How to Judge Grape Ripeness Before Harvest

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Grape ripeness is an elusive concept for many people and sometimes an elusive achievement for vineyards. Much of the difficulty with discussions of grape ripeness is that there is often an implied standard, but in reality, ripeness is an entirely subjective judgment. So, there are really two issues to address: 1) how do we define grape ripeness and 2) how do we measure ripeness parameters to assist our harvest decisions.

What is Grape Ripeness?

To paraphrase an old adage - ripeness is in the eye of the beholder. Numerous ripeness indices have been investigated (summarized by Bisson, 2001) and a few analytical laboratories are attempting to quantify grape ripeness through complex chemical analyses of flavor and aroma constituents, phenolics, color compounds, sugars, acids, and pH. But there will never be a single set of numbers that define ripeness for a particular grape variety under all circumstances and for all purposes. Ripeness is really defined by the individual, whether grape grower or winemaker, and it is primarily a function of the intended use for the grapes. Often, an individual's definition of ripeness is also influenced by what is "typical" for that variety in their growing region. Some benchmark of ripeness is achieved in one or more seasons and all subsequent crops are compared to that benchmark.

Grape varieties have fruit characteristics that are often distinctive. Combinations of aromas and flavors, tannins, sugars and acids create the unique "varietal character" of a winegrape. But even for the common maturity parameters of sugar, acid and pH - what constitutes your definition of ripeness in one variety may not be the same for another variety. The chemical composition of grape berries is determined by the genetic makeup of the variety and influenced by environmental conditions and growing practices. It is the seasonal influence on the expression of fruit characteristics that led to the practice of wineries printing the year of harvest on the wine bottle.

Grape berry development and ripening is a continuous process and there is no single stage of development or point in time that the fruit can be universally considered "ripe". Remember that the grapevine's objective in producing fruit is to provide an attractive vessel for dispersal of its seeds, not to produce wine for our pleasure. So to get the desired fruit ripeness the vineyard must be managed appropriately to enable the vines to achieve the targeted ripeness. Then, fruit maturity must be closely monitoring to determine the appropriate time to harvest.

Winemakers commonly have a target for grape ripeness that they would like to have the fruit achieve for the wine they will produce. That target can vary, even within the same grape variety, depending on the type or style of wine that will be made. For example, Pinot noir intended for sparkling wine production will have a very different ripeness target compared to that for a Pinot noir still wine. Lower sugar, higher acidity and more neutral flavors are desired for sparkling wine compared to still wine, so "ripeness" and harvest for sparkling wine occurs earlier.

Wine stylistic differences will also necessitate varying ripeness targets. One recent trend with some varieties in California is to extend the "hang-time" (i.e., delay harvest) of fruit with the expectation of increased or better flavor development. Often the resulting wines will be described with terms such as "ripe fruit" or "jammy", and some people may even consider these flavors to be "overripe". An example of the progression of aroma and flavor characteristics for red grapes is shown in Figure 1. But ripening processes continue while fruit is on the vine so as flavors may be developing or changing with extended hang-time, sugars may continue to increase and acidity decrease. Consequently, wines produced from such extended hang-time fruit usually have relatively high alcohol content and may not have adequate natural acidity to make a balanced wine. Timing of harvest, therefore, is a matter of determining that point along the ripening continuum that best fits the winemaker's objective for the wine.

Figure 1. Evolution of flavorants in Cabernet Sauvignon. (From Bisson, 2001).

Grape growers must also be aware of the capabilities of their vineyard so they will have appropriate expectations for fruit ripening. Unrealistic expectations can cause a grower to postpone harvest without any real gains in ripening, but with a greater risk of crop loss from disease, depredation, or dehydration. Conversely, a grower could unnecessarily sacrifice ripeness and better fruit quality by harvesting too early. Consider that crop load and seasonal weather can greatly influence a vineyard's ability to ripen its fruit. Ripening can be delayed, and the attainment of desired ripeness inhibited by an excessive crop load.

The Ripening Process

The onset of grape ripening (veraison) begins during the final stage of berry growth when berries begin to soften and size increases due to cell enlargement. The sugar content of the berry increases rapidly, acidity decreases, and the pH increases (Figure 2). During veraison, berry skins lose chlorophyll and begin to synthesize and accumulate phenolic compounds that are responsible for development of characteristic colors: yellow-gold (flavonols) and pink and red (anthocyanins) colors (Watson, 2003).

