Unravelling the relationship between grape and wine tannin and colour

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INTRODUCTION

The concentration of tannins and anthocyanins in red grapes is an important factor in defining the colour and texture of red wines and is influenced by a wide range of factors. These compounds are present in the pulp, skins and seeds of grapes, but the degree to which they are extracted during the winemaking process can vary significantly.

Skin tannins and anthocyanins are generally extracted quickly during the initial part of ferment once the yeast is active (Peyrot des Gachons and Kennedy 2003, Cerpa-Calderon and Kennedy 2008). Seed tannins are extracted during the latter part of fermentation and this tends to coincide with the formation of tannin-anthocyanin condensation products (pigmented tannins), which stabilise red wine colour. The use of alternative winemaking techniques, such as extended maceration, can increase both tannin and anthocyanin concentration in wine.

A number of published studies have attempted to explain the relationship between phenolic compounds in grapes and those present in wines. Many have shown a strong correlation between the two for anthocyanins (Fragoso *et al.* 2011, du Toit and Visagie 2012), but generally the relationship is much weaker for tannins. This is principally due to the analytical methods employed to measure grape tannins.

Most grape analysis methods use an exhaustive extraction approach to maximise tannin extraction from the grapes (AWRI publications #894, #975). This typically involves the use of high power homogenisation equipment to break up the seeds and skins as much as possible. The reality of the winemaking process, however, is that the extraction environment is much milder and leads to a lower concentration of (predominantly skin) tannins in the finished wine. Analytical measures for both maximum potential tannin and extractable tannin could inform wine producers on the best approach to processing grapes and guide decisions on aspects such as pressing or maceration.

Figure 1. Comparison of total grape tannin measured following extraction using different homogenisers.

Figure 2. Comparison of total phenolics measured following extraction using different homogenisers.

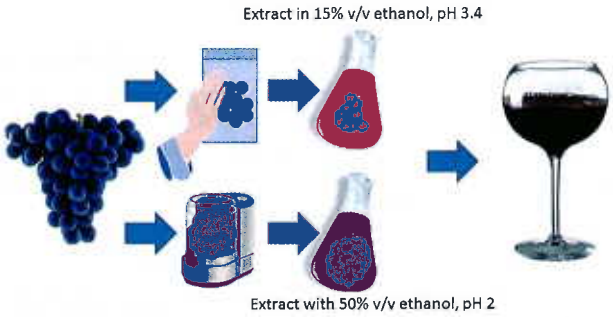

Figure 3. Experimental approach for comparing grape tannin and anthocyanin levels extracted with two different methods.

INFLUENCE OF SAMPLE PREPARATION METHOD

A previous AWRI study (AWRI publication #814) has shown that the way grapes are prepared can have an impact on the analysis of colour components. The type of homogenisation method employed can affect the accuracy of phenolic measurements and measured anthocyanin concentrations have been shown to decrease when grapes have been frozen for longer than three months. High-powered homogenisation equipment is powerful enough to break up the skins and seeds and enhance the extraction of tannins prior to measurement.

Tannin results generated using the AWRI's methyl cellulose precipitation (MCP) assay appear to be approximately two to three times higher (Figure 1) and total phenolics are approximately 50-100% higher (Figure 2) when using a high-powered homogeniser compared with a kitchen-type blender. The magnitude of these differences appears to be variety specific. The variability in tannin, colour and phenolics data is also higher when a standard kitchen-type blender is used.

Further studies carried out in collaboration with wine producers in Europe have also shown that the extraction medium used and its volume compared with the amount of grape homogenate can also affect on grape tannin measurement.

INFLUENCE OF SAMPLE EXTRACTION METHOD

In order to assess the impact of sample preparation and extraction solvent on measured grape tannins, a detailed study was carried out (AWRI publication #1616) that compared the total anthocyanins and tannin measured from extraction of grapes using two different methods (Figure 3):

- the standard industry method - 50% acidified ethanol extraction of grape homogenate (Iland *et al.* 2004).
- a new 'wine-like' extraction method which involves gentle crushing of 50g grapes, adjusting to 15% (v/v) ethanol, pH 3.4 and extraction for 40 hours.

The grapes were vinified using a standardised winemaking procedure in triplicate 1kg lots and the wines produced were analysed for tannin and anthocyanin using both the MCP tannin assay and the modified Somers method, respectively. The study included 39 batches of 2014 Cabernet Sauvignon and Shiraz grapes at different ripeness levels from various regions within Australia.

