Ohio Grape–Wine Electronic Newsletter

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Content:

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Ohio WINES Grown Here

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

Vineyard Update from OARDC in Wooster: September 21, 2017

By Diane Kinney and Imed Dami, HCS-OSU

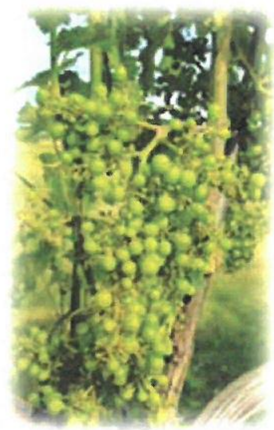
Grape phenology:

We are patiently waiting for our acid levels to decrease pretty much across the vineyard to begin harvest. The cool weather has delayed harvest when compared to previous years. By this time in 2016, we had already harvested Aromella, Chardonnay, Marquette, Regent, and Sauvignon blanc. Fortunately, the dry weather has allowed us to let the fruit hang safely without risks of late season diseases.

Phenology progression of Cabernet franc:

25 Apr 17

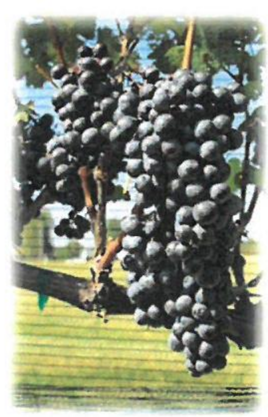
30 May 17



29 June 17

17 July 17

23 Aug 17

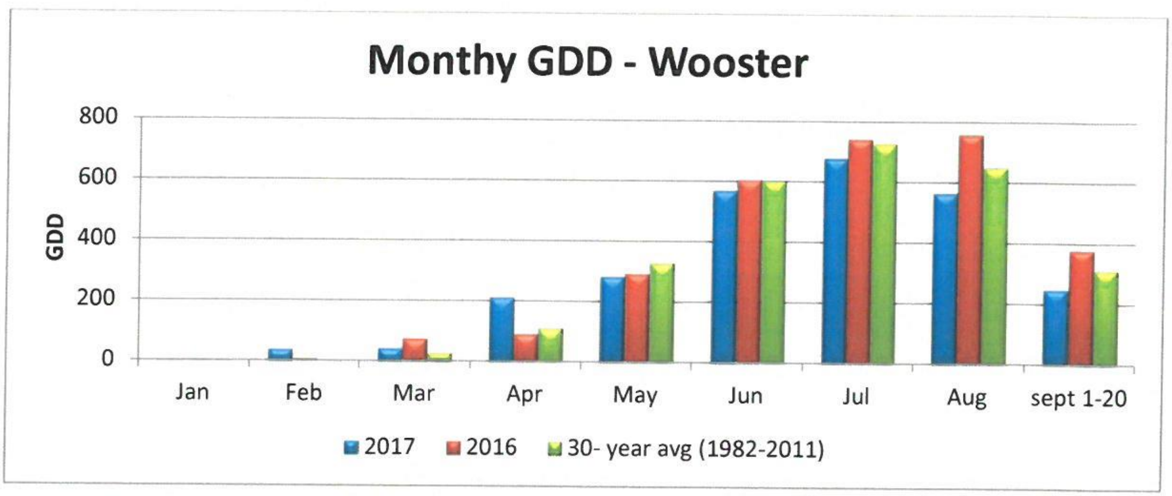


21 Sept 17

Weather conditions:

As of the 20th of September, we remain 126 GDD behind the 30-year average and a dramatic 319 GDD behind 2016. We have been fortunate to have the past 7 days with highs in the upper 70's and low 80's and it looks as though that will continue for another week. These warmer days have helped us gain back some of our GDD which should also translate into lower acid levels in the grapes.

The months of August and September have been very dry with less than half the anticipated amounts of rain which has been good to help with retaining healthy fruit on the vines. On the year, we remain at 4" above average with 27.98" for the year.



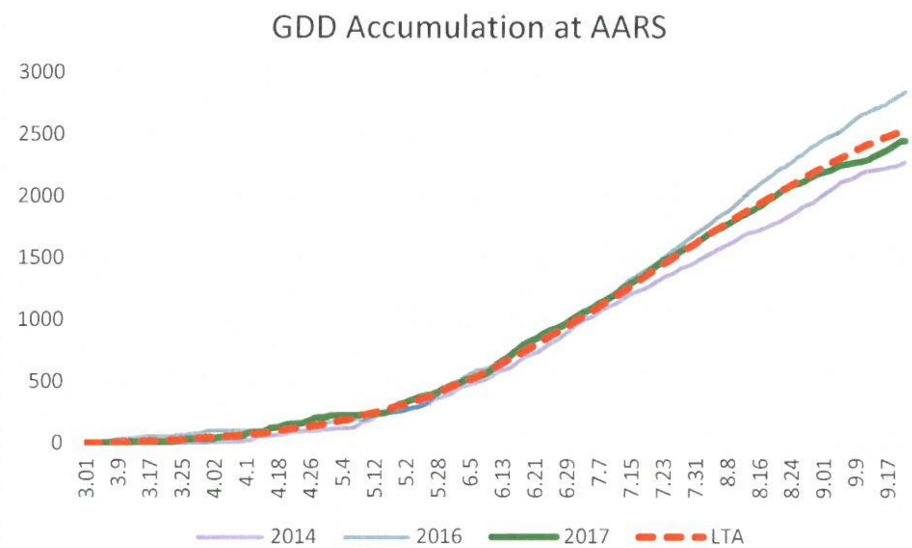
Cultural Practices:

Growers can continue to follow fruit maturity either through the OGEN email subscription or by following the weekly posting on the website. We seem to have had a higher than normal problem with bird damage as well as raccoon this summer which at times, greatly effects our final crop level. Our last spray application (#11) was on August 30. Just this week, (Sept 19), we began our first round of hilling in the vineyard for our grafted varieties.

AARS Vineyard Update. 9/22/2017.

Andy Kirk. Research Specialist & Station Manager. Ashtabula Agricultural Research Station.

