

Grape and wine tannin – are there relationships between tannin concentration and variety, quality, and consumer preference?

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Abstract

Amongst researchers and wine industry practitioners, it is speculated that tannin measures could be used to help target grape and wine quality specifications, and also that red wine tannins may be closely correlated to red wine quality. The first steps toward assessing these possibilities have been achieved by developing and applying the MCP (methyl cellulose precipitable) tannin assay, which is a simple, robust, high throughput method for tannin quantitation. The subsequent development of a reference database from a survey of grape homogenate extracts (~ 600 samples) and wines (~1200 samples) now allows for benchmarking and classification of low, medium and high tannin categories for Cabernet Sauvignon, Shiraz and Merlot.

In addition, the relationship between red wine quality and red wine tannin concentration was investigated by relating tannin concentration to quality grades as assessed by commercial allocation tasting within a major Australian wine company in 2006. A strong, positive correlation was shown between wine quality and wine tannin. Also, the relationship between astringency ratings of a trained sensory panel, and red wine tannin concentration for 20 commercial red wines was shown to be strong ($r^2=0.85$). Furthermore, the relationship between MCP tannin concentration and the 'liking' rating of a consumer panel indicated a tannin concentration preference, or 'tannin sweet spot', by a large proportion of consumers. These relationships demonstrate that tannin measurements such as MCP tannin can assist with decisions regarding quality assessment, product specifications, vineyard and winery management procedures; and complement sensory assessment related to consumer preferences and astringency.

Why measure tannins?

At the most fundamental level, measuring tannins helps to understand the composition of the products the Australian wine industry rely on – grapes and wine. Amongst researchers and wine industry practitioners, it is speculated that tannin measures could be used to help target grape and wine quality specifications, and also that red wine tannins may be closely correlated to red wine quality. Compositional parameters crucial to characterising red grapes and wines include pH, acidity, sugar, and anthocyanin and tannin concentrations. Established procedures are widely used to measure pH, acidity, colour and sugar content of grapes and wine. While numerous methods for determining tannin concentration are documented in the literature (Herderich 2005), no comprehensive data are available to determine and benchmark the tannin concentration of grapes or wine. As grape phenolic composition and extraction of tannins during vinification critically influences the astringency and colour attributes of red wine, such routine tannin measures may improve the capability to stream grapes based on their tannin concentration and to tailor the tannin concentration of red wine to a particular style or market. A grapegrower or viticulturist may benefit from measuring tannins by gaining a better understanding of how drought influences tannin concentrations in their vineyard and the implications of longer hang time for fruit. A winemaker may gain a more objective measure of the influence of e.g., modified pumpover methods, or numerous other processing variables on the tannin concentration and colour of their wines. A marketer may gain a better understanding of the taste preferences of the Asian market with regard to astringency. However, all these benefits require the ability to first measure tannin.

Tannin concentration can be measured easily in industry

The first steps toward assessing these possibilities have been achieved by developing and applying the MCP (methyl cellulose precipitable) tannin assay, which is a simple, robust, high through-put method

for tannin quantitation (Mercurio et al. 2007). The MCP tannin assay is based on precipitation of tannins by the polysaccharide methyl cellulose and requires only cheap, readily accessible reagents (methyl cellulose and ammonium sulfate) and instruments (a UV-Vis spectrophotometer). The assay is based on polymer-tannin interactions that result in an insoluble polymer-tannin complex which precipitates and is separated by centrifugation. It is a subtractive measure requiring the preparation of a control and treatment sample. The control sample allows measurement of all phenolic compounds present in the sample; whereas the treatment sample allows measurement of the phenolic compounds remaining in the supernatant solution after the tannin has been removed by precipitation. The phenolic content is directly monitored by measuring the absorbance at 280 nm (A_{280}) using a UV/Visible spectrophotometer. By subtracting the A_{280} of the treatment sample from the A_{280} of the control sample, the A_{280} of the tannin in the sample can be determined. The A_{280} can either be used as an arbitrary value or converted to monomer equivalents (epicatechin equivalents mg/L). The concentration in monomeric equivalents gives an indication of the amount of polyphenol subunits present in the multi-subunit polymeric tannin. Figure 1 highlights a schematic of the procedure for performing the MCP tannin assay.

