the acidity to the desired concentration and is still the most common method used by International Organisation of Vine and Wine (OIV) country members[2]. It is **relatively easy** to do and the amount of acid to be added can be determined by bench tests and using web-based calculators. Other than chemical acidification, other methods of adjusting the acidity include the **blending** of low-acid musts/wines with high-acid musts/wines as well as **membrane** techniques.

Do I make acid adjustment decisions based on pH or titratable acidity?

Titratable acidity and pH are two different measures: **Titratable acidity provides information regarding the concentration of acids and will tell you more about the perception of tartness, while pH provides more information on the acid strength and tells you more on the microbial and chemical stability of the wine.**

One would hope that the pH can be adjusted to the desired value and at the same time achieve the desired titratable acidity 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.

How do I choose an acid for chemical acidification?

Many factors need to be considered when choosing an acid for correcting too high pHs, the most important being the local and international **permissions** for the use of the product. The **acidifying power** of the acid and the **cost of the product** are also fundamental criteria as well as the **practicality of use (storage and addition)**. Moreover, the addition of the acid must **neither diminish the general**

quality of the wine nor **negatively modify its organoleptic properties**. It must imperatively **maintain or even improve the stability** of the product during storage.

How do the acids differ in acidification power?

Acids differ significantly in their acidification power. Some acids are stronger than others, meaning that they release more hydrogen ions into the solution per weight. A recent study[2] investigated the acidification power of the main acids by reporting the acid concentration needed to decrease the pH by 0.1 units **in real musts and wines**. Results showed that the **amount of fumaric acid and tartaric needed to decrease the pH was systematically lower when compared to the other acids** included in the study (citric acid, malic acid and lactic acid). These two acids, therefore, had higher acidifying power in musts and wines. It is interesting to note that significantly less (30%) fumaric acid was needed to lower the pH when compared to tartaric acid. Lactic acid was found to be the weakest acid.

The strengths of the studied acids were classified as follows (tested in real musts and wines):
For musts: Fumaric acid > Tartaric acid > Citric acid ≈ Malic acid > Lactic acid
For Sauvignon blanc wine: Fumaric acid > Tartaric acid > Malic acid > Citric acid ≈ Lactic acid
For red wines: Fumaric acid > Tartaric acid > Malic acid > Citric acid > Lactic acid

How does the solubility of the different acids compare?

A study[2] compared the solubility of the main acids used in winemaking (tartaric, malic, citric and fumaric acid). Results showed that **citric acid was the most soluble followed by malic and tartaric acid, which in many cases were very similar in their solubility. Fumaric acid showed the lowest solubility**.

References[3,4]

(1) Wilkes, E. N. Wine Acids, Not Just Tartaric. *The Australian Wine Research Institute Technical Review* **2016**, *221*.
(2) Gancel, A.L.; Payan, C.; Koltunova, T.; Jourdes, M.; Christmann, M.; Teissedre, P.-L. Solubility, Acidifying Power and Sensory Properties of Fumaric Acid in Water, Hydro-Alcoholic Solutions, Musts and Wines Compared to Tartaric, Malic, Lactic and Citric Acids. *OENO One* **2022**, *56* (3), 137–154. https://doi.org/10.20870/oeno-one.2022.56.3.5455.
(3) De Klerk, J.L. Succinic Acid Production by Wine Yeasts, Stellenbosch University, 2010.
(4) The Australian Wine Research Institute. Acidity and pH. *The Australian Wine Research Institute Website*.