Harvest is here and the smell of concords is in the air. Many vineyards in the Grand River Valley are into their second or third week of picking. Here in the chilly Northeastern reaches of Ashtabula County, we are still a few weeks away from our prime harvesting conditions. When I wrote a month ago, we were experiencing a demonstrably cool August. Temperatures have picked back up here in mid-September, and the GDD for 2017 is quickly catching up to the historical average GDD curve.



Source: OARDC Weather System; Includes March-September 21 (1986-2017); GDD Base 50F

Below are selected results from the OSU GDD Calculator, for three zip codes all within the Lake Erie AVA. To put this in perspective, we have recently come through a warm week, with daytime temperatures in the high-70s to mid-80s. During that week, we accumulated 115 GDD at AARS. With that bench mark, one might roughly say that there is a 2 week GDD lag between here and our neighbors in Madison. To look further west along the lakeshore, there is a three to four week lag between Kingsville and Vermilion. I find this interesting to consider in the context of viticulture region designations. It is important to note, though, that "ripening" is actually a complex system of changes that is impacted by many factors including vine water status (Van Leeuwen et Al. 2009), sunlight exposure (Rojas-Lara and Morrison 1989), nitrogen availability (Keller et Al. 1998), in addition to temperature (Spayd et al. 2002).

Zip Code	Corresponding Town	2017 GDD Accumulation
44048	Ashtabula/Kingsville	2519
44057	Madison	2706
44089	Vermilion	2932

Operations in the AARS vineyards have largely centered on harvest preparations. Of interest to the reader might be our somewhat improvised net rigging set-up. Many thanks to Greg Johns and Ken Noble for their guidance on constructing this. In the last several weeks, our operation has also expended time on the installation of an electric fence wire around the perimeter of our 8-foot tall deer fence. This is a result of continued Raccoon pressure. On a positive note, our staff have observed that it has not been a heavy year for bird damage at the research station.

Figure 2: Makeshift Net Applicator at AARS

A friendly reminder here to be mindful of replacing old pH electrodes, when the time comes. We were having trouble calibrating our pH meter, as well as difficulty stabilizing readings. Todd Steiner, Enology Program Manager and Outreach Specialist for OSU, suggested that we might need a new electrode. We replaced our electrode and have been pleased with the consistency and performance since then. I would suggest getting in touch with Todd if you suspect you may be having electrode problems.

A limited amount of Downy Mildew was spotted in in our vineyards, beginning a few weeks ago after some heavy rains. A spray was applied in accordance with Dr. Melanie Lewis Ivey's 2017 edition of "Developing an Effective Fungicide Spray Program for Wine Grapes in Ohio". Please contact her for specific fungicide application recommendations, or regarding the availability of that publication. So far, we have seen little botrytis or bunch rot in AARS vineyards this harvest season.

Lastly, keep an eye on the Buckeye Appellation page and the OGEN email updates for grape maturity information from our vineyards and OARDC vineyards in Wooster. Here a few key varieties, as of September 18th. As you can see, we may be harvesting well into late October this year.

Variety	Brix	pH	TA (g/L)
Auxerrois	17.6	3.08	5.57
Pinot Noir	18.2	3.16	8.19
Regent	18.2	3.19	6.65
Pinot Gris	17.8	3.15	6.47

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Rots, Birds and Yellowjackets (and Other Wasps)

Gary Gao, Ph.D., Small Fruit Extension Specialist and Associate Professor
OSU South Centers

Growing quality grapes in Ohio is quite a challenging task. Hopefully, your spray schedule has done a good job in keep diseases and insects at bay. At this time of the year, bird damage can be a big problem. Not only do they eat a lot of fruits, they also break open many berries and help invite yellowjackets and other wasps to feed on the fruits, since grape berries are very high in sugar content. Growers should weigh the pros and cons of gaining more sugar and reducing acid level vs. more fruit rots and damage from birds and wasps. Quite often, a compromise is probably the way to go.

Yellowjackets can be a big nuisance in ripening grape clusters. Photo by Gary Gao.

Controlling birds with netting is still one of the best ways to minimize fruit damage. Repairing damage to bird netting is a yearly chore. An opening large than ½" could be a big problem. Birds are quite smart and can find ways to get inside the netting. Sometimes, they can even sit on the nets and pick fruits through the netting. Prevention is the key.

Hope weather will cooperate during the home stretch of the 2017 harvest season. Wishing everyone a beautiful harvest!

Initial Observations of the 2017 Vintage: An Enology Perspective

By Todd Steiner
Enology Program Manager and Outreach Specialist
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Initial Vintage Observations:

Each vintage brings both excitement and new challenges during harvest time. Although summer conditions provide us with a glimpse of what we might expect in regards to grape ripening conditions through August, the weather conditions received from mid-August through the rest of harvest really dictates the condition of the grapes in regards to rot and maturity progression. This holds true for both white and red varieties and how we decide to handle them in regards to must handling, chemical adjustments, sulfur dioxide addition rates, pressing regimes and fermentation management in the cellar.

This year appears to be no exception. With the cooler conditions received earlier in the summer and carrying through August and the first two weeks of September, we expected a slight delay in desired harvest which was confirmed with initial season berry data. This held true especially for pH and titratable acidity values. We have been amazed at the very high acid content with somewhat low to moderate pH values we have been noting in our berry samples as you may have observed through Imed Dami and Diane Kinney publishing in the OGEN Newsletter. Although soluble solid levels started out lower than desired, they have appeared to have made a comeback and are relatively close to what we would expect on average at this point of the harvest season.

The good aspect of this vintage comes in the fact that we have had relatively little rain from mid-summer through the current time of harvest. This means that disease pressure has been very manageable to this point for those monitoring and performing their spray program from berry set until now. Due to the relatively low pH and high acid values for nearly all varieties we are vinifying into wine at OARDC from three separate vineyards at AARS in Kingsville, OARDC in Wooster and OSU South Centers in Piketon, we have not harvested much of anything to this point. At the present time, we have only harvested Siegerrebe from AARS which appeared to be in really nice condition. We are awaiting arrival of Vidal Blanc from Piketon today in addition to Chardonnay from Wooster tomorrow. We also have Ortega which has Siegerrebe in the parentage coming in from AARS as well tomorrow. Both Siegerrebe and Ortega are relatively low acid varieties which do not develop very high sugar concentrations that exhibit respectable pH values at harvest. Pinot gris is looming on the horizon for upcoming harvest in which we are watching grape condition as this variety can break down relatively quickly in a short period of time due to insect and bird predation but even more drastic with increased rainfall. Other varieties such as Auxerrois are similar to Pinot Gris in this fact which is also ready to harvest. Additional white varieties are definitely on the radar as well for harvest in the near future.

