

What makes a red wine green?

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A multi-pronged approach to researching 'green' flavours in red wines is paying dividends for researchers and wine producers. Innovative sensory approaches have led to new understanding of what is meant by the terms 'green' and 'green tannin' in wine. Experiments looking at inclusion of stems and leaves in ferments and the influence of local vegetation on wine flavour have contributed insight into the origin of 'green' flavours and how winemakers may be able to manage them to achieve a desired style.

INTRODUCTION

Producing appealing and distinctive wines without sensory defects is the goal of most wine producers. Helping grapegrowers avoid sensory deficiencies has been a major role of the AWRI since its inception. One negative sensory characteristic of red wines that has been hard to manage is the 'green' flavour that can be seen in some red wines. Part of the challenge from a technical point of view is the vagueness of the term 'green' when it is applied to finished wines. The ambiguity and variation of flavour descriptors used across our industry means there is a lack of clarity regarding what is meant when describing a wine as having a 'green' character. For some industry personnel, 'green' can mean 'grassy' or 'herbal', for others it might refer to 'green capsicum' or 'asparagus-like' aroma, or 'cooked vegetal', or 'lower fruit' flavour combined with higher acidity and tannin. Still others may use the term 'green' to refer to a particular texture or mouthfeel of the wine, which can be labelled 'green tannin'. For some people all of the above characteristics might be lumped into describing a wine as 'green', which can be used as a synonym for unripe. In addition, some winemakers might describe wines with a noticeable 'mint' or 'eucalyptus' flavour as having 'green' nuances. In unripe fruit, 'green' characters can be quite easily understood. For example, in apples, high acid, low flavour and low sweetness would be clearly linked to 'greenness', or for bananas, high drying astringency, firm texture and low sweetness would be the dominant sensory properties. With wine the situation is more complex.

Over the last several years, the AWRI has worked on a project to better define the chemical basis of 'green' flavours in red wine, and to find the main causes of these characters. This aim was pursued via several different avenues.

DEFINING 'GREEN' WINES: RELATING WINEMAKER DESCRIPTORS, CHEMICAL COMPOSITION AND SENSORY DESCRIPTIVE ANALYSIS ATTRIBUTES

Commercially-available red wines with a range of 'green' characters were selected and studied extensively to achieve a detailed understanding of what winemakers mean when they use different terms to describe wines with 'green' characters, and to provide a link between chemical composition and sensory properties. There was also interest in shedding light on what might be meant by the term 'green tannin' (sometimes used by winemakers) and establishing the compounds that are related to this sensory term.

Forty candidate Cabernet Sauvignon wines and 60 Shiraz wines were initially selected from a wide range of regions, based on previous experience of wines showing some 'green' characters. Following a series of sensory evaluation sessions, 18 wines of each variety were selected that showed a variety of different 'green' sensory properties, including some with no

AT A GLANCE

- 'Green' or 'green tannin' characters in red wine are often considered negative by winemakers, but have been difficult for researchers to define.
- The AWRI flavour and sensory team combined traditional and newer sensory analysis techniques with chemical analysis to tease out green characters in Shiraz and Cabernet Sauvignon wines in more detail.
- Fermentation experiments revealed that grape stems in ferments significantly increased 'green capsicum' and 'green stalks' characters, while also influencing colour, fruit and astringency. Grape leaves in ferments did not enhance any 'green' characters but did increase fruitiness.
- The compound 2-isobutyl-3-methoxypyrazine, known to be a contributor of 'green' characters in Cabernet Sauvignon, was found also to be important in Shiraz wines, with its origin likely to be grape stems.
- When grown close to vineyards, Monterey cypress trees contributed 'herbal/pine-like' flavours to wine, whereas she-oak and radiata pine trees had no clear sensory impact.
- Simple steps such as choosing whether or not to include stems in ferments or removing vegetation from picking bins can give winemakers greater control over the development of 'green' flavours in red wines.

'green' or unripe characters at all to act as controls. The wines were characterised using two different sensory techniques: sensory descriptive analysis and projective mapping, with the Cabernet Sauvignon wines assessed separately from the Shiraz wines.

For the sensory descriptive analysis, the AWRI's trained and highly experienced panel evaluated the wines using terms generated by the panel, which were extensively discussed and refined through multiple training sessions. The final list of 'green' terms chosen by the panel to describe the Cabernet Sauvignon wines were 'green stalks', 'fresh herbs', 'eucalypt' and 'vegetal' for aroma, and 'green stalks' and 'mint'/'herb' on the palate. Palate attributes such as 'acidity', 'astringency', 'bitterness' and 'viscosity', and standard fruit-related terms were also rated. The panel evaluated the wines against these terms in triplicate.

The projective mapping exercise involved a group of 20 wine professionals, with each judge producing maps of the wines in duplicate. The judges were asked to evaluate each wine, and then place it on a 60cm x 90cm sheet of paper according to their own criteria, with similar wines placed close to each other and

dissimilar wines placed far apart from each other. Judges were also asked to write comments beside each wine describing the characteristics responsible for its placement. Once all the maps were completed the location data and attributes/comments were entered into a sensory software package and a group map was obtained, along with the associated attributes/comments from the judges. The judges came up with 121 unique comments to describe the wines, and 18 of those terms related to 'green' characteristics. For an attribute or a close synonym to be included in the data analysis, it had to have been used at least four times by the judges, which reduced the number of terms to 52.