As the berries approach full maturity, berry size reaches a maximum and sugar accumulation slows.

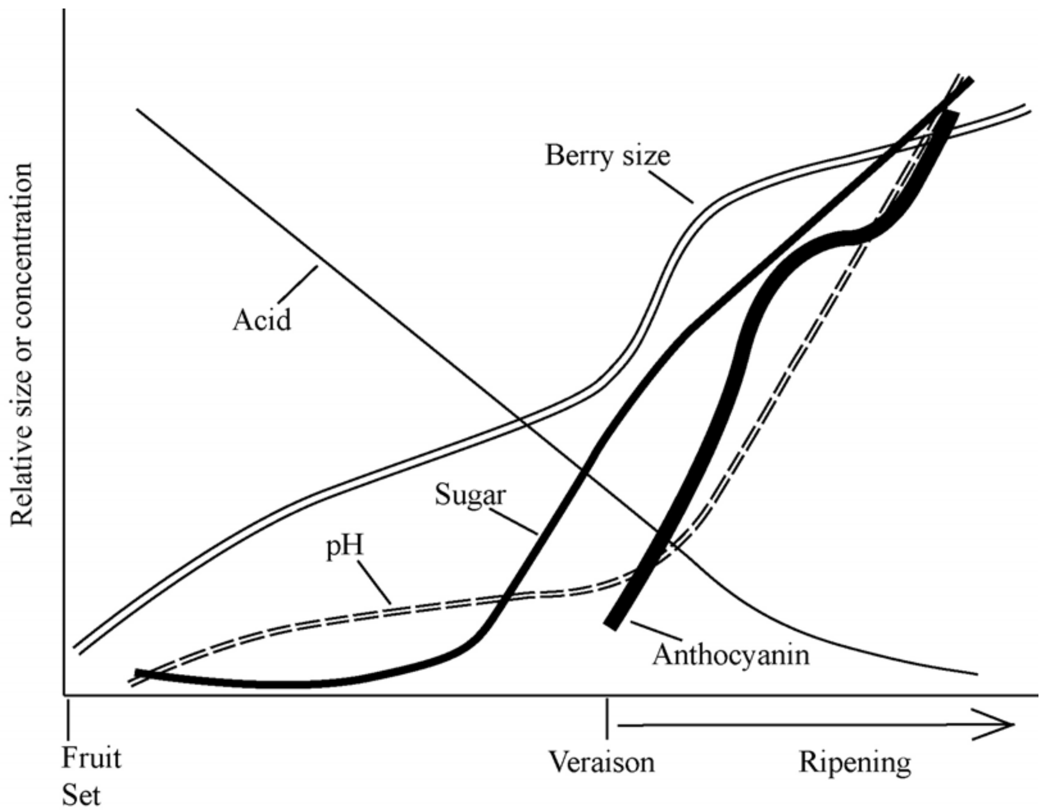

Figure 2. Generalized graphical representation of grape berry compositional changes during development and ripening. (From Watson, 2003).

At the start of veraison, aromas and flavors begin to develop, primarily in the skins of most varieties. Grape aroma compounds occur as both volatile aromatic compounds and non-volatile aroma precursors and are extracted during processing and fermentation (Watson, 2003). Aroma and flavor complexity typically increases during the later stages of ripening. Canopy management and cropping levels can have a dramatic effect on aroma and flavor development. For more complete discussions of grape berry development and the ripening process see the review article by Coombe (1992), the book chapters by Watson (2003) and Kanellis, et al., (1993) and the recent articles by Bisson (2001) and Kennedy (2002).

Measuring Ripeness for Harvest Planning

The ability to harvest grapes at your desired fruit ripeness is dependent upon your current knowledge of the progression in fruit maturity occurring in the vineyard. Weather conditions will cause seasonal differences in the rate and characteristics of grape ripening. Varieties and even blocks of the same variety are likely to have different patterns of ripening. The only way to know where the fruit is on the ripening continuum is to periodically collect samples of the fruit and assess ripeness. An excellent discussion of how to monitor fruit ripening can be found in the book chapter *Monitoring Fruit Maturity* (Watson, 2003). Much of the forthcoming discussion is adapted from this chapter.