The high acid concentrations observed to this point have concerned us in regards to potential lengthening of the harvest season needed to ripen not only the white varieties but especially the red varieties we produce in the state. Prior to this point it appeared as though we would be good in regards to Concord, Frontenac, Marquette, Pinot Noir, Dolcetto and some of the older hybrids such as Chancellor, Leon Millot, Foch and Dechaunac in reaching desired maturity levels. However, the real concern involves some later ripening varieties such as Chambourcin, Syrah, Regent, Cabernet Franc and Cabernet Sauvignon in terms of needing to extend the ripening period for this season.

Just to show that Mother Nature is in charge and making this a unique vintage; we have received some recent warm and dry weather which looks to extend through most of next week. This is also coupled with relatively cool nights which will also help progress grape maturity for nearly all varieties at a rapid pace. Careful monitoring of berry data and flavors in the vineyard will be important the next few weeks to help determine optimum maturity of each variety with an important eye on the long term weather for future harvest decisions. The current weather will certainly help provide good conditions for ripening the red varieties of concern listed above. This is good to see and hopefully we will see the acid values drop significantly over the next few weeks for most all varieties and look with anticipation for an excellent vintage all around. We must remember though that this is Mother Nature and you never know when to expect additional curveballs in the future.

It is our goal as winemakers is to work with what we have been dealt with in regards to the current vintage conditions and produce the best quality wine showcasing both varietal character and overall balance. It is important to utilize every resource possible to us in the cellar in addition to outsourcing expertise from those around us in addition to contacting the OARDC Enology program in helping achieve better wine quality and meeting our desired goals for both the winery and consumer.

Must Management based on Initial Vintage Observations:

In light of the initial vintage observations included above, I thought it would be good to mention the important topic of must and wine adjustment in regards to brix, acid and pH values. I will only briefly mention about acid addition, brix adjustment and pH values below but more attention will be provided with an additional article I have included on acid reduction techniques that may or may not be a major application to the 2017 vintage (time will tell). This will depend on how long the current (ideal) weather conditions last through this year's harvest. Another rather detailed article from the 2012 annual Ohio Grape and Wine Conference on adjusting acidity with membranes by Clark Smith that I felt would be a great addition to the focus of acid management within this article is also included in this newsletter.

Acid Addition

Opposite to what we have observed for the 2017 vintage to this point, must with low acid values would require acid addition to the must/juice. This may also be the case with must coming in from a much warmer climate such as California. The choice of tartaric acid addition is preferred in getting the most "bang for your buck" in addition to cold settling later for wine stabilization purposes. This also expresses the best effect in lowering the pH of the wine if desired ultimately improving wine quality and stability. As a general rule of thumb, 3.8 g/gal will raise the TA .1% with a corresponding drop of .1 pH units to the must/ juice to be treated. Of course, this represents more of a theoretical yield and not necessarily the actual result based on the wine matrix and buffering capacity. Remember that potassium bitartrate has only moderate solubility in alcoholic solutions, so some of the acid added is likely to precipitate during primary fermentation.

Sugar Adjustments and Acid Management

With lower than desired brix values at harvest, we can simply add sugar to reach the desired brix level and corresponding alcohol content. This can be accomplished through the addition of dry cane sugar or to ameliorate with sugar and water depending on the initial must data and variety being vinified into wine.

Despite vintage conditions looking more positive as mentioned above, we do not expect to experience extremely high brix values for a majority of varieties being vinified in Ohio for the 2017 vintage. However, fruit or juice purchased from California (especially red varieties) can push the limit of maturity in producing high brix (> 27 °brix), high pH and a low acid content. Unless we have access to reverse osmosis with ion exchange or other membrane techniques, musts with these values can be adjusted utilizing acidulated water with tartaric acid. It is best to bring the brix down to more acceptable levels in reaching the desired alcohol content and choosing the correct yeast strain known to ferment in a high alcohol environment (17-18%).

The high brix effect can also be observed at harvest with many of the Minnesota varieties. In this case, the addition or amelioration with water does not have to be acidulated due to these varieties being high in acid content at harvest time. A majority of the must/juice acid content in these varieties may consist mostly of malic acid. In this case, it is good to choose a malic acid reducing yeast strain in addition to balancing with the appropriate amount of residual sugar and or blending.

pH Values Prior to Primary Fermentation

However, brix and total acidity cannot be looked at alone, it is very important to make sure that must/juice pH is below 3.6 going into primary fermentation. A preferable value in general would be near 3.4 to 3.5 for red varieties and 3.2 to 3.4 for white varieties. This will help yield a more microbial and color stable wine. Fine tuning acid and pH as it relates to mouthfeel can then be dealt with through blending or additional procedures on a smaller basis to the wine after primary fermentation has occurred.

As mentioned above, more detailed information will be provided pertaining to our initial observations of the 2017 vintage with two articles on acid reduction and adjusting acidity with membranes which follow this article.

Acid Reduction Techniques in Must and Wine

Todd Steiner
Enology Outreach Specialist
The Ohio State University/OARDC
Department of Horticulture and Crop Science
Wooster, OH

Since each harvest year is different, the winemaker must be able to adapt his vinification practices in achieving a well-balanced wine. Excess acidity at harvest may occur in cool climate viticultural areas such as it does in the Northeastern United States and Canada.

Wine acidity is responsible for freshness, tartness and crisp taste. Wines of high acidity may appear to be very tart or acidic whereas wines of low acidity may appear flat or insipid. Therefore, it is vital to develop a wine that has a good balance with acid being a major factor.

