Lactic acid in acidification of musts & wines

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WINE ACIDS

Of all 400 components of wine, one of the most important is acids.

Wine includes the fixed organic acids from the grape, synthesized in leaves and clusters. Of these, tartaric and malic acids account for over 90%.

Tartaric acid is found in the form of L-isomer(+), in quantities of 20 to 25 g/l at veraison and from 3.5 to 11.5 g/l at maturation.

High temperatures tend to consume large quantities of tartaric acid by combustion, while the existence of moisture increases the presence of this acid in the grapes.

Malic acid is an intermediary product of the grape cluster, forming the L-isomer(-) and accumulating significantly in the unripe stage.

From veraison onward, the concentration of malic acid begins to drop, until it reaches 1 to 5 g/l of must due to sugar processing or aerobic combustion.

If malolactic fermentation ensues, the concentration of malic acid decreases by 50%, going from an initial acidity at harvest of 20 - 40% of total acids, to 10 to 20% after this fermentation.

Citric acid is found in a smaller amount, between 0.2 to 0.5 g/l, located mainly in the roots of the vine in significant quantities, and in the course of travelling to the leaves is transformed by oxidation into malic acid.

These acids, along with sugars, form phenolic compounds and salts, which can be regarded as the basic structure of wine.

Besides these acids, the vine is capable of forming other acids in much smaller quantities, such as glyoxylic, ketoglutaric, galacturonic, fumaric, glycolic, glyceric, oxalic, pyruvic, oxalacetic acids, and so on.

In the course of alcohol fermentation, and due to bacterial activity, other acids occur, such as succinic, lactic, acetic and gluconic acid.

The wines in which tartaric acid predominates are more acid and harder than those in which there is more lactic, malic, citric or succinic acids, which feature a more candid, fine and pleasant acidity.

Old wines that have lost most of their tartaric acid acquire certain fineness.

ACIDITY CORRECTIONS

Acidity correction in grape harvests—must or wine—either by excess or by default, is generally considered less important than sugar correction. But from a technical perspective, acidity correction is very important to give wines a proper balance, as well as contribute to some important aspects such as their preservation and development.

Certain viticultural practices make it possible to modify the acidity levels of grape harvests, addressing fertilisation issues particularly affecting potassium, as well as irrigation and vineyard productivity.

By choosing an appropriate harvest date, the optimum level of acidity can be determined, although to limited by the balance of other components of the harvest.
For EU member states, acidification is regulated by the Council Regulation governing the organisation of the wine market, on "Authorised oenological practices and processes":

<table>
<thead>
<tr>
<th>Viticultural Regions</th>
<th>Acidification</th>
<th>Deacidification</th>
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<tbody>
<tr>
<td>A, B, CII-a, CII-b</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>CII, CIII-a</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>CIII-b</td>
<td>Yes</td>
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The general principles relating to acidification are as follows:

1. Acidification is permitted in wine-growing regions CII, CIIIa and CIIIb.
2. With fresh grapes, grape must, partially fermented grape must and new wine still in fermentation, the acidification limit is 1.5 g/l, expressed in tartaric acid, or 20 meq/l.
3. In wines, the acidification limit is 2.5 g/l, expressed as tartaric acid, or 33.3 meq/l.
4. Acidification and artificial increase of naturally-occurring alcohol, and acidification and deacidification of the same product, are mutually exclusive.
5. Acidification has to be done by direct addition of authorised organic acids; the use of mineral acids is expressly prohibited.
6. Natural tartaric acid in its L(+) form is what should be used, excluding the isomeric forms of this acid, especially the synthesis racemic or DL-tartaric acid.
   Tartaric acid for acidification of musts and wines, also called L-tartaric acid, must be of agricultural origin, extracted mostly from grape products.
   It must also comply with the purity criteria stipulated in Commission Directive 96/77/EC.
   The provisions relating to control of the use of tartaric acid are established by each member state.
7. The practice of delayed acidification with tartaric acid immediately prior to bottling is not advisable, as it gives wines the dry and hard palate associated with this acid.
8. The addition of citric acid for wine stabilisation is legally limited to a total content of 1 g/l, a figure which includes the small amount in the grapes, estimated at about 0.3 g/l.
9. Final stabilisation with citric acid is done mainly with white wines—which are already well stabilized and free of possible bacterial growth—in order to give them certain freshness.
10. Correcting the acidity of red wines with citric acid is not advisable because of the increased risk of bacterial attack, with an increase in volatile acidity.
11. Ascorbic acid, with a legal limit of 100 mg/l, is used as an antioxidant, as is the case of sulphur dioxide.