Fruit maturity of grapes is commonly monitored by periodically measuring soluble solids content of ripening berries with a handheld refractometer. But sugar content is not necessarily related to accumulation of flavor and aroma compounds. Tasting fruit for a subjective assessment of flavor development typically augments the quantitative measure of sugar content. Such simple techniques can be very useful indicators of grape maturity, but only if the sample tested is appropriate. Too often however, conclusions about grape ripening status are drawn from very small, nonrandom and unrepresentative fruit samples. The key to a good estimate of fruit maturity is to collect a sample that is truly representative of the entire harvested unit (i.e., block of one variety). This requires a systematic sampling strategy that collects a large enough sample, in random fashion, to objectively represent the entire crop that will be harvested and processed. A good pre-harvest sample should give analysis results that are comparable to the juice or must at the time of harvest and processing. It is important to recognize the high level of variability in fruit composition that exists within a vineyard and even within a single fruit cluster. The range in maturity among berries on a cluster and among clusters on a vine may vary by up to one to two weeks.

The first step in collecting a representative sample is to develop a sampling scheme that collects fruit from vines in every portion of the vineyard block. Sample vines can be selected either randomly throughout the block or by a grid system (for example, every twentieth vine in every fourth row). Avoid sampling from vines at the end of rows, or from odd vines that are obviously different than the majority of vines in the vineyard block. It is best to determine the sampling scheme before you enter the block, and do not vary from the prescribed sampling routine. Sample size should be related to the size of the vineyard block and the degree of variability within the block. Large vineyards require a larger sample size, and vineyards with a high degree of variability require sampling a larger percentage of the vines to obtain a representative sample.

Fruit samples should contain proportional quantities of fruit collected from exposed and shaded locations in different parts of the canopy, at different heights on the vine, and on opposite sides of the row. Secondary clusters should be included in the sample if they will be harvested and processed along with the rest of the crop.

Samples may be taken as individual berries or whole clusters, but either way careful attention must be given to obtain a truly representative sample. Although berry sampling is commonly practiced, the method can be flawed by the tendency to sample too few berries and to select riper, more mature ones. Exposed berries tend to be sampled more than the shaded interior berries, and berries on the inside of clusters tend to be less ripe than other berries on a cluster. This can result in sugar measurements as much as 1%

higher in pre-harvest berry samples compared to the juice or must at harvest. For a small block of 5 acres or less, berry samples should probably consist of at least 500 berries that proportionally represent all berry positions within the cluster and cluster locations in the canopy. The difficulty in collecting such a representative sample makes a strong argument for sampling whole clusters.

Cluster samples typically gives compositional data that is closer than berry samples to that of the fruit at harvest. Collecting whole clusters has the obvious advantage of representing all berry positions within a cluster, thereby accounting for the within-cluster variation in berry ripeness. Obtaining a representative sample of the vineyard is then simply dependent upon a good vine sampling scheme (described above) and proportional sampling of clusters from different positions within the canopy. A typical cluster sample for a block of 5 acres or less will consist of about 20 to 25 clusters.

Fruit samples should be taken weekly beginning about three weeks before harvest is anticipated. More frequent sampling should be done as the anticipated harvest date becomes closer, particularly if there are changes in the weather that could affect ripening or condition of the fruit.

Sample Preparation and Analysis (adapted from Watson, 2003). Accurate assessments of fruit ripeness also depend on proper sample preparation and analytical procedures. Fruit samples should be processed quickly, preferably within a few hours of collection, and processing procedures should simulate winery conditions as closely as possible. The fruit can be crushed and pressed by hand, taking care to thoroughly crush each berry. Large samples are more easily crushed with a small roller-crusher and pressed with a small bench-top press. Crushing should be accomplished without breaking the seeds and the crushed fruit can be hand-squeezed tightly through cheesecloth to obtain both the free run and the pressed juice. Fruit constituents are not evenly distributed in the pulp of the berry so a thorough pressing or squeezing is necessary with all of the juice combined. A common mistake is to only use the free run juice for analysis, which tends to have higher sugar and titratable acidity, lower pH, and lower potassium than fully expressed juice. Juice yields from commercial processing can be approximated by pressing hard enough to obtain approximately 300 ml of juice per pound of fruit. This corresponds to about 160 gallons/ton equivalence.

Red winegrape samples are best prepared by crushing, de-stemming, and macerating on the skins for 1-2 hours at room temperature before pressing. Ripe red grapes rapidly release the anthocyanin pigments from the skin upon crushing and pressing.