The predominate acids found in must and wine are tartaric and malic acid often accounting for over 90 percent of the total acids found in grapes with citric acid considerably lower in concentration (1). Other organic acids formed mainly during fermentation at different levels would include acetic, succinic and lactic acids (2).

In determining correct acid concentrations in wine one must not make acid adjustments based on the titratable acidity and taste alone. It is vital to examine juice and wine acids and their direct effect on pH. Monitoring juice pH is important to help determine ripeness of the grape, wine color, chemical and microbial stability. The degree of dissociation of acids into H^+ ions, influence a wines pH. The free hydrogen ion (H^+) concentration measured by electrodes is then placed on a logarithmic scale. Acid levels significantly influence both juice and wine pH which usually falls between 3.0 and 3.9 on the pH scale. As grape maturity develops we have a lowering of the acidity with a corresponding increase in pH.

As mentioned earlier, grapes in cool climate growing regions often have a high acid content ranging from 5 to 10.0 g/L (3). This paper will not include the viticultural aspects leading to musts with higher acidity other than to mention practices such as over cropping, vines of high vigor and unorganized spray programs may all delay maturation and cause high acidities (4). The rest of this article will examine acid reduction techniques in must and wine.

Listed below are several methods to consider:

$ Amelioration
• Acid reducing yeast strain
$ Blending
$ Malolactic fermentation
$ Sugar addition
$ Chemical neutralization

According to Boulton (5), there are four scenarios of classifying acidity and pH conditions.

1) Low TA and high pH	(TA<6g/L)	(pH>3.5)
2) Moderate TA and pH	(TA 6-9g/L)	(pH 3.0-3.5)
3) High TA and low pH	(TA>9g/L)	(pH<3.0)
4) High TA and high pH	(TA>9g/L)	(pH>3.5)

The first acidity and pH condition represents a warmer climate such as California. This would require acid addition. I will focus more on the second through fourth case observations. Depending on the variety, final acidity, and residual sugar, must or wine with a moderate TA and pH can be candidates for amelioration, acid reducing yeast strain, blending, malolactic fermentation, sugar addition or chemical neutralization. In the case of chemical neutralization, the use of potassium carbonate or potassium bicarbonate can be effective. Utilizing these compounds create less risk of calcium instability. Again, depending on variety and desired final TA, a must or wine with a high TA and low pH may benefit from all the above cellar techniques with chemical neutralization becoming more apparent pending variety and wine style. As mentioned above in chemical neutralization, the use of potassium bicarbonate is preferred for lower acid reductions between 8.0 to 10.0 grams per liter due to its ability to drop out as potassium bitartrate during cold stabilization. For larger acid reductions as in this case, the use of calcium carbonate is usually preferred for deacidification (1). Even though there is a risk of calcium instability, the increase in pH is less using calcium carbonate. Keeping the pH lower is beneficial in preventing chemical or microbial instabilities throughout vinification. It would also be advisable to make larger acid adjustments to the must rather than to the wine (6). Must or wine with a high TA and high pH are problematic. This scenario would be dealt with most satisfactory by using either calcium carbonate or better yet the "double salt method" in providing the best results. I will briefly describe each deacidification procedure below. Another option for acid reduction can be observed through membrane filtration techniques that are covered quite well in another article associated with this topic by Clark Smith included in this newsletter.

Amelioration

Amelioration is the blending of sugar, water and or sugar-water to the must to be fermented. According to federal regulations this may be used in reducing the acidity as long as the TA is not reduced below 0.5 percent and the volume of water or sugar water added is not greater than 35 percent of the resultant volume of the must. Although, this is an effective method in reducing acidity, it is often used for certain American or labrusca varieties due to their strong aromas and flavors. It is advisable to refer to the TTB regulations regarding amelioration when using this procedure.

Acid Reducing Yeast Strain

Recently, newer technology has identified some acid reducing yeast strains which have the ability to naturally reduce higher levels of malic acid which are known to be associated with Minnesota released varieties and specific vintage conditions. Some yeast strains of interest would include Lallemand - 71B, Lallemand - Lalvin C and Anchor Exotics SPH to name a few.

Blending

Blending is an effective technique in reducing wine acidity. In addition, this technique is often used to alter other important wine constituents in improving wine quality. These include: oak and tannin management, body and mouth feel to name a few. Blending trials should always be performed in the laboratory before making the final blends in the winery. It must be understood, however, that even if all wines going into the final blend are considered to be stable, changing the wine chemistry in the final blend may produce an unstable wine in terms of microbial and tartrate stability.

Malolactic Fermentation

Acid reduction may be achieved in using certain lactic acid bacterial strains. In general, there are three types of lactic acid bacteria found in must and wine. These include Pediococcus, Lactobacillus, and Leuconostoc with the former being the most desirable. Malolactic fermentation refers to the bacterial conversion of malic acid to lactic acid and carbon dioxide. This secondary fermentation which is not actually a true fermentation usually takes place at the very end or after primary fermentation. The benefits of malolactic fermentation show a reduction in acidity adds complexity and provides a more microbial stable wine. Some limiting factors of completing successful malolactic fermentations include low pH (2.9-3.1), high levels of $S0_2$, temperatures below 65° F. and aeration (7). It is also advisable to choose a commercially recommended malolactic strain that is compatible with the selected yeast strain used.

Sugar

One must not forget the positive attributes of a little sugar. Depending on the final target acidity, variety and style, the addition of small amounts of sugar may reduce the perception of a slight to moderate acidic wine. Even wines finished in a dry style may benefit in body and mouth feel with the addition of .25 to .45 percent without being noticed on the palate. In any case, bench trials should be performed in determining the correct amount of sugar to be added.

Potassium bicarbonate

For must and wine with slight to moderate acid reductions of 8-10g/L with a low pH around 3.0 – 3.2 the use of potassium bicarbonate is preferred. The benefit of potassium bicarbonate is that potassium is naturally occurring in wine and therefore its reaction with tartaric acid involves both neutralization of hydrogen ions and precipitation of tartrate ions as potassium bitartrate. It also has the ability of being used in combination with other acid reducing techniques such as amelioration and malolactic fermentation (8). Typically adding .9g/L will reduce the TA by 1g/L in must or wine. Potassium bicarbonate can be added to either the clarified must or filtered wine. The disadvantage of using potassium bicarbonate in high acid must and wine is that it is not effective in reducing the acidity adequately without raising the pH excessively.