Grape anthocyanin concentrations, measured using the two extraction methods, correlated strongly with the anthocyanin concentrations in the wines (Figure 4B, D - see page 30). Grape tannin levels were strongly correlated with the tannin levels seen in the wines when the 15% method was employed (Figure 4A). When considered on a varietal basis, correlations between the grape tannins measured using the 50% extraction method and resulting wine tannins were strong (Figure 4C - see page 30). ►

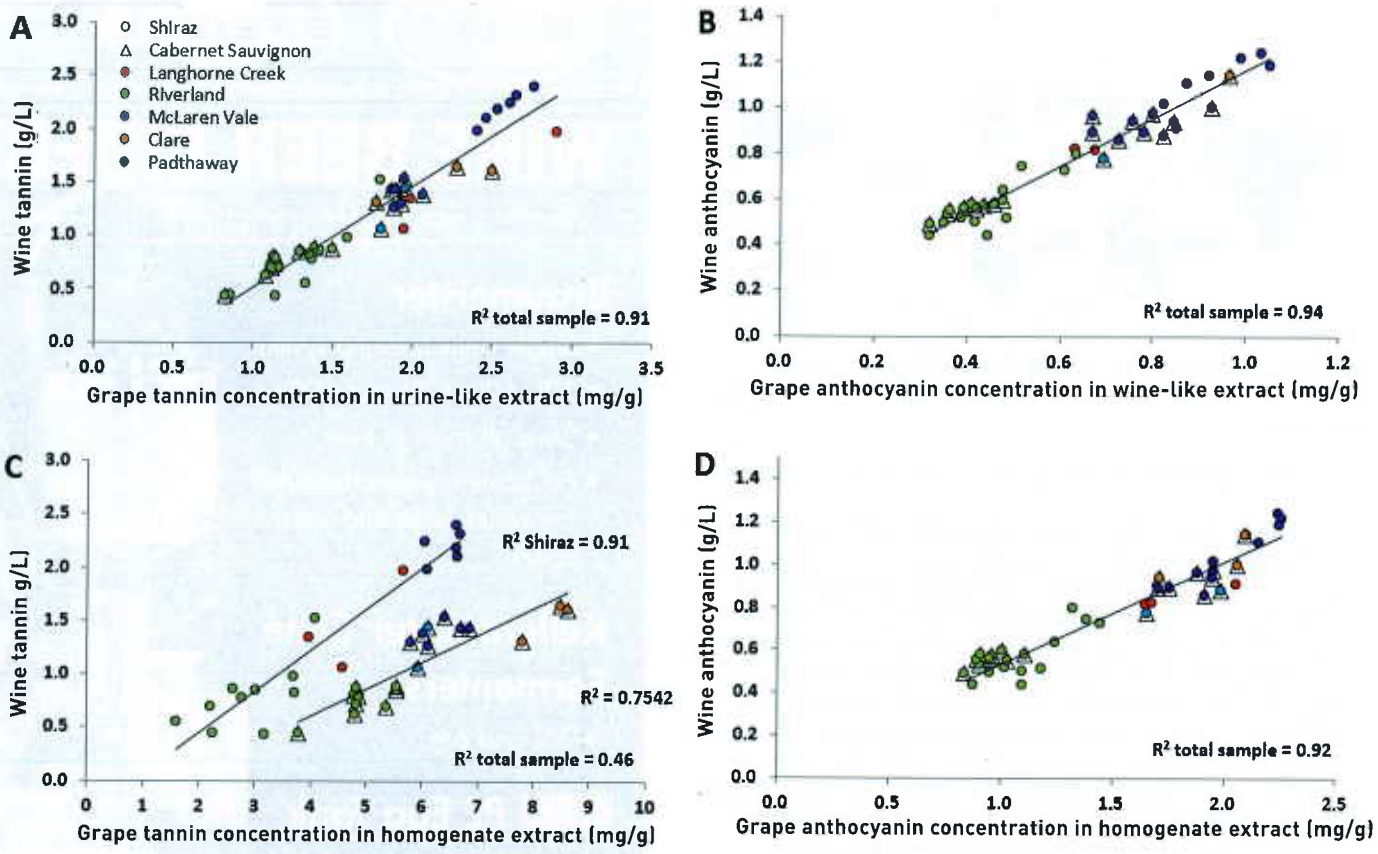

Figure 4. Correlation of grape tannin and anthocyanin concentrations, measured using two different extraction methods, with resulting wine tannin and anthocyanin concentrations.