The original research method was established and validated using a 10 mL final sample volume and reading of the absorbance at 280 nm in a 10 mm quartz cuvette (Sarneckis et al. 2006). However, to complement the 10 mL format, two new assay formats have now been developed: a 1 mL format and a high through-put (HTP) format. In both cases the assays were scaled down to a final volume of 1 mL. The 1 mL format is a direct downsizing of the original 10 mL format and is performed in 1.5 mL microfuge tubes. In addition to smaller sample volumes and reduced reagent costs, a significant advantage of the 1 mL format is that it allows laboratories with small bench-top centrifuges to adopt the assay without the significant financial outlay associated with larger centrifuges. The HTP format

can be performed in 1.1 mL 96 well deep-well plates and read on a microplate reader spectrophotometer. This format is more likely to be adopted by research groups with access to this more sophisticated equipment (although winery laboratories would find many useful applications for such a microplate reader). Through the use of multi-channel pipettes the HTP format allows for the simultaneous preparation of 48 samples within one hour (as a treatment and

control are required for each sample). In addition, the HTP format permits the direct transfer of supernatant from the deep-well plate, used for sample preparation, into a 96 well microtitre plate used for measurement. Using a microplate reader spectrophotometer, a total of 96 treatment and control samples can be read simultaneously, resulting in a five-fold reduction in analysis time.

The AWRI also now has methods for rapid measurement of grape and wine tannin by spectral prediction, using predictive models. This significantly increases the speed and simplicity with which tannins can be measured and those interested in this technology are encouraged to contact Dr Bob Damberg or Dr Paul Smith at the AWRI. A standard operating protocol for performing the assay is available at www.crcv.com.au/resources/ and the AWRI Analytical Service offers this assay.

Australian survey of tannin in grapes and wines

Having developed our capacity for measuring tannin, it was necessary to understand the variation and magnitude of tannin concentration in red grapes and wines, particularly in Australia. A review of published results from tannin surveys showed that limited sample numbers have been studied so far. To improve our knowledge on tannin concentration in Australian grapes and wines we have used the efficient HTP format to undertake a comprehensive survey and we are continuing the development of the reference database through analysis of grape homogenate extracts (currently ~600 samples) and wines (currently ~1200 samples). The results from this survey now allow for benchmarking and classification of low, medium and high tannin concentration categories for Cabernet Sauvignon, Shiraz, Pinot Noir and Merlot wines. Figure 2 highlights the distribution and categories for these varieties. As it demonstrates, variety affects average tannin concentration, though region and other variables result in a moderate overlap of concentrations among varieties.

Vintage can affect tannin concentration

If we consider the average tannin concentrations for the last five vintages of Shiraz and Cabernet Sauvignon wines included in our survey it appears that there is also a variation with vintage. For example, Figure 3 demonstrates that there appears to be a steady increase in the average wine tannin concentration from 2004 to 2007 for both Cabernet Sauvignon and Shiraz. This provides objective evidence that vintage can affect tannin concentration and that the trend can be similar for different varieties.

Region affects tannin concentration

The survey also highlights the magnitude of differences in wine tannin concentrations that can occur from region to region. Figure 4 shows the tannin concentrations for a number of Australian regions, with the highest and lowest average tannin concentration regions circled.

