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Determining Grape Maturity and Fruit Sampling

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Time of grape harvest is probably the most important and challenging viticultural decision for grape producers due to the difficulty of assessing grape maturity in the vineyard and predicting wine quality. The yearly dilemma is whether to delay harvest until desired quality parameters are reached since, once picked, grapes do not improve in flavor, color or sugar content. On the other hand, if the grapes are left hanging too long on the vine, the berries may shatter, get damaged by wildlife or insects, or break down due to rot; and yields and quality are negatively affected. During the past 15–20 years, we have come a long way from the days of determining time of harvest by simply going out to the vineyard with a refractometer. Today, overall ripeness evaluation involves much more than an analysis of °Brix, titratable acidity and pH; and many winemakers use flavor/aroma assessment in addition to the routine standards.

In this fact sheet, I have highlighted considerations to take into account when deciding on time of harvest and have described objective and subjective methods to determine optimum fruit maturity, which is a balance between the two methods. Sampling methods are also described. The information is especially useful for new growers/vintners and is a refresher for seasoned producers.

Factors Affecting Time of Harvest

First, let's clarify a never-ending misconception by many involved in the grape and wine industry. Physiologically, *grape maturity* is reached when seeds are able to germinate, which is immediately after veraison, or initiation of fruit ripening. The man-made maturity (typically referred to as *technological maturity* in Europe) is an arbitrary set of parameters used by the vintner/grower to determine the time of harvest based on the cards they were dealt that season. In other words, unlike physiological maturity which is consistent, technological maturity varies from year to year, which makes determining time of harvest even more challenging. Under our unpredictable environmental conditions, time of harvest is a complex compromise since it is affected by several factors including:

- season
- weather (daily and diurnal temperature, rainfall)
- likelihood of pest, disease and wildlife damage
- vintner preference
- communication and mutual agreement between grower and vintner
- labor availability
- grape composition
- viticultural characteristics: variety (early vs. mid- vs. late season ripening), crop load (heavy vs. light load), sun exposure (exposed vs. shaded fruit), vine health, and vine vigor

Objective Criteria for Estimating Grape Maturity

At maturity, grape juice is generally composed of the following: water (74%), sugars (25%, primarily fructose and glucose), organic acids (0.8%, primarily tartaric and malic acids), minerals (0.5%, mainly potassium), and phenolic, aromatic and nitrogenous compounds (0.2%). Due to their abundance and ease of measurement, it is no wonder that the primary fruit maturity indicators and "industry standards" are sugar and acid contents, and pH. Flavor and aroma compounds are laborious and expensive to quantify and thus are not commonly measured and winemakers assess them subjectively instead.

Sugar Content: A large proportion of the soluble solids in grape juice are sugars. Glucose and fructose are the main sugars in the juice. At ripening, glucose and fructose are usually present in equal amounts. Both fructose and glucose are fermentable sugars and during fermentation, yeast converts these sugars to alcohol and carbon dioxide. Generally, sugar levels

are expressed in degree Brix (a scale to measure total soluble solids) which represents grams of sugars per 100 grams of juice. Levels between 18 and 24 °Brix are desirable, depending on variety and wine style. Sugar level is measured with a refractometer. Juice is placed on a refractometer glass and light travels through the juice to register on a degree scale. The thicker the juice, the sweeter it is, the more it bends the light, and the higher the °Brix that registers on the scale.

Acid Content: Next to sugars, organic acids are the most abundant solids present in grape juice. They are responsible for the tart (sour) taste of juice and wine and have noticeable influence on wine stability, color, and pH. The predominant acids found in grapes are tartaric, malic and citric acids. Malic and tartaric acids account for more than 90% of the total acids present. During the early period of berry growth, the concentrations of both acids increase in the fruit. At veraison, the soluble solids accumulate in the fruit and the acid concentration decreases. Total acidity (TA, also referred to as titratable acidity) is the actual amount of acid reserve in the wine. Acid levels generally fall between 0.6 and 0.8 grams of titratable acids/100 mL (%TA) at harvest. TA is measured by titrating sodium hydroxide into a sample of grape juice to neutralize the acid in the juice. This amount of sodium hydroxide is then used in a formula to determine how much total acid is in the juice.

Level of pH: Acids upon dissociation in a juice solution liberate H+ ions, which are measured and expressed in terms of pH. The pH is a measure of active acidity in the juice and wine, and thus acidity and pH are related. The pH level influences a wide range of factors in the wine including microbial stability (spoilage), physical stability (protein, tartrate), oxidation level, SO_2 activity, color and flavor. Generally, white grapes are harvested at a pH of 3.1 to 3.3 and red grapes at a pH of 3.3 to 3.5. A pH meter is used to measure pH and assesses the strength of H+ ions in solution and registers the number on a scale of 1 (acid H+) to 7 (neutral) and up to 14 (basic OH-).