Figure 5. Grape maturity trending using the Grape Portal.

The actual concentrations of grape anthocyanins and tannins measured using the 15% method were very similar to those observed in the wines. The concentrations measured using the 50% method were very different to the levels seen in the wines: grape anthocyanins were approximately twice the final concentration in the wines and grape tannins tended to be significantly over-estimated compared with tannin concentrations in the wines. The relative difference between the grape and wine tannin concentrations was higher with Cabernet Sauvignon than with Shiraz.

AWRI Commercial Services has built a calibration model that allows the prediction of extractable grape tannin concentration using absorbance values at three specific wavelengths (280nm, 320nm and 520nm). The relationship between tannin concentration measured using the reference MCP assay and that predicted using UV-Vis data is strong, with the calibration model

exhibiting a standard measurement error of 0.18g/L total tannin.

This body of work has shown that the use of a 'wine-like' 15% ethanol extraction method for grapes can provide a strong indication of tannin concentration that is likely to result from vinification of those grapes. The predictive method, utilising UV-Vis spectral data, will allow wine producers to access this capability in a practical way.

IMPLICATIONS OF MEASURING EXTRACTABLE TANNIN

Currently available methods for grape tannin analysis provide a good indication of the 'total tannin potential' available within the grapes. However, not all of this tannin is accessible, in practical terms, depending on the part of the berry that the tannin resides in and the winemaking methods employed to extract it. The application of a 'wine-like' extraction method would provide a good indication of tannin and anthocyanin concentrations that are extractable during fermentation. However, it is important to note that different winemaking practices can impact on total tannin concentration in the wine (Sacchi *et al.* 2005).

Based on this, knowledge of the extractable components of tannin and anthocyanin in grapes could provide winemakers with the information they need to make informed decisions for the processing of grapes and achieve specific targeted tannin and anthocyanin concentrations in the finished wines. For example, for grapes with a high level of extractable tannin, adequate extraction may be obtained through a short skin-contact period; whereas for grapes exhibiting a relatively low level of extractable tannin, extended maceration time or the use of targeted yeasts known to increase tannin extraction (AWRI publications #1542, #1562) may be required.

The benchmarking of extractable grape tannins and anthocyanins across different vintages, regions, vineyards and varieties could yield important information, particularly when combined with information on viticultural management practices being used. This may allow producers to select the most appropriate management techniques and growing attributes that can yield grapes with the optimal characteristics for the intended wine.

PROVIDING THE CAPABILITY TO MEASURE EXTRACTABLE TANNIN

The Grape Portal is part of the AWRI WineCloud, a web-based application that can be used to measure and compare a range of attributes in grape and wine samples. Users can generate total tannin, anthocyanin and phenolics data for grapes and wine using their own UV/Vis equipment, through the use of a predictive spectral method developed by the AWRI (AWRI publication #1436).

This predictive model is based on tannin measurement using the exhaustive 50% ethanol extraction method, which provides an indication of the 'total tannin potential' of the grapes. This spectral method could be adjusted for a particular cultivar to allow accurate predictions of wine tannin concentration by using the approach outlined in the tannin extractability study.

AWRI Commercial Services is currently working to incorporate the extractable tannin measurement into the WineCloud in time for use during vintage 2015. This would allow users to measure both the 'total tannin potential' and extractable tannin components simultaneously, as well as the total anthocyanins and phenolics.

This type of capability could allow:

- more efficient viticultural management and improved harvesting logistics
- more objective fruit grading and allocation
- enhanced ferment management to achieve desired tannin and anthocyanin profile ▸

- better understanding of factors influencing wine colour development and stability.

IN SUMMARY

A number of different methods are available for determining the tannin and anthocyanin concentrations in grapes and wine, but very few provide the capability to directly explore the relationship between the two. Rapid measurement techniques developed by the AWRI can be used to investigate both the 'total tannin potential' and extractable tannin components in grapes and provide a better understanding of the likely phenolic profile of the resulting wines. Being able to identify the optimal winemaking approach for any individual batch of grapes could be a very powerful weapon in the winemaker's arsenal.

The WineCloud is a subscription-based service. For more details please contact AWRI Commercial Services at **commercialservices@awri.com.au** or telephone (08) 8313 6600.

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