Juice samples should be temporarily stored in sealed, full containers and allowed to settle to remove suspended solids. Refrigeration aids settling and delays enzymatic browning. Browning can be reduced by the addition of 25 mg/liter each of sulfur dioxide and ascorbic acid (vitamin C), which also helps maintain sample freshness for sensory evaluation. Pectolytic enzymes can be added to enhance juice clarity, if necessary. The settled, clarified juice is then ready for analysis. Juice should be analyzed for soluble solids (degrees Brix), titratable acidity, and pH. A sensory evaluation of aromas and flavors should also be conducted. Samples can be held refrigerated in full containers for up to 1-2 weeks for comparison with later samples.

Soluble solids are measured as degrees Brix using either a refractometer or a hydrometer. Refractometers should be calibrated by using a drop of distilled water at 20^0 C and adjusting the instrument to read zero degrees Brix. Accurate hydrometers are calibrated to narrow ranges of 5 to 10 degrees and are subdivided to 0.1 degree units. Inexpensive hydrometers typically have a large range such as 0-30 degrees and have other scales such as ‘potential alcohol’. These hydrometers are not very accurate. Both hydrometer and refractometer readings are usually calibrated at 20^0 C (68^0 F) so if the juice sample is at a different temperature, a correction must be made.

Laboratory procedures for determining soluble solids, titratable acidity, and juice pH are found in several books (Iland, et.al., 2000; Ough and Amerine, 1988; Watson, 2003; Zoecklein, et.al., 1995). The accuracy of a chemical analysis is highly dependent upon following appropriate procedures and maintaining properly calibrated equipment. Common errors with refractometer measurements include failing to calibrate with distilled water and not making the necessary temperature corrections. Titratable acidity measurements can be inaccurate because of careless pipetting of the sample, failure to neutralize the acidity in the water before adding the juice sample, over-titration, and failure to calibrate the pH meter properly. Common errors in pH measurement include failure to standardize the pH meter, disregarding temperature correction, and the use of worn or insensitive electrodes. A recent article by Weeks (2002) provides excellent advice on pH analysis and troubleshooting.

Sensory evaluation can be conducted by tasting fruit in the vineyard, however, too often only a few berries are tasted and the variability within the vineyard is not adequately represented. A more accurate assessment can be made on a juice sample collected using the processing procedures described above. Crushing and pressing extracts aroma, flavor and color from the grape skins. The juice sample should be evaluated for both intensity and quality of aroma and flavor, acidity and taste balance, and color.

Summary

The ability to accurately assess grape ripeness is essential for determining when to harvest for high quality wine production. A clear and attainable objective for fruit ripeness should be established by the winegrower and winemaker, and the crop must be closely monitored to determine progress toward this goal. The keys to accurate fruit assessment are to use appropriate sample collection methods, proper analytical equipment and procedures, and careful sensory evaluation.

References

Bisson, L. 2001. In search of optimal grape maturity. Practical Winery & Vineyard. July/August. Pp. 32-43.

Coombe, B.G. 1992. Research on development and ripening of the grape berry. American Journal of Enology and Viticulture 43:101-110.

Iland, P., Ewart, A., Sitters, J., Markides, A., and N. Bruer. 2000. Techniques for Accurate Chemical Analysis and Quality Monitoring During Winemaking. Wine Promotions, Campbell Town, Australia.

Kennedy, J. 2002. Understanding grape berry development. Practical Winery & Vineyard. July/August. Pp. 14-18.

Kanellis, A.K. and K.A. Roubelakis-Angelakis. 1993. Grape. Pp. 189-234. In: Seymour, G.B., J.E. Taylor, and G.A. Tucker (eds.). Biochemistry of Fruit Ripening. Chapman and Hall, London.

Ough C.S. and M.A. Amerine.1988. Methods for analysis of musts and wines. 2nd Edition. John Wiley & Sons.

Watson, B. 2003. Evaluation of Winegrape Maturity. In: E.W. Hellman (ed.) *Oregon Viticulture*. Oregon State University Press. Corvallis, Oregon. Pp. 235-245.

Weeks, S. 2002. Measuring, maintaining, and trouble-shooting pH. Practical Winery & Vineyard. September/October. Pp. 74-77.

Zoecklein, B.W., Fugelsang, K.C., Gump, B.H., and F.S. Nury. 1995. Wine Analysis and Production. Chapman & Hall Enology Library.

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