ask the AWRI

Does having thick skin pay off when it comes to measuring sugar in grapes?

Winemakers recently asked the AWRI helpdesk why some grape varieties produce wines with greater than expected alcohol concentrations, even when based on initial glucose plus fructose (G+F) concentrations measured in pressed grape juice. Is it because varieties with small berries and/or thick skins have additional sugar extracted from their skins during skin maceration, or during skin contact in red wine fermentations? In this article, AWRI Senior Oenologist **Geoff Cowey** investigates whether initial sugar concentration measured in pressed juice from thick versus thin-skinned varieties differs from the sugar concentration measured in an equivalent homogenate sample.

Why measure sugar as G+F concentration in grape juice rather than Baume or Brix?

Baume or Brix density measurements are commonly used as quick ways to estimate sugar content in grape samples or must. It has become a 'rule of thumb' to expect that 1 Baume = 1.8 Brix = 18 g/L sugar = 1% potential alcohol. Several articles have addressed the challenges of using density measurements to estimate fermentable sugar concentration in juice and then calculating expected alcohol levels in wine (Cowey 2016, Wilkes 2016). Fermentable sugars can be accurately quantified using enzymatic assays or high-performance liquid chromatography (HPLC) to better estimate potential alcohol, yet despite this, variations are still observed.

How do I calculate potential wine alcohol from initial sugar measurement in juice?

Potential alcohol can be estimated using the official European conversion ratio of 16.83 g fermentable sugar per litre for 1% v/v alcohol, though the ratio can vary from 16.5-17.2 g/L sugar for 1% alcohol based on the commercial yeast strain used when evaluated in the laboratory (Varela et al. 2008).

Why are there variations in final alcohol levels in wine compared to potential alcohol calculations?

Fermentations are rarely closed systems, with both alcohol and carbon dioxide lost to the environment. Ferment vessel type (open versus closed), fermenter size and fermentation conditions, such as temperature, speed, nutrient availability and aeration, all affect the final alcohol concentration and the degree of evaporation. Not all fermentable sugars

are converted to ethanol, with some consumed for yeast biomass production. There is rarely a 1:1 mole-to-mole ratio of ethanol produced, with yields generally only 90% of the theoretical value.

Does pressed grape juice adequately represent total soluble solids in the grape?

Peynaud (1984) reported that sugar levels across the different parts of the berry remain relatively constant. Hirlam *et al.* (2021) evaluated the differences in Brix measurements between pressed white and red grape juice and homogenised grapes, and overall found no significant difference between results. Large variability, however, was seen between replicate samples, suggesting that bunch or berry heterogeneity may affect results.

Does pressed grape juice adequately represent sugar concentration?

In thick-skinned grapes or shrivelled ripe fruit harvested in warm years, or grapes with a greater proportion of solid to liquid components, the solids would contain a greater proportion of grape sugars. The lower proportion of liquid can also make it difficult to obtain a representative sample of pressed juice to measure sugar concentration accurately. When determining the G+F concentration in juice samples with high sugar concentrations, dilution is required for HPLC or enzymatic methods to lower the concentration to within the analysis calibration range. This can also increase the uncertainty of measurement to around 5%.

To understand the practical implications of these factors for different varieties, an investigation was conducted to compare varieties with different skin thicknesses. Twenty samples each of Semillon (thin-skinned), Viognier (thick skinned), Tempranillo (moderate skin thickness) and Durif (thick skinned, small berries) were collected from vineyards according to the Industry Endorsed Standard Procedure detailed by Australian Grape & Wine (2023). Samples were sourced from regions across South Australia, Victoria and New South Wales, collected approximately two weeks prior to the expected commercial harvest date.

Whole-bunch samples (2 kg) were destemmed by hand into a ziplock bag and pressed to extract the juice, ensuring all grapes had been pressed, and a 5 mL sample was taken for analysis. The pressed grapes were then transferred to a Ninja™ Pro X blender and blended for 90 seconds to obtain a consistent berry

homogenate, followed by centrifugation at 4,000 rpm for 5 minutes to obtain liquid for measurement. The G+F concentration was measured by enzymatic assay using a discrete analyser.

The G+F concentration of the homogenate grape sample was subtracted from the pressed juice sample to determine if there was a greater contribution of sugar being measured or extracted from the grape skins and solids.

Statistical analyses were applied to assess differences between juice and homogenate G+F results for all samples, then comparing G+F differences between thick- and thin-skinned white grape varieties and between thick- and thin-skinned red grape varieties.

