

Pre-Harvest Winegrape Juice Testing

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The UVM Grape Program

Maximizing juice quality at harvest is fundamental to wine making. Regular sampling of winegrapes on the vine can easily track juice qualities such as sugars, general acidity (pH), and titratable acidity (TA) that are important determiners for harvest.

Sugar is key indicator of juice quality. Measuring sugars during the ripening process allows for attainment of juice with a certain target potential when made into wine. Sugars are measured as °Brix, and Brix levels are often also indicators of other changes in juice of interest to winemakers. Some cold-climate grapes, like Frontenac and Marquette, can ripen to 25-27° Brix, which would convert to 15% or more alcohol in finished wine. Other *labrusca*-based cultivars, like St. Croix and Brianna may only reach 19-22° Brix before developing off flavors and aromas.

Acidity is another key component of juice and wine, and is often adjusted in the winery. While some grapes, especially when grown in hot climates, require addition of acid in the winemaking process to balance and stabilize the wine, grapes grown in cooler climates tend to have higher levels of acidity that must be managed downward for best wine quality. This is for two reasons: acidity changes during the grape ripening process, as acids change from one form to another and metabolize; and many cold-climate cultivars contain *V. riparia* or (to a lesser extent) *labrusca* in the breeding parentage, which are naturally high-acid fruit than the traditional *V. vinifera* winegrape. Acidity is measured as two components: general acidity, or more accurately total hydrogen ion concentration (pH); and titratable acidity, which is measured in units of tartaric acid equivalent concentration. However, not all acid in grapes, especially cultivars with strong *riparia* lineage, is in the form of tartaric acid, which is a 'softer' acid and is commonly associated with traditional wine flavors. Malic acid, which has a distinctly 'sharper' flavor, can be in grape juice in fairly high concentrations.

Growers and winemakers should work together to develop target values for grape ripeness for a certain wine style. Once the grapes are harvested, quality can only go down, so harvest timing is critical to maintaining fruit and making the best wine from it.

Timing

Growers should start sampling grapes at least two weeks prior to anticipated harvest. In some years, juice quality parameters can be quite far off from 'expected' values. That may mean advancing or delaying harvest, and both harvest labor and winemaking operations need to be ready for the crop. Weekly sampling is typically sufficient to assist with harvest timing. However, values can advance rapidly, especially in hot weather.

Collecting Samples

A properly collected, representative sample is essential to accurate assessment of crop maturity. Begin weekly after veraison; increase frequency closer to harvest.

- Sample each cultivar separately. Also, collect separate samples in different blocks. This is especially important when factors that may affect microclimate and or maturity, such as slope aspect, canopy density, or crop load, differ among blocks.
- Collect at least 200 berries per cultivar, per block; more will provide better accuracy. If possible, assess fruit from about 10% of the panels in the vineyard.
- Sample random clusters (both sides of trellis); random berries on cluster (inner, outer, upper, middle, lower)
- Store berries in a sealed plastic bag and keep cool until juicing.

- To prepare the juice sample, gently crush berries in the bag. Then, cut one corner of the bag and squeeze juice into a beaker or other container.

NOTE: Berry seeds turn brown closer to harvest

Soluble Sugars (°Brix)

Soluble sugars in juice are measured using a refractometer. The bend of light passing through the sample and a glass prism is measured in degrees Brix. (1° Brix = 1g sucrose/100g solution)

- Place several drops of blended, clear juice (no pulp) from the crushed sample berries onto the glass measuring surface of the refractometer.
- Close refractometer cover, creating a thin film of juice.
- Look through the refractometer eyepiece and hold sample end to the light; focus as needed.
- Where the dark and light areas meet on the scale is the degrees Brix.
- **Soluble sugars will increase as berries ripen.**
- **Harvest target for cold-hardy varieties: 18-25+ °Brix depending on cultivar**

NOTE: Check calibration of a refractometer with distilled water (should be 0° Brix) and calibrate according to the directions.

General Acidity (pH)

The general acidity of juice is measured using a pH meter. The meter probe measures the concentration of free hydrogen ions ("potential Hydrogen") in a solution that follows a negative exponential curve (i.e. larger difference at either end) from acid to alkaline (basic). (pH = 1 acid; pH = 7 neutral; pH = 14 = alkaline)

- Always calibrate your pH meter probe before using and at regular intervals following manufacturer's directions. This will typically involve checking against known stock solutions of pH 4.0 and 7.0. Those solutions are available from the place where the meter was purchased.
- Pour enough of blended, clear juice (no pulp) from the crushed sample berries into a clean glass cup so depth of juice will cover the pH meter probe.
- Rinse probe with water and insert into juice.
- Swirl juice and wait for pH meter to stabilize a reading.
- **pH will increase as berries ripen (become less acidic).**
- **Harvest target for cold-hardy varieties: pH 3+ depending on cultivar.**

NOTE: pH meter probes are very fragile! Always rinse with distilled water and store in proper storage solution.