**HISTORICAL BACKGROUND ON THE ACIDIFICATION OF MUSTS AND WINES**

The exclusive use of tartaric acid for acidification is now a thing of the past, mainly due to the hard and astringent taste it confers to wines, compared with the smoothness and better mouthfeel provided by lactic acid.

The International Organisation of Vine and Wine (OIV), prepared two draft resolutions that were voted on in the General Assembly in July 1999, adopted in Paris on 30 August, 1999. These are resolutions OENO 3/99 on chemical acidification of musts and OENO 4/99 on chemical acidification of wines. Both were approved with the condition that the limits or levels of acidification be set by the General Assembly by 2001 at the latest.
The aims of these resolutions include:

1. increase titratable acidity or total acidity and real acidity (lower pH) by adding organic acids
2. develop organoleptically balanced wines
3. promote proper biological development and a successful maturation of the wine
4. correction of insufficient natural acidity of wines from warm climates or due to oenological practices that involve a decrease of natural acidity
5. The adding of acids should not be done to conceal a fraud. The use of mineral acids is also banned.

As a result of the condition prescribed in these resolutions, in March 2001 several groups of experts met in joint sessions at the head office of OIV in Paris to discuss the draft resolutions, among which was the second item on the agenda, entitled “Ceilings for acidification of musts and wines.” Participants included experts in wine microbiology, wine technology and in the International Code of oenological practices.

After a lengthy discussion and exchange of views, the group decided to modify the project so that it specified a limit relative to the increase in acidity more than to the amount of acid added.

This amended draft was submitted to the 2001 General Assembly held in Adelaide (Australia). It was adopted with language in favour of more flexible specific viewpoints by Australia, South Africa and New Zealand.

The limitation determined and expressed in Resolutions OENO 13/2001 and OENO 14/2001 specifies that for musts and wines, acids may only be added provided that they don’t increase acidity beyond 4 g/l, expressed in tartaric acid.

When wine and its must of origin are acidified, the cumulative net increase should not exceed 4 g/l, expressed as tartaric acid.

**LACTIC ACID AS AN ACIDIFYING AGENT**

Lactic acid is naturally present in wine as a result of the alcoholic fermentation of sugars, together with the formation of acids such as succinic and lactic acid.

Consequently, lactic acid is recognised as a constituent of fermented beverages, very often found in many different types of wine.

Lactic acid formation during alcoholic fermentation of grape must is widespread but relatively weak, ranging between 180 and 400 mg/l.

Wines not subject to bacterial action contain a maximum of 500 to 600 mg/l, of which 60 to 90% is D-isomer(-).

By contrast, wines where lactic acid comes from malolactic fermentation, the lactic acid content is much higher than before, consisting primarily of L-isomer(+), which may account for 75% of total lactic acid, since this fermentation produces only L(+)‐lactic acid.
Malolactic fermentation, which takes place in wines rich in malic acid, gives rise to the appearance of L(+)-lactic acid, which results in improved smoothness in these wines, because lactic acid has a softer palate (due to weaker acidity) than malic acid, which is harder and more acerbic.

Malolactic fermentation reduces the fixed acidity of non-sulphited wine—or wine with very low concentration of sulphur dioxide—thanks to the transformation by bacteria of two malic acid equivalents into an dioxide gas equivalent that is discharged and results in a minimum amount of volatile acidity.