What did the results show?

All sample sets showed normal distributions. When all four grape varieties were pooled together, as for Brix in the Hirlam study, there was no statistical significance between the mean G+F concentration in the pressed juice samples versus the homogenate samples. The difference between the mean G+F concentration in pressed grape juice compared to the mean G+F concentration in the homogenate grape samples was only 1.2 g/L (Figure 1).

When the difference in sugar concentration between pressed juice and homogenate was examined comparing variables of skin thickness (thin versus thick-skinned varieties), as hypothesised, the pressed juice of thick-skinned grapes gave a significantly lower mean concentration of G+F, for both red and white grape comparisons, around 12 g/L less compared to a homogenate sample. This could suggest that extra sugar had been extracted from the skin and solids. For the thick-skinned grapes, there was also a much larger overall variance in results.

Should I measure G+F concentration in a juice or a homogenate sample?

If processing white grapes intended to have some skin maceration before fermentation, then G+F analysis of a homogenate sample could be considered, but in general for white grapes that are pressed at grape intake with no intended skin contact, maturity measurements of pressed grape juice rather than a homogenate sample will likely better represent the juice obtained in the winery.

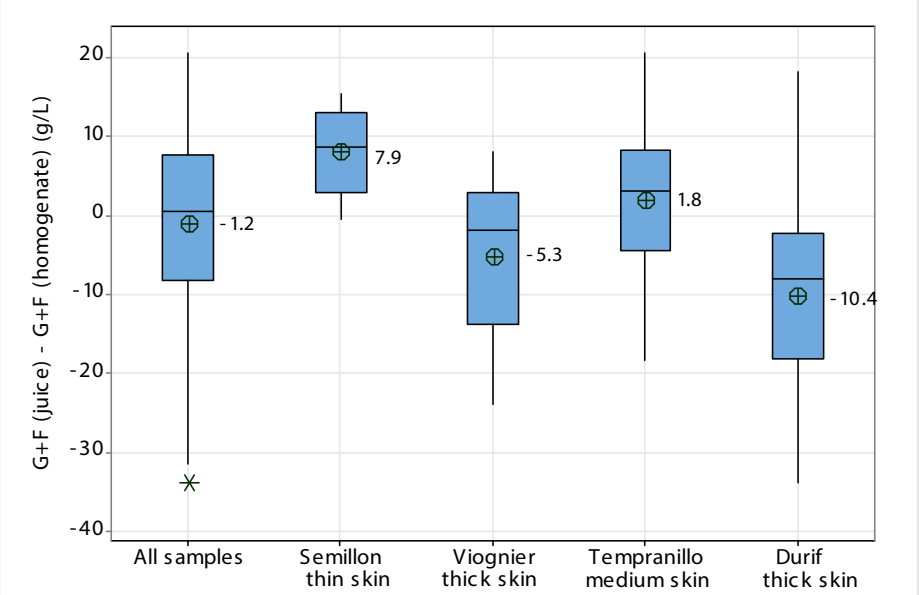

Figure 1. G+F concentration measured in a grape homogenate sample subtracted from the G+F concentration measured in a pressed grape juice sample. All varieties are grouped together (All samples), then a thin-skinned white grape (Semillon) is compared to a thick-skinned white grape (Viognier) and a medium-skinned red grape (Tempranillo) is compared to a thick-skinned red grape (Durif). The blue boxes represent the spread from the first to third quartile of data, and the horizontal line within the box represents the median value. The whisker lines above or below each box extend to the maximum and minimum values, excluding outliers.

For very ripe red fruit, small-berried or thick-skinned red grapes, a G+F concentration of a homogenate sample may give a better indication of the initial sugar concentration in the batch and an estimate of up to 0.7% greater potential alcohol. The additional effort, however, to homogenise a sample, centrifuge and measure G+F compared to a simple °Brix measurement on a pressed bunch of grapes may not be worth the additional benefit. Producers could instead potentially just take into account the likely impact of thick-skinned varieties when estimating final wine alcohol. It should be noted that the impact of fermentation enzymes, which may release sugars bound as soluble glycosides, was not investigated in this trial and these would not be measured in either a pressed juice or a homogenate G+F sample.

AWRI helpdesk

The AWRI helpdesk provides a free-of-charge technical advice service to Australia's grapegrowers and winemakers. For further information about grape maturity measurements or any other technical matter, contact the helpdesk on (08) 8313 6600 or helpdesk@awri.com.au

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