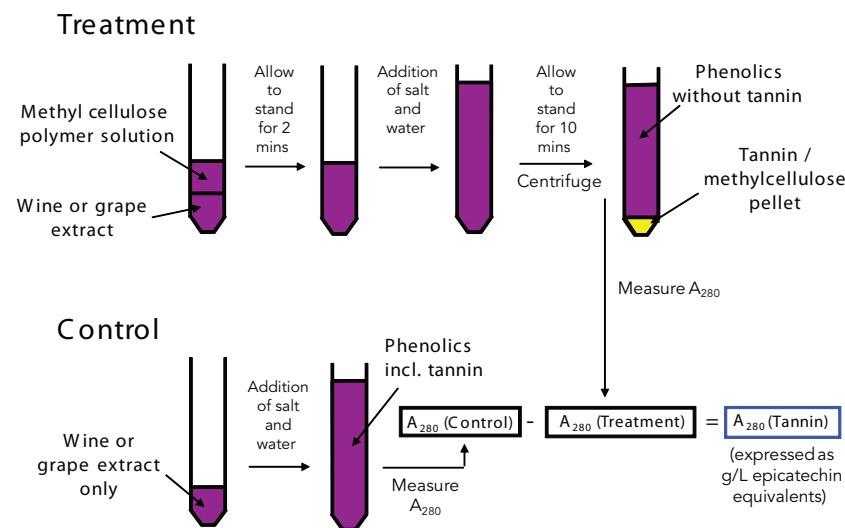


Figure 1. A schematic of the procedure for performing the MCP tannin assay

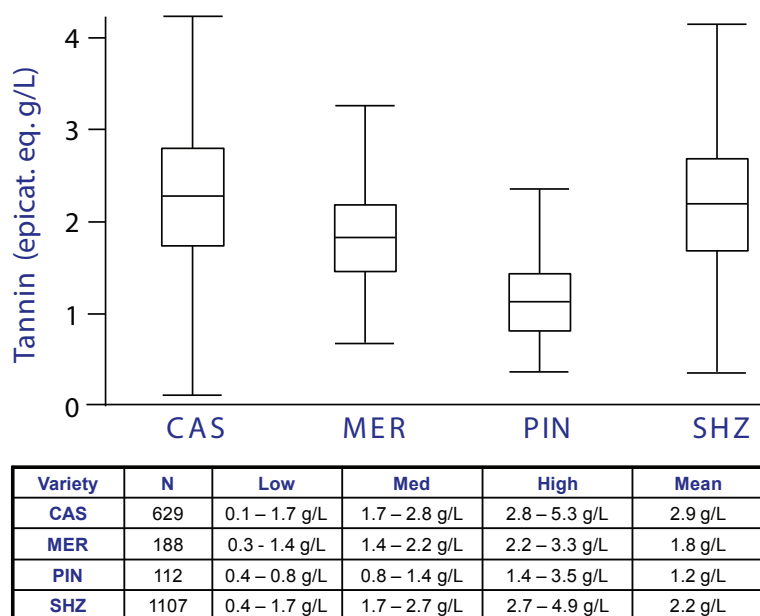


Figure 2. The classification of low, medium and high tannin concentration categories for Cabernet Sauvignon (CAS), Shiraz (SHZ), Pinot Noir (PIN) and Merlot (MER) wines from the AWRI tannin survey of Australian wines

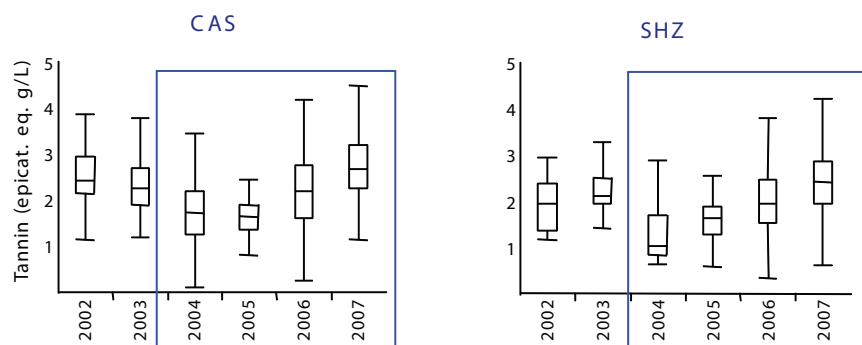


Figure 3. The average tannin concentrations for the last five vintages of Shiraz (SHZ) and Cabernet Sauvignon (CAS) wines included in our survey. It highlights the variation with vintage and the steady increase in the average wine tannin concentration from 2004 to 2007

The tannin concentration of red grapes and wines has implications for quality

In addition, the relationship between red wine quality and red wine tannin concentration was investigated by relating tannin concentration to quality grades as assessed by commercial allocation tasting within a major Australian wine company in 2006. A strong, positive correlation was shown between wine quality and wine tannin – the higher the quality, the higher the tannin concentration. For red wines, a similar trend appears across three wine companies, and one set of data for 2004 – 2006 samples is shown in Figure 5.