Subjective Criteria for Estimating Grape Maturity

It is a good practice for growers and vintners to periodically check berry skins and seeds and taste the juice collected to measure °Brix, pH and TA. It is a subjective way to monitor the development of color, flavor and aromas of a given variety. Research and experience have shown that optimum °Brix don't always match optimum flavors and aromas in white or red varieties. For example, grapes may measure 18 °Brix and flavor and aroma are fully developed in one year. In another season, sugars may be at 22 °Brix and the grapes have not fully developed the typical varietal character. The same is true for acid and pH levels. Since this is subjective, it is difficult to have "hard numbers" to make proper decisions. A scorecard was developed to aid with this process using a check list for subjective criteria for assessing grape maturity as follows:

Attribute	Level of attribute	Points Awarded
Color	Green (lack of color)	0
	Color change; translucent	1
	Fully matured color	2
	Over-mature color	1
Ease of removal of berries from pedicels	High resistance	0
	Moderate resistance	1
	Little/no resistance	2
Texture upon touch	Firm	0
	Soft/elastic	1
	Shriveled; loss of shape	0
Texture—initial bite		
Ease of skin collapse	High resistance	0
	Moderate resistance	1
	Low resistance	2
Mechanical features of the pulp	Thin; watery	0
	Viscous	2
	Jelly-like	1
Aroma	None	0
	Recognizable varietal aroma	2
Flavor upon chewing		
Initial character (upon chewing)	Unripe; green; bland	0
	Some varietal character	1
	High varietal character	2
Release from skin	None	0
	Typical varietal character	1
After taste	None	0
	Bitter; astringent	0
	Typical varietal character	1
Maximum total		**15**

Considerations for Fruit Sampling

In order to determine harvest date, grapes are sampled periodically before harvest to see how the levels of sugar, pH, acids and flavor compounds are progressing through the season. The determination to pick grapes is based on a small sample. Therefore, it is important that a sample is collected properly so that it will reflect the level of maturity of the entire crop. It is also important

that sample preparation and juice extraction mimic the juice obtained from an actual winery crush. The goal is to have vineyard samples accurately reflect must composition at the winery. There are two types of grape sampling: cluster sampling or berry sampling. With either method, it is critical to collect a "representative" sample with a minimum number of berries or clusters from a large number of vines.

Sampling guidelines:

A proper sampling procedure is listed as follows:

- Begin berry sampling at 15 °Brix or weekly after veraison. Sample daily when close to harvest.
- Sample at least 200 berries per block and per variety. At least 10% of the vines should be sampled. You could use a grid sampling approach; for example, berry samples are collected from every 10th vine in every 10th row.
- If the vineyard has a high degree of variation among the vines, for example, after severe winter injury, disease infestation, or other type of stress, increase the number of berries collected per sample.
- Sample from both sides of the trellis. If the rows run north and south, for example, take half the berries from the east side and half from the west side.
- Pick "random" berries as you walk down the row. There should be an equal chance of a berry being picked anywhere on the bunch or anywhere in the fruiting zone of the vine from both the sun and shade side of clusters. Don't favor colored berries over green. Collect berries from top, middle and bottom of selected clusters.
- Avoid row end plants, outside rows and off-type or otherwise unusual plants.
- Early morning sampling is preferred. If you are tracking the sugars, pH and TA through the season, the samples should be collected at the same time of day if possible.
- Store berries in a sealed plastic bag or container in the refrigerator until processing. If you will be out in the field sampling for a while, store samples in a cooler. Try to process berries within the next 24 hours.

Things to remember and consider when sampling:

- With berry sampling, in order to be within 1.0 °Brix of actual sugars at harvest, you need to collect 2 samples of 100 berries. To further increase the accuracy within 0.5 °Brix, you need to collect 5 samples of 100 berries. With cluster sampling, you need to collect 10 clusters to be within 1.0 °Brix.
- Realize that 90% of the variation in berry sampling is believed to come from variation in the position of the cluster on the vine and the degree of sun exposure.
- Juice sample collected in the morning can be 1 °Brix lower than juice sample collected in the afternoon.
- Rate of °Brix increase is usually 1 °Brix per week.
- Sugars of crushed must at harvest are usually lower than those of the sample juice. Therefore, you need to check harvest sample with crushed must to see how far off it was and take that into account in future sampling.
- Standardize a sampling method and apply it all season and use the same sampler(s) if possible.

Useful References

Dami, I.E., M.A. Ellis, D.C. Ferree, B. Bordelon, M.V. Brown, R.N. Williams, and D. Doohan. 2005. *Midwest Grape Production Guide.* Ohio State University Extension Bulletin 919, Columbus, OH.

Keller, M. 2010. *The Science of Grapevines: Anatomy and Physiology.* Elsevier Inc. Oxford, UK.

Wolf, K.T. 2008. *Wine Grape Production Guide for Eastern North America.* NRAES-145. Cooperative Extension, Ithaca, NY.

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