Figure 1 shows the map generated from the winemakers' descriptions and groupings of the Cabernet Sauvignon wines. The wines to the right of the figure were considered 'ripe' with fuller body, 'dense' 'black' fruit characters, with the terms 'texture' and 'ripe tannin' used for these wines. Wines situated on the left of the map were described with various 'green' terms, with the examples to the top left of the figure indicated as being 'leafy', 'herbal', 'asparagus', 'capsicum-like', with lower 'fruit' or 'red fruit'. Those to the bottom left of Figure 1 were described as 'simple', 'blue fruit/fruit-driven', 'medium body', and were also described with the terms 'green' and 'green tannin'.

The most interesting aspect of this mapping technique is the way it can be used to explore the relationships with chemical data and sensory descriptive data. All wines plotted to the left of Figure 1 were described by the AWRI panel as being higher in 'vegetal' and 'green stalks' attributes. These wines were generally higher in 2-isobutyl-3-methoxypyrazine and dimethyl sulfide, two compounds known to cause these types of flavours. The wines in the 'green tannin' group were distinctive as they were rated by the AWRI panel as being higher in bitterness. The inclusion of bitterness as a feature of 'green tannin' is a new piece of information, and it was interesting that the panel of wine professionals did not use bitterness as a specific term.

Bitterness was related to the chemical features of the tannins in the 'green tannin' wines, notably the proportion of epicatechin or galloylation in the tannin. This observation will be confirmed in further studies, but it opens up the possibility of being able to define chemically what is responsible for undesirable 'green tannin' textural elements in red wines, and to assess viticultural or winemaking ways of adjusting the tannin make-up.

For the Shiraz wines, a closely similar assessment procedure was followed, and there were a similar set of outcomes (Figure 2, page 36). The 'vegetal' attribute was more closely linked to higher DMS in these wines. The winemakers described the high DMS wines as being 'green' and 'hard' with 'hard tannin', but this seemed to be associated with the 'vegetal' and 'stemmy' flavour and somewhat higher acidity rather than textural aspects of the wines. From a scientific point of view, a noteworthy result was that the 'stemmy'/'stalky' wines had elevated 2-isobutyl-3-methoxypyrazine, which is not usually considered a characteristic of Shiraz wines, and which was most likely related to the use of whole bunch fermentation in these wines. This observation was explored further in a subsequent study.

Overall, this investigation of commercially available wines laid the foundation for more controlled studies of the causes of these 'green' characters in wine and ways to control them.

INCORPORATION OF STEMS AND LEAVES IN COOL CLIMATE SHIRAZ FERMENTATION

A second aspect of the 'green' research was an assessment of the impact of grape stems (the rachis) and grape leaves on Shiraz flavour. With the increasing use in recent years of whole bunch (incorporating the stems), or whole berry (use of intact, uncrushed berries) fermentation, exploring the effect of including stems and leaves on 'green' characters was of value.

Shiraz fruit (2014 vintage) from a premium Adelaide Hills vineyard was harvested and winemaking was completed by WIC Winemaking Services at the Waite Campus. The project