Titrateable Acidity (TA)

The major organic acids in grape juice are tartaric and malic acids. There is no direct way to measure these acids as part of juice pH due to other chemicals present in the juice. These acids are best measured by titration: adding a basic solution of sodium hydroxide (NaOH) of known concentration to a known volume of juice until a specific end point is reached, then calculating tartaric acid equivalence.

- *Note: NaOH is caustic, wear gloves and safety glasses when performing this procedure.*
- Transfer 3ml of blended, clear juice (no pulp) from the crushed sample berries into a clean glass tube; dilute with 6ml water.
- Add 3-4 drops of phenolphthalein acid indicator.
- Start with a known volume of 0.1N sodium hydroxide (NaOH)

- SLOWLY add drops of the volume of NaOH to contents of tube, pausing frequently to assess; indicator may appear pink when it hits the liquid in the tube. A 3 ml syringe may be helpful to properly conduct the titration.
- Swirl contents of tube and view against a white background; look for a color change from clear to pink (at pH 8.2)
- Stop adding NaOH when color change is constant throughout the tube and does not disappear upon swirling.
- Measure the amount of NaOH added to reach this end point; perform calculations.
- **TA will decrease as berries ripen.**
- **Harvest target for cold-hardy varieties: 0.8-1.5% TA depending on cultivar.**

Approximate target juice parameters for harvest of some cold-climate in Vermont and similar regions¹			
Cultivar	Soluble solids (°Brix)	pH²	Titrateable acidity (g/l)
Frontenac	21 - 23	3.2 - 3.6	< 14
La Crescent	21 - 23	3.2 - 3.6	< 12
St Croix	18 - 20	3.2 - 3.6	8 - 10
Frontenac Gris	21 - 23	3.2 - 3.6	< 12
Louise Swenson	18 - 20	3.2 - 3.6	9-11
Marechal Foch	19 - 22	3.2 - 3.6	7-10
Marquette	22 - 24	3.2 - 3.6	< 12
Prairie Star	18 - 20	3.2 - 3.6	8 - 10
Petite Pearl	22 - 24	3.2 - 3.6	7 - 9
Crimson Pearl	22 - 24	3.2 - 3.6	7 - 9
Verona	22 - 24	3.2 - 3.6	8 - 10
Itasca	22 - 24	3.2 - 3.6	9 - 11

¹ Actual measurements may differ based on growing season, site, or winemaking style.
² Juice pH can vary depending on many factors. Ideal juice pH is between 3.2 – 3.6 for most cultivars, but some juices may not achieve that level. Best practice is to ferment juices with pH > 3.0 to avoid stress on yeasts during fermentation

NOTE: The titration end point (pH 8.2) can also be measured using an accurate and responsive pH meter. Meters capable of accurately measuring the end point without overdosing the NaOH tend to be lab-grade and more expensive than the units that are suitable for field assessment of juice pH.

Calculations for measuring tartaric acid equivalent:

$$\% \text{ TA (g/100ml) of tartaric acid} = \frac{\text{ml NaOH} * \text{Normality of NaOH} * 75 * 100}{\text{ml sample} * 1000}$$

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$$\% \text{ TA (g/100ml) of tartaric acid} = \frac{\text{ml NaOH} * 0.1 * 75 * 100}{3 * 1000}$$

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$$\% \text{ TA (g/100ml) of tartaric acid} = \text{ml NaOH} * 0.25$$

NOTE: If a 5ml sample is used, use ml NaOH * 0.15

TA can also be expressed as grams of tartaric equivalent per liter. 1% TA = 10 g/l



Figure 1: A simple and effective juice field lab can be set up on a bench in the shop, or even on a truck tailgate. Pictured here are (counter clockwise, beginning at lower left): bagged grapes for squeezing; a refractometer for measuring sugars; a pH meter; and a titrator for dispensing NaOH.



Figure 2: Ripening is substantially improved when grapevines are well-managed. These Frontenac clusters were well-exposed to sunlight by appropriate shoot positioning and leaf pulling performed in early-mid July.

Taste Testing, Other Factors

The human element is very important to determining optimal harvest. Routinely taste whole berries and juice samples for overall flavor. Varietal aromas and flavors, including off-flavors, can be as important as juice chemistry characteristics in determining harvest. Other factors, such as berry condition (splitting, insect pressure) or impending weather (heavy rains), may also affect harvest timing.

Additional Resources

- Determining Grape Maturity and Fruit Sampling <https://ohioline.osu.edu/factsheet/HYG-1436>
- How to Use a Refractometer <http://www.fruitandvegetable.ucdavis.edu/files/237293.pdf>
- Use and Care of a pH Meter https://morewinemaking.com/web_files/intranet.morebeer.com/files/wphmeter.pdf
- Titratable Acidity <https://www.extension.iastate.edu/wine/titratable-acidity>

Equipment Sources

- Vermont Homebrew Supply <http://vermonthomebrew.com/>
- MoreWine! <https://morewinemaking.com/>
- Presque Isle Wine Cellars Supply Store <https://www.piwine.com/winemaking.html>

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