Calcium Carbonate

Harvest years providing must and wine with high acidities can be treated with calcium carbonate. Calcium carbonate is mainly recommended for large acid adjustments of 2g/L and higher (TA above 9g/L) (9). The addition of .67g/L of calcium carbonate theoretically will yield a reduction in TA of 1 g/L. This reaction will commonly produce calcium tartrate a neutral salt with precipitation occurring over time. The choice of calcium carbonate will deliver the maximum acid reduction with a minimum increase in pH. As mentioned earlier, large acid reductions are mainly done to the must where smaller reductions are made to the wine (6). Even though there is no cooling required for calcium tartrate precipitation, a disadvantage is seen with the slow precipitation rate along with no guarantee of calcium stability (2). However, wines with a higher pH will benefit greatly with the reduction in acidity using calcium carbonate with a minimal increase in pH.

Double salt method

The double salt method may be used for must or wine with a high TA and high pH. The true double salt method comes from the use of a proprietary compound called Acidex. To my knowledge, I do not believe this product is no longer available. However, according to Henick-Kling (9), similar results can be achieve with the use of calcium carbonate alone and careful monitoring of pH which is the critical part of this procedure. The critical pH must reach and be maintained at 4.5 or higher for the removal of calcium malate and calcium tartrate.

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HANS WALTER-PETERSON

Unlike eastern growers who battle weather yearly, the 2011 took the West Coast by surprise.

Adjusting Acidity With Membranes

California has just survived its most challenging vintage in decades—almost as difficult as a typical vintage anywhere else. Until recently, acid adjustment in West Coast wines consisted of deciding whether to add to the must one gram per liter of tartaric or two. Even our high pH/high TA (titratable acidity) challenges were mostly high potassium problems that were overcome by the nerve-wracking but effective practice of lowering pH with even more massive tartaric bumps, followed by precipitation of a blizzard of cream of tartar.

The cool, rainy vintages of 2010 and 2011 have resulted in a comic assortment of pH and TA conditions that have sent winemakers back to their schoolbooks to relearn the basics. When pHs wander into the 4s during a cool, long season, sometimes the culprit is high malic (under-ripeness), sometimes high potassium + (over-ripeness). Treatments differ entirely. In 2011, it wasn't unheard of to get both conditions in the same must.

In this we have joined the ranks of our Eastern winemaker brethren now laboring for fully half the wineries in North America, and for whom expertise in this field is their chief employment qualification in the chilly northern climes of the Midwest.

The front office may sing love songs of non-intervention, but every winemaker knows that a dry white wine with 12 grams/liter or a brown, tired, dried-up Pinot will fight an uphill battle to please the most luddite consumer. Sure, they want natural, and we want to give it to them. But above all, they want tasty wines and won't settle for less.

Fortunately, today's winemaker is blessed with a broad and rapidly expanding array of choices for bringing wines into acid balance, and a number of membrane techniques have recently been added to the dizzying array of tools. Choosing among them requires a firm grasp of acid-base chemistry.

The basics about acids

An acid is just a dissolved substance that can slough off a hydrogen ion (H+), really just a proton. Because the acids in wine are "weak," some portion of the acidic hydrogen ions (protons) remains bound to them.

To figure when to pull the trigger on harvesting a block, winemakers look at both TA and pH. A glance at this season's must chemistry will convince the most unschooled winemaker that pH and TA are not very closely related.

Both measure acidity (high TAs and low pHs denote lots of acidity), but TA is the sour taste, while pH is the amount of free, dissociated protons controlling the wine's chemistry and microbiology. TA is like the cops on the payroll, while pH is like the

Highlights

- Climate change and the conquering of new cold-climate regions demand that winemakers get smarter about acidity.
- The author reviews the standard ways to control pH and TA, and he explores the potential of new membrane technologies to do the same.
- Choosing among options requires a firm grasp of the technical functionality, cost benefits and legal factors involved in each.

cops on the beat fighting crime. TA is higher in tart wines, but low pHs mean high free acidity.

In normal maturation, malic acid is burned inside the berry, furnishing energy that grapes use to concentrate sugar into the fruit and lower TA. While TA is dropping, pH is rising from around 3.0 to as much as 4.0.

The strength of an acid is determined by its protein kinase A or pKa, (i.e. the pH at which half of the acid is ionized). Lactic acid, for example, has a pKa of 3.8. Above pH 3.8, it's mostly ionized, and below 3.8, it's mostly undissociated.

Some acids have multiple pKas. Grape juice has two diprotic acids: the stronger tartaric acid (symbolized as H2Ta) with pKas of 3.0 and 4.2, and the weaker malic acid (H2Ma) with pKas of 3.5 and 5.0. Big difference. At wine pH (3.0-4.0), tartaric acid is always a lot more ionized than malic acid. Malic acid is like a really good donut shop where the proton cops like to hang out instead of patrolling the wine. In geek-speak, we say that the solution is heavily buffered.

A lovely characteristic of tartaric acid is that bitartrate precipitates with potassium to form crystals that reduce TA—very handy. This effect is maximized at pH 3.6, the peak of the bitartrate curve. This turns out to be a big deal, the natural great divide for winemaking.

Here's something weird: Above 3.6, KHTa (potassium bitartrate) precipitation lowers TA and raises pH, just as you'd expect. However, below 3.6, TA is lowered but pH is also lowered. The acid goes down but it also goes up, resulting in softer taste, but more stability and freshness. Not too shabby.