Tannin influences sensory aspects and consumer preferences of wine

Tannin concentration has been shown by numerous authors to be positively correlated to sensory panel ratings of astringency. An area of keen interest is the development of techniques to predict astringency. Such model systems might allow pre-screening of wines for studies or give an indication of wine astringency without the need for costly and time-intensive sensory studies. We collaborated as part of an AWRI ‘consumer preference’ study in which 20 commercial red wines (Shiraz and Cabernet Sauvignon) were carefully selected as representative examples of the major wine types made in Australia and were assessed to determine how well liked they were by consumers (Lattey et al. 2007). In addition, the wines were subjected to sensory descriptive analysis by a trained AWRI sensory panel and the sensory properties were quantified in triplicate. The relationship between astringency ratings of the trained sensory panel and red wine tannin concentration (by the MCP tannin assay) for these 20 commercial red wines was shown to be strong ($r^2=0.85$), as shown in Figure 6.

Having established and quantified the range of sensory properties of the wines, the next stage of the study was to assess how well a subset of the wines was liked by consumers. Cluster analysis on the consumer data showed that the consumers could be grouped into segments who behaved similarly, generally liking and disliking the same wines. Four distinct clusters comprised varying proportions of consumers, with the largest cluster (cluster 4) including 45% of the consumers, or 90 people. The relationship between astringency (drying) ratings for a trained sensory panel and the ‘liking’ scores of a consumer cluster (45% of the consumers) indicate that wines with intermediate tannin concentrations, or a ‘tannin sweet spot’ between 1.3 and 1.9 g/L, were most liked by these consumers. This is highlighted in Figure 7, where the MCP tannin concentrations are shown next to each wine (blue dots).

Work such as this helps to address questions such as ‘what do consumers think about astringency in wines?’, ‘what level of astringency is liked or disliked?’ and ‘is there a concentration of tannin they prefer in red wines?’

Summary

These relationships demonstrate that tannin measurements such as MCP tannin assay can assist with decisions regarding quality assessment, product specifications, vineyard and winery manage-

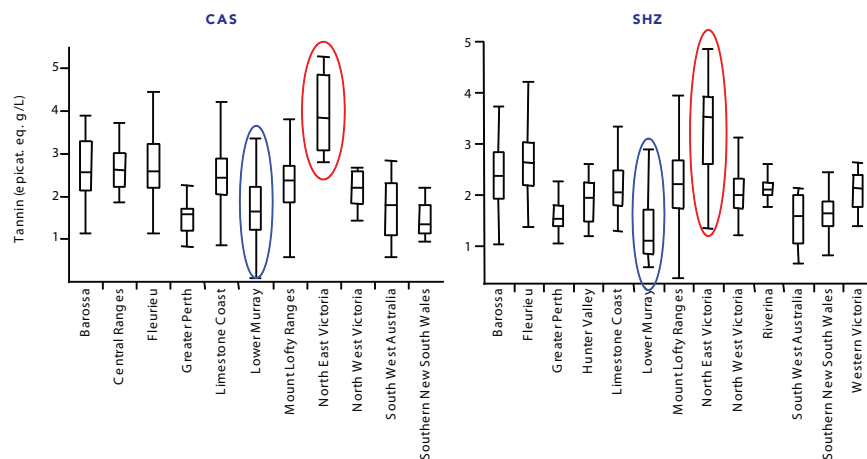


Figure 4. Tannin concentrations for Shiraz (SHZ) and Cabernet Sauvignon (CAS) wines from a number of Australian regions, with regions having the highest and lowest average tannin concentration circled

