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Ripeness 101

Knowing when grapes are ripe depends on science, experience and a little luck

Liza Gross

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Ask a dozen winemakers how they know their grapes are ripe enough to harvest and chances are you'll get a dozen different answers. Everyone agrees that high quality wine starts with properly ripened fruit. Yet the definition of ripeness remains notoriously elusive.

Even as scientists offer better tools to track grape development, winemakers still rely on instinct as much as science to decide when grapes will produce the best wine. The vast majority of a wine's flavor and aroma compounds develop in the vineyard as grapes ripen. But scientists understand surprisingly little about how environment, vineyard management practices and choice of plant material interact to optimize ripeness and contribute to a wine's distinctive bouquet, body and flavor.

Historically, winemakers relied on sugar content (typically measured in units called Brix or Baumé) as the most important indicator of ripeness. But as scientists refined their understanding of ripeness-and recognized the complexity of the ripening process and the difficulty of finding a single index of maturity-winemakers adjusted their practices to follow suit.

By the 1990s, researchers had discovered that grapes can reach optimal sugar levels without reaching their full flavor potential. "We realized that Brix was just a measure of potential alcohol and just one of many indicators of ripeness," says Zelma Long, one of the first winemakers to bring cutting-edge science into the winery. "There are at least a dozen things we look at, and it's extremely unlikely that all those indicators of ripeness will reach their optimum at the same time."

Each component follows a different trajectory every year and in every unique vineyard site, adds Long, who makes Chardonnay at her family winery in Napa Valley as well as Bordeaux-style blends at Vilafonté in South Africa. "That's why ripeness is so hard to pin down," she concludes.

In an ideal winemaking world, sugars would develop at the same pace as flavors and aromas. But sugars (and acids) accumulate inside the berries, while flavors, aromas and tannins accumulate primarily in the skins, stems and seeds, through independent pathways and at different times.

Until seeds reach maturity, berries remain green, firm and full of bitter, astringent compounds, notably tannins and acids. "Tannins are designed to prevent damage from herbivores," explains Gavin Sacks, assistant professor of enology at Cornell University. "You'll find high concentrations of tannin in leaves, woody parts and the skins of unripe berries, where it offers the most protection, and in seeds, to protect them from damage."

Once seeds become viable, berries undergo the physical and biochemical changes technically known as veraison. Grapes soften, turn a more conspicuous color as they churn out pigments, and accumulate sugar rather than acids and tannins. The plant's goal is to attract hungry birds and mammals, which disperse the seeds.

Reconciling the reproductive needs of the grape with the sensory demands of the wine poses distinct challenges. After veraison, winemakers monitor changes in berry chemistry, checking sugar levels, acid content and pH to gauge the strength of the acids. As sugars rise, acids fall, and producers aim for different ratios for different wine styles. For example, Pinot Noir grapes grown for sparkling wine should have lower sugar and higher acidity than grapes destined for still wine. For most styles, too little acid can result in cloyingly sweet wines, while too much can produce harsh, overly tart wines.

Sugar and acid balance, however, can't predict the ripeness of flavors and aromas. That explains why a 2006 Vineyard Economics survey found that even though winemakers consider sugar content a useful and objective indicator of ripeness, the majority ultimately use "taste" to decide when to harvest. Still, winemakers shouldn't expect their grapes to offer the same flavors they like in their wines. "From a physiological standpoint, this isn't what you should be looking for," says Mark Greenspan, president and viticulturist of Advanced Viticulture, a winegrowing consulting company based in Windsor, Calif. "Most of the fruit flavors aren't released until fermentation."

Most flavor and aroma compounds in grapes remain bound to other grape constituents and are mostly imperceptible until fermentation breaks the bonds. Once fruit tastes ultraripe, Greenspan says, it's starting to decay.

For producers in warmer winegrowing regions like California and Australia, using a sensory approach to determine ripeness often means harvesting at higher sugar levels, which means higher alcohol. Sensory studies show that alcohol can enhance bitterness, sweetness and mouthfeel, as well as mediate astringency. But as Ann Noble of University of California, Davis, revealed in a 1998 study, these effects vary with a taster's genetic makeup; the study showed that the rate of saliva flow affects how a person perceives bitterness and astringency in wine.

Matt Wenk, winemaker at Two Hands Wines in South Australia, doesn't worry about picking his grapes at a specific potential alcohol level. For Wenk, whose Bella's Garden Shiraz has made Wine Spectator's Top 100 list six times since its debut in 2001, sugar becomes a concern only when levels threaten to interfere with fermentation. Above 26 degrees Brix, yeast runs into trouble converting sugar to alcohol. "I've got to keep the numbers in mind," Wenk says, "but if the flavor profile isn't there, there won't be any fruit in the end."

Wenk gets ready to harvest when his grapes offer "silky, rich and long flavors," the tannins no longer assault the mouth and "you can't stop eating the fruit." If the grapes are so sweet they're hard to eat, he says, they're probably overripe.

At some point during berry development—scientists aren't sure exactly when—vines stop delivering sugar and water to berries. "We think it's somewhere between 13 and 14.5 degrees potential alcohol," says Tyler Thomas, a UC, Davis-trained enologist who makes single-vineyard Syrahs at Donelan in Sonoma.

Once sugar and water accumulation stops, sugar concentrates as berries dehydrate on the vine. When grapes cross the line between ripe and overripe, Thomas notes, you'll see signs of dehydration, like golf ball dimpling on the skins. Allowing dehydration can lead to richer, darker, jammy flavors, "but at some point you start going toward a raisin. And a Chardonnay raisin tastes like a Cabernet raisin," he says. "You start losing varietal character."

Producers can't tell when rich fruit flavor will turn raisiny based on potential alcohol alone. A flavor profile of red cherry leaning toward blackberry at 14 degrees potential alcohol one year might lean toward raisin the next. A single number can't determine why a wine tastes the way it does, says Thomas, adding, "This is agriculture, not math."

When producers leave berries on the vine until they shrivel, sugars can concentrate in the skins as the berries dry out, says Cornell's Sacks. "So when you look at the juice, the Brix might look like 25 when the sugar's really much higher."

In one of the first studies to examine how picking grapes at higher Brix levels affects wine flavor, Hildegard Heymann, a sensory scientist and enology professor at UC, Davis, worked with growers in California's Central Coast to harvest Cabernet grapes in 2006 and 2007 at six different Brix levels, ranging from 21 to 30.7 degrees. She asked a group of Napa Valley winemakers to assess the quality and optimal maturity of those grapes using their own methods.

The winemakers expected the higher Brix grapes to produce better quality wines. But though they agreed that wines from grapes above 26 Brix were of higher quality than those below 25, they couldn't discern any differences in quality among wines from grapes 26 Brix and above. Heymann concluded that grapes don't have to be harvested at high Brix levels to make high quality wines.

In the end, says Long, the definition of ripeness depends on the winemaker's vision. As notions of ripeness continue to evolve, she hopes winemakers will follow their creative instincts. "In winemaking, nothing is absolutely right or wrong, it's all context-dependent," she says. "Wonderful wine can be made in many different ways."

Liza Gross is a freelance writer based in the San Francisco Bay Area.

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