Because of this effect, it often works to de-acidify low-pH wines by adding potassium carbonate (K_2CO_3). This is always Plan A. Here's how it works. First, as the compound dissolves, it ionizes into potassium cations and carbonate anions:

$$K_2CO_3 \Rightarrow 2K^+ + CO_3^{2-}$$

Next, the carbonate neutralizes some protons, benignly turning that nasty acid taste into carbon dioxide bubbles and water:

$$CO_3^{2-} + 2H^+ \Rightarrow H_2O\ \text{(water)} + CO_2\ \text{(bubbles)}$$

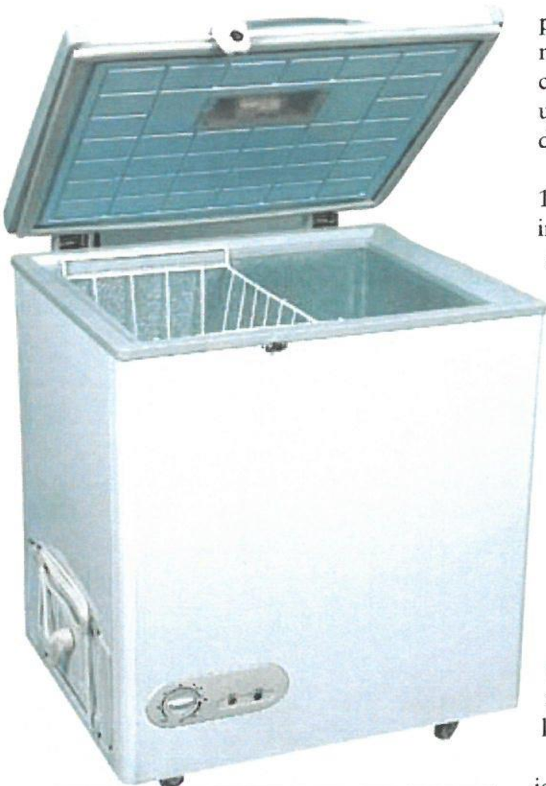
Since it removes free protons, this reaction does raise the pH. But the K+ ions will enhance bitartrate precipitation. As long as this happens below pH 3.6, this precipitation will lower both TA and pH, moving us back in the direction of the original low pH. A wine with a TA of 10 grams/liter and a pH of 3.1 can emerge with a TA of 7.5 grams/liter and a pH of 3.3 at negligible cost. Hot stuff.

We are completely unprepared for the impact of our new de-acidification capabilities.

Bad acid trips

If we have a lot of tartness in a wine, we might expect a nice low pH. Lots of critics and master sommeliers think that tart wines age longer. 'Tain't necessarily so.

The wrong mix of acids can give you very tart wines with very poor shelf life. Grapes can get out of sync, so you get really high pHs when you still have high TAs. A high TA means the juice has lots of



To test for malic acid, use tartaric acid to bring a juice sample to pH 3.6 and freeze overnight before running a TA test.

protons and a sour taste, but the high pH means they aren't free and available. This can only happen if your protons are tied up somewhere. You have a lot of cops off duty, or in donut shops.

In a typical case, a juice may have a TA of 10 grams/liter and a pH of 3.9. Normally in California, the culprit is a high amount of potassium and tartrate. Tartrate is not a very good donut shop, but it will do the job if there's enough around.

In such a wine, we have lots of K+, lots of tartrate, so we might expect a big precipitation. But high tartrate will not readily form KHTa if the pH is too far above 3.6.

The other way juice can have high pH and high TA is high malic acid. This happens all too often in Europe and North America, but it is rare in California except during chilly years like 2010 and 2011, when it's anybody's guess. Since malic acid is not easily removed, the first step is to determine whether it's our problem at all.

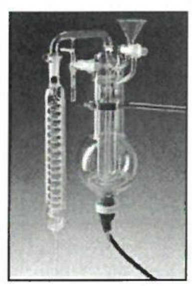
Lab analysis for potassium and malate is expensive and time consuming, but there's a simpler way. To test for this condition onsite, dissolve some tartaric acid in a small amount of warm water and simply acidify a sample of the juice to exactly pH 3.6.

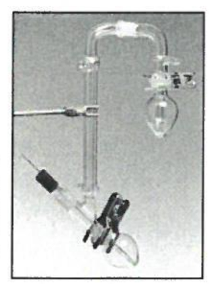
Now freeze the sample overnight (allowing for ice expansion), then thaw it out in the morning. Hopefully you'll see lots of white crystalline powder in the bottle. Either centrifuge, filter or settle out in the fridge, then run a TA. If the problem was high potassium, the resulting juice will have a big drop in TA to maybe around 8.5 grams/liter and a pH still at 3.6. If it works, go and do likewise to the big tank. If not, read on.

Getting the bugs out

Before we get on to high-tech membrane solutions, let's discuss biological solutions. Organisms that eat acid have great appeal to our inner cheapskate. I will only speak generally here, because yearly advances in our knowledge promise to invalidate any specific information I might offer in this area.

Historically, biological de-acidification has been fraught with hidden costs and dangers. Thanks to the beloved and recently deceased Ralph Kunkee's work at the University of California, Davis, in the 1970s, malolactic fermentation is a big success story, and today few





winemakers are daunted by the prospect of pushing a wine through ML. But malolactic has huge impacts on style and is thus tricky to use to reduce acidity without harming fruit aromas. Most other biological solutions also create byproducts that alter style, so biological de-acidification methods must be evaluated with extreme care.

All saccharomyces cerevisiae yeasts consume some malic acid (generally around 10%) during primary fermentation without undesirable flavor production. Recently, strains like Lallemand's 71B have received favorable marks in reducing as much as one-third of malic acid.

Pass the double salt

Were it not for the fuss and bother it entails, double salt de-acidification would be the standard treatment to reduce malic acid. It takes advantage of the precipitation of calcium malate that occurs at high pH. A portion of the juice (usually 20%–30%) is drawn off and treated with an excess of calcium carbonate ($CaCO_3$). The carbonate reacts with 100% of available protons, both free and bound, completely neutralizing the juice to pH 7.0, while the TA drops to zero. Under these conditions, calcium precipitates both tartrate (CaTa) and malate (CaMa) in proportion to what is present, as well as its namesake double salt (Ca_2TaMa).

Unlike conventional cold stabilization, membranes protect colloidal structure of the wine and save lots of energy.

When recombined into the main lot, a wine with a TA of 10 grams/liter will be reduced to 7.0, with 30% of its buffer capacity removed. The wine can then be re-acidified with tartaric if needed, restoring acid balance. The process does not create calcium instability because the final wine has only 30% calcium saturation.