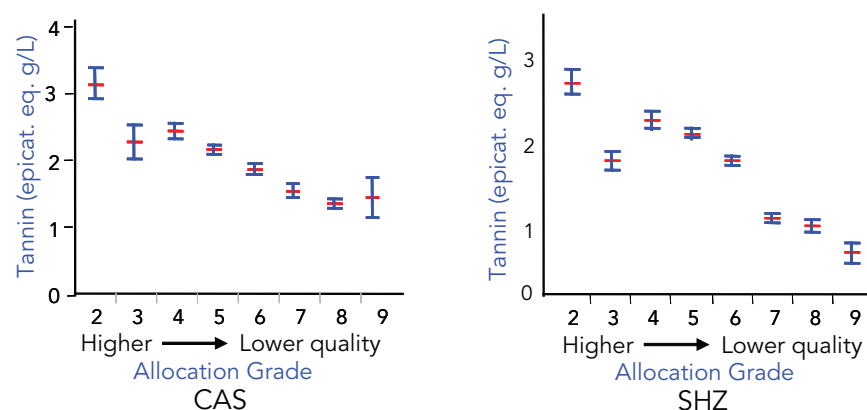


Figure 5. The relationship between red wine quality and red wine tannin concentration was investigated for Shiraz (SHZ) and Cabernet Sauvignon (CAS) wines by relating tannin concentration to quality grades as assessed by commercial allocation tasting within a major Australian wine company – the higher the quality, the higher the tannin concentration

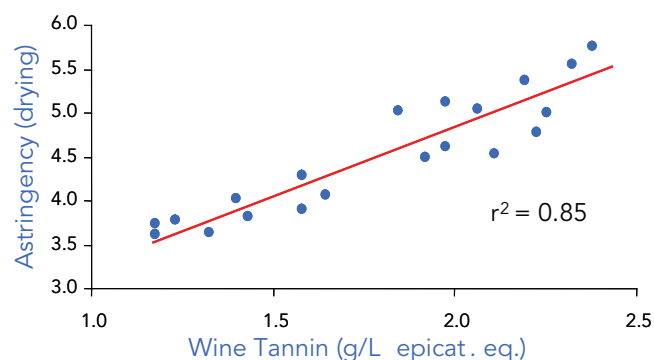


Figure 6. The positive relationship between astringency and tannin (as measured by MCP tannin assay) shows that the assay mimics human perception of astringency

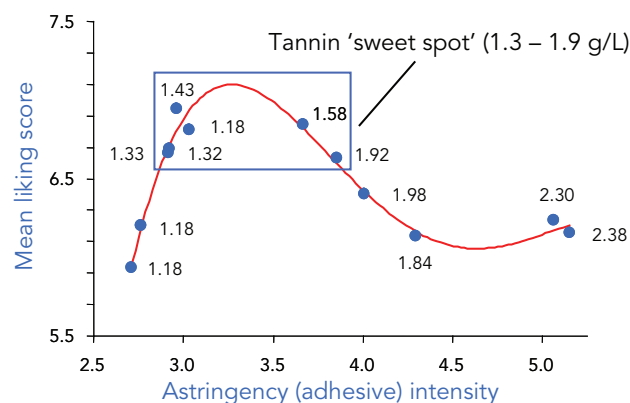


Figure 7. The relationship between astringency (drying) ratings for a trained sensory panel and the ‘liking’ scores of a consumer cluster (45% of the consumers)

ment procedures; and complement sensory assessment related to consumer preferences and astringency. Such improved definition of composition and style might also allow exploration of tannin measures for development of product specifications. In this context it is important to remember that sensory expectations of consumers, particularly in emerging markets, might well be different to our views as researchers, winemakers and experienced wine enthusiasts. Therefore, it is important to continue with unravelling the compounds responsible for wine flavour and mouth-feel and, at the same time, to increase our understanding of consumer preferences.

The MCP tannin assay can be easily implemented in a basic laboratory or samples can be sent to the AWRI Analytical Service for analysis. Our grape and wine tannin survey will continue, but we encourage interested wine industry personnel to consider measuring tannin for themselves, in both grapes and wines as part of a suite of approaches to allow them to better understand their products. We invite any interested parties to approach us for assistance in any aspect of implementation and tannin research in general. Adding tannin measurements to the existing protocols for grape and wine analysis will certainly be a step toward better understanding of the important role tannins play throughout the production of quality wine.

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