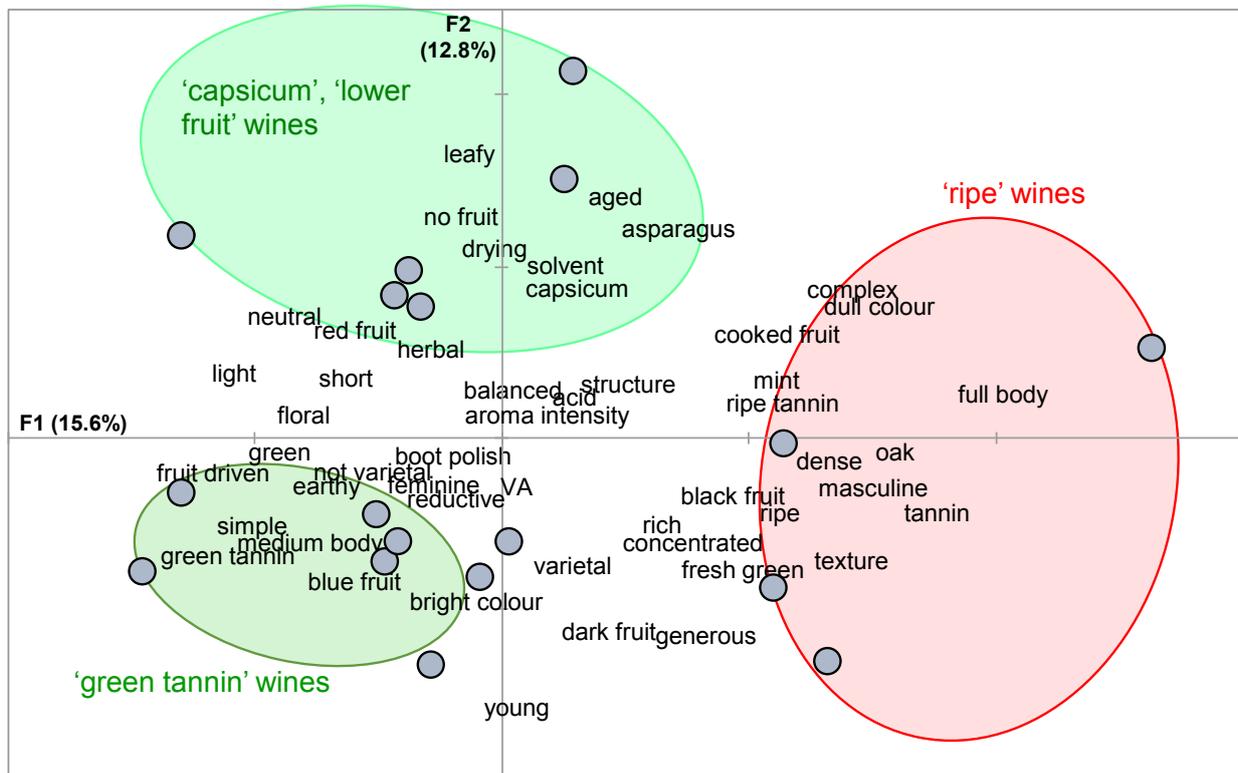


Figure 1. Plot of the projective mapping data and descriptors generated by 20 experienced winemakers for 18 commercially-available Cabernet Sauvignon wines (grey circles).

were studied: a Pinot Noir vineyard in the Adelaide Hills with a radiata pine (*Pinus radiata*) windbreak, a Shiraz vineyard at Langhorne Creek with a windbreak row of she-oaks (*Casuarina cunninghamiana*), and a Cabernet Sauvignon vineyard in the Yarra Valley close to plantings of Monterey cypress (*Cupressus macrocarpa*). In the 2016 vintage, wines were made from grapes picked from the rows closest to the trees and from rows furthest away. An additional set of ferments was conducted with the fruit from the rows furthest from the trees plus added leaf material from the trees. Similar to the previous studies with eucalyptus trees, it was noted that some bunches on vines close to the trees clearly contained pine needles or other tree material.

Chemical and sensory analysis showed that there was no clear sensory influence from the radiata pine and she-oak trees. For the wines made from the vines planted near Monterey cypress trees, a 'herbal'/'pine-like' aroma and flavour was observed. The wines made from the grapes grown closest to the trees had the highest ratings from the sensory panel for 'eucalypt'/'pine' aroma and flavour attributes. The wine made from grapes sampled farthest away from the trees was rated lowest in these attributes, while the addition of foliage material from the trees to these grapes resulted in intermediate ratings for these attributes in the wines. Overall, it seems some types of 'green' character can result from certain types of vegetation grown close to vineyards.

CONCLUSION

These interlinked investigations into 'green' flavour have provided valuable outcomes for Australian grapegrowers and winemakers. The most notable in some ways has been the observation that 2-isobutyl-3-methoxypyrazine can be found in important levels in Shiraz wines, a variety which was not considered previously able to produce this class of compound. It seems likely that it arises in wines from extraction from the rachis, but further work is currently being carried out with collaborators at CSIRO to confirm this. The observation of a link between 'hard', 'bitter', 'green' tannins and specific tannin structures is also a significant step forward. Overall, these studies involving the examination of 'green' aroma compounds in combination with non-volatile mouthfeel and textural compounds have great promise in finally allowing growers and winemakers to manage these characters in red wines.

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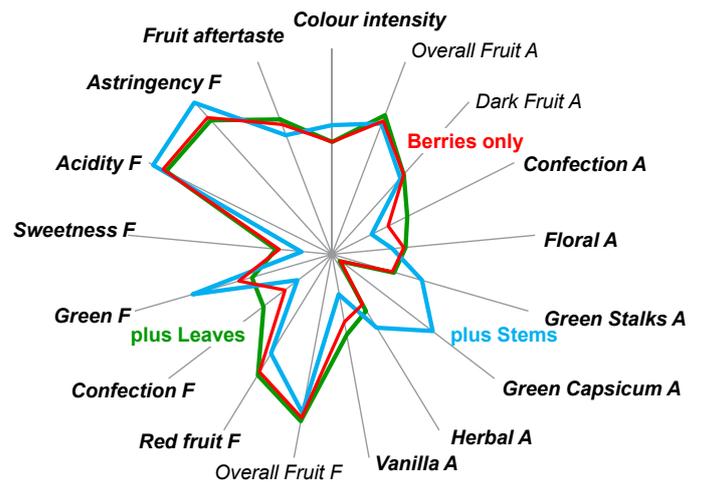


Figure 3. Sensory profile of an Adelaide Hills Shiraz wine made with crushed and destemmed grapes (berries only, shown in red), with added stems (shown in blue), and with added grape leaves (shown in green). A: aroma attributes, F: flavour attributes. The attributes in bold differed significantly across the wines. (Grape berries with added peduncles treatment not shown).




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