Sounds good. The only trouble is, before recombining the treated portion, it is essential to filter it to remove all crystals and excess $CaCO_3$, to say nothing of pulp solids—a slow, messy proposition. Cross-flow clarification to the rescue. The new tangential-flow filters making appearances all over the country to replace DE filtration seem tailor-made for double-salt filtration. Time to start sucking up to your neighbor who has one.

Double salt must be done prior to malolactic, and preferably at the juice stage, due to the hazards of taking a wine to such a high pH even for a short time.

Choose your weapon

Cross-flow clarification is emblematic of a dizzying array of new membrane technologies sweeping the wine world. Reverse osmosis (RO), an increasingly popular and available tool for removing rainwater from juice as well as for adjusting wine alcohol and VA content, has interesting prospects for de-acidification.

Reverse osmosis membranes used in the wine industry are made of the same materials employed in conventional sterile filters, but with pore sizes 10,000 times tighter. While sterile filters attempt to remove only particulates, RO membranes retain all but the smallest dissolved compounds. We rate RO filters according to the molecular weight (MW) of a compound that passes 50% of its constituents into the filtrate (permeate).

I pioneered the use of tight reverse osmosis for the removal of volatile acidity. With a membrane MW cut-off of 80 daltons, only acetic acid passes into the permeate, to be trapped by a resin prior to recombining with the retentate.

The method takes advantage of the fact that ions are very large. The H_2O molecule is a dipole attracted by the dozens to the charge on any ion, clinging like a gel layer that increases the ion's functional molecular weight (FMW) by at least 500 daltons. The un-ionized acetic acid at 60 daltons will pass easily through an RO filter with an 80-dalton porosity, but its ionized acetate counterpart with a FMW of 600 daltons, doesn't pass through at all.

A precisely identical method may be used in de-acidification of excessively tart wines by employing looser RO membranes (near the 150-dalton legal limit) to pass malic acid at 134 MW. With a 150-dalton porosity, more flavor will be lost, but useful amounts of lactic and malic acids (pKas of 3.8 and 3.5, respectively) can be removed if the pHs are not too high.

The new generation of membranes focuses on membrane selectivity. Although the wine industry is tiny by global industrial standards, we are beginning to receive trickle-down benefits from other industries, and off-the-rack technologies frequently appear and improve our options.

While RO membranes are impervious to ions, membranes have been developed that do just the opposite—ion-selective membranes that pass only the ions. Electrodialysis (patented by Eurodia and marketed in the United States as STARS), a method perfected some 20 years ago in France for economical and gentle cold stabilization, has been increasingly employed to great advantage for de-acidification.

Treatments differ entirely for the two different causes of high pH / High TA.

In electrodialysis, wine is pumped between two membranes, a cation-permeable membrane that will only pass H^+, K^+ and Ca^{2+} and an anion-permeable membrane that passes tartrate and malate ions. A low-voltage DC current propels ions through these membranes—cations gravitating to the negative pole and anions attracted to the positive pole. In effect, KHTa is drawn into a brine that is discarded or sold.

In de-acidifying the high-TA wines of recent cool years, neutralization with potassium or calcium carbonate is limited by rising pH. If followed by electrodialysis, pH can be brought back down while simultaneously removing K+ and Ca2+ to prevent instability.

The beauty of this method is that unlike conventional cold stabilization, it protects the colloidal structure of the wine and saves a lot of energy. Electrodialysis can remove KHTa without the entrainment of colloids that accompanies crystal precipitation. Thus there is very little flavor stripping, and the method has been highly preferred to chilling by a trained sensory panel.

When used in concert with tartaric acid addition, electrodialysis can often give you virtually any desired pH and TA. Since it requires high clarity, electrodialysis runs

Cross-flow clarification is emblematic of a dizzying array of new membrane technologies sweeping the wine world

on finished wine, even post-ML. Besides producing superior wines, electrodialysis can trim your energy bill by more than 25%. A system with an output of 200 gallons per hour costs upwards of $200,000. Because of its high capital cost, electrodialysis systems are usually accessed as a service except by large wineries.

Because it is less ionized due to its higher pKas, loose RO preferentially removes malic acid over tartaric. For the same reason electrodialysis, which only removes ions, is not very effective in removing malic acid. This is its Achilles heel—it is not the tool of choice for those overly crisp Midwestern whites.

An additional alternative selective membrane technology is currently being marketed by Mavrik Industries. CEO Bob Kreisher is frank about its proprietary nature. "We want winemakers to feel comfortable with what our process does, but we worked hard on developing a system that works well, and we don't want to give away essential information to our competitors," he said. Mavrik was nonetheless quite open to my observing what their system does, and I got a first-hand look at the de-acidification of a 2010 Cabernet.

Mavrick's technology is reportedly based on an acid-selective membrane that passes *both* molecular and ionized species. This is big news, greatly simplifying our lives because we no longer need to pay attention to ionization pH and malolactic status. Colorless, flavorless permeate from this membrane is passed through a weak anion exchange resin where malic, tartaric and lactic acids are retained. A cation-exchange column can also be employed to exchange potassium for H+, with the effect of re-acidfying the permeate prior to recombination.

In this way, buffer capacity is removed, and pH and TA can be adjusted more or less at will. Although I cannot claim to fully grasp the details of Mavrick's proprietary magic, I can at least attest that the Cabernet came through it with flying colors and no discernible aroma loss. As Mavrick refines this technology, it may very well be the toy of choice in regions plagued by high malic acid.

Back in sunny California, extended hangtime often results in high-potassium wines that resist pH adjustment with tartaric. A new approach to acidification of high-pH wines and musts now being pioneered by Eurodia uses a bipolar membrane on the cation side to exchange potassium ions for protons, thus raising the TA. Unlike tartaric acid addition, this lowers pH without increasing buffer capacity. The membrane works much like

Consumers want natural, but above all, they want tasty wines and won't settle for less.

a cation-exchange resin, removing potassium ions in trade for H+, but without the stripping of flavor elements that occurs during direct contact of wine and resin. Bipolar anion applications may also be on the horizon.

The bottom line

Any reporter loves a scoop. In preparing this article I was treated to a generous handful of new technologies that promise to transform American winemaking in an era of climate change, up-end modern winemaking precepts and render current teachings obsolete.