Studies on the specific action of lactic acid in musts and wines identify mechanisms that lower the pH, boost total acidity and stabilise wine chemically and microbiologically.

Since lactate salts do not precipitate, they can also be added at the bottling stage.

**SCIENTIFIC TESTING IN WINE ACIDIFICATION WITH LACTIC ACID**

To search for alternatives—both from a technical and a financial standpoint—to the use of tartaric acid in the acidification of musts and wines, comparative tests and trials comparing lactic acid vs. tartaric acid have been conducted in various Oenological Centres in Spain, France and Italy.

Specifically, tests of physical, chemical and organoleptic properties were conducted at the Estación de Enología del Penedés (INCAVI), Estación Enológica de Almendralejo, the Istituto Sperimentale di Enologia de Asti (Italy), at the University of Bordeaux (France), Champagne Wine Institute (France) and the National Station for Viticulture and Enology (Portugal).

1. **Increase in total acidity**

   Lactic acid is more effective for increasing total acidity due to the higher solubility of its salts with potassium, and the fact that total acidity does not decrease after stabilisation by refrigeration.

   In a study conducted at the Almendralejo Wine Research Station, 40 meq/l (3.8 g/l lactic acid, 3.0 g/l tartaric acid) were added to a white wine with an initial total acidity of 4.52 g/l, to compare and contrast the effects of the two acids on total acidity.

   The addition was carried out in two stages to see if any effect related to the time of addition was detected.

   Lactic acid was most effective in increasing total acidity, and both acids showed that adding the acids to wine was more effective due to its greater stability.

2. **Chemical stability**

   It has been demonstrated that lactic acid salts are more soluble than tartaric acid salts.

   Given this feature, lactic acid added in musts and wines persists after stabilisation by refrigeration and is not reduced by ionic combinations.

3. **Effect of lactic and tartaric acid in potassium content**

   To verify this effect an experiment was conducted at the National Station for Viticulture and Enology (Portugal) to study the effects of adding lactic and tartaric acid onto potassium content in musts and wines.

   Results showed that the potassium levels were maintained in cases where lactic acid was added.

4. **Sensory aspect**
Lactic acid is suitable for musts and wines since its mild and prolonged traits are not aggressive to taste and contribute interesting features to the aroma.

Several tastings were conducted at the Asti Experimental Institute of Oenology at the INCAVI aimed at studying differences or preferences in musts or wines acidified with equivalent amounts of lactic and tartaric acids.

Tastings conducted at the University of Bordeaux, and the Almendralejo Wine Research Station were guided by the subjective valuation system.

Samples with lactic acid ranked at the top in both musts and wines.

5. **Improved aromas**

Part of the Asti Experimental Institute of Oenology study focused on the formation of lactic acid esters, mainly ethyl lactate and isoamyl lactate, as wine aroma enhancers.

Wines to which lactic acid was added were examined two and three months after the addition, to analyse the development of these esters.

Their presence increases pleasant aromas due to the formation of ethyl and isoamyl lactates.

6. **Enhanced colour**

The same Asti study also showed slight influence on the colour, especially in brightness and hue, particularly in red wines in which colour is important.

**CONCLUSIONS**

The findings of the various experiments into the acidification of musts and wines with lactic acid can be summarized in the following points:

1. It gives wine a chemical and microbiological stability, as well as enhanced sensory qualities.
2. It improves the alcohol fermentation of musts, fostering clarification, using lower doses of SO2 and ensuring the development of aromas during the aging of wine.
3. It ensures harmonious acids, improving wine brightness, freshness, vibrancy, balance and body.
4. It allows a greater increase in total acidity and buffer capacity, maintaining the wine’s potassium content.
5. It causes a lesser decrease in pH, but always predictable and calculable, as compared to tartaric acid.
6. It may be added before bottling thanks to the solubility of its salts.
7. Its presence increases pleasant aromas due to the formation of ethyl and isoamyl lactates.