Yet there is no bottom line to report. To a man, technology developers waffled and temporized concerning release dates, performance, efficiencies and capital costs of their new darlings. The complex and peculiar machinations of TTB approval are an uncharted minefield through which wineries must walk with care and do their own homework.

We are smack in the middle of an era much like the 1960s, when a tsunami shift from Ports and Sherries to table wines left us in total ignorance. Today we are completely unprepared for the impact of de-acidification capabilities even their providers have yet to fathom. Smart postmodern winemakers throughout the country and their state-sponsored academic partners are well advised to place a high priority on understanding and evaluating the diverse menu of options soon to be thrown on our plates.

In all candor, this article provides no dependable Consumer Reports purchase guide to de-acidification. In its stead I have sought to lay the groundwork for such an evaluation by tracing a roadmap of the options we must immediately get smart about. W&V

Clark Smith is winemaker for WineSmith and founder of the wine technology firm Vinovation. He lectures widely on an ancient yet innovative view of American winemaking.

Vine & Wine News @ Buckeye Appellation 2017

By: Diane Kinney, Research Assistant and Imed Dami, Viticulture State Specialist

Vine & Wine News continues to provide updates on grape growing and wine making in Ohio and elsewhere. These updates will be posted on the program website, Buckeye Appellation at: http://ohiograpeweb.cfaes.ohio-state.edu/ . We would like to invite you to visit the website on a regular basis to help inform you of what our OSU Team has available to you through OGEN, TGE, research updates, events and news. Our hope is that it becomes a resource you look up periodically. So why not bookmark this site today?

In the past month, we have posted the following:

Educational Materials:

- Ohio Grape Electronic Newsletter (OGEN) on homepage and tab (current issue).
- The Grape Exchange (TGE) on the homepage and tab (latest posting on Sept 21).

News:

- Cornell-led project to improve grapes gets big boost.
- Fruit Maturity at OSU-Wooster and AARS-Kingsville

Upcoming Events:

- February 19-20: 2018 Ohio Grape and Wine Conference

Upcoming Events:

1. **<u>2018 Ohio Grape & Wine Conference, Embassy Suites Dublin:</u>** February 19-20, 2018.

2018 Ohio Grape & Wine Conference

DATE:
FEBRUARY 19-20, 2018

LOCATION:
Embassy Suites Columbus– Dublin
5100 Upper Metro Place
Dublin, OH 43017
(614) 790-9000

PROGRAM HIGHLIGHTS:

- Two information-packed days with viticulture, enology, entomology, plant pathology, virology and weed science presentations, as well as an industry trade show, Ohio wine reception, and exquisitely-prepared banquet.
- Flexible registration options and affordable registration fee.

Ohio Grape Industries Committee
8995 E. Main Street
Reynoldsburg, OH 43068-3342

OSU Grape & Wine Research & Outreach Specialists

Please contact the following Research, Extension/Outreach Specialists and Educators if you have any questions relating to their respective field of expertise.

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Dr. Doug Doohan, Professor Dept. Of Horticulture & Crop Science 205 Gourley Hall – OARDC 1680 Madison Avenue Wooster, OH 44691	330-202-3593	Email: Doohan.1@osu.edu Website: OARDC Weed Lab	Vineyard weeds and control. Recommendation on herbicides.
Dr. Gary Gao, Small Fruit Specialist and Associate Professor, OSU South Centers 1864 Shyville Rd, Piketon, OH 45661 OSU main campus, Rm 256B, Howlett Hall, 2001 Fyffe Ct Columbus, OH	740-289-2071 Ext. 123 Fax: 740-289-4591	Email: gao.2@cfaes.osu.edu Website: OSU South Centers	Viticulture Research and Outreach, VEAP visits in southern Ohio, vineyard management practices, soil fertility and plant nutrition, fruit quality improvement, variety evaluation, table and wine grape production.
Dr. Melanie Lewis Ivey, Assist. Professor Dept. of Plant Pathology 224 Selby Hall – OARDC 1680 Madison Avenue Wooster, OH 44691	330-263-3849 330-465-0309	Email: ivey.14@osu.edu Website: OSU Fruit Pathology Facebook: OSU Fruit Pathology	Grape Diseases Diagnostics and Management. Recommendation on grape fungicides and biocontrols. Good Agricultural Practices and Food Safety Recommendations.
Andrew Kirk, AARS Station Manager Ashtabula Agricultural Research Station 2625 South Ridge Road Kingsville, OH 44048	330-263-3881	Email: Kirk.197@osu.edu Website: OSU Branch Campus	Wine grape production in Northeast OH, especially *vinifera* varieties
Dr. Elizabeth Long, Assist. Professor OSU/OARDC Entomologist 105 Thorne Hall 1680 Madison Avenue Wooster, OH 44691	330-263-3725	Email: long.1542@osu.edu	Fruit and vegetable insects.
David Marrison, County Extension Director, Assoc. Professor & Extension Educator OSU Extension – Ashtabula County 39 Wall Street Jefferson, OH 44047	440-576-9008 Ext. 106	Email: Marrison.2@osu.edu Website: Ashtabula OSU	Vineyard and winery economics, estate planning and extension programs in Northeast Ohio.

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Patrick Pierquet, Dept. Of Horticulture & Crop Science 130 Gourley Hall – OARDC 1680 Madison Avenue Wooster, OH 44691	330-263-3879	Email: Pierquet.1@osu.edu	Wine Cellar Master – OSU Micro-vinification, sensory evaluation and laboratory analysis
Todd Steiner, Enology Program Manager & Outreach Specialist Dept. Of Horticulture & Crop Science 118 Gourley Hall – OARDC 1680 Madison Avenue Wooster, OH 44691	330-263-3881	Email: Steiner.4@osu.edu Website: Buckeye Appellation	Commercial wine production, sensory evaluation, laboratory analysis/setup and winery establishment. Todd is the primary research and extension contact of the enology program.
Dr. Celeste Welty OSU main campus Department of Entomology Columbus, OH	614-292-2803	Email: Welty.1@osu.edu	Fruit and vegetable insects