Technical notes

Defining 'green' flavour in Cabernet Sauvignon wines

The term 'green' is used commonly in the wine world, but its meaning can be ambiguous. With descriptive terms such as 'banana aroma' or 'sweet taste', there is generally a universal understanding of what is meant. Similarly, when someone uses the term 'green' to describe a colour, it is clear what is being communicated. However, what do people mean when they use 'green' to describe a flavour? The AWRI sensory team set out to investigate the different attributes that could be associated with the term 'green' in Cabernet Sauvignon wines, using the AWRI's trained descriptive analysis panel, a winemaker panel, and an untrained consumer panel. The study forms part of a wider project assessing the contribution of volatile and non-volatile compounds to 'green' flavour in red wine. Avoidance of 'green' characters, especially in red wines, through harvest timing and other interventions is a major concern for winemakers, and better understanding of which components in wine give rise to specific undesirable flavours could greatly assist with decision-making.

Cabernet Sauvignon wines are often described as having 'green' characters. The compounds known as methoxypyrazines have often been associated with these 'green' characters, as they are responsible for aromas described as 'capsicum', 'green beans' or 'vegetal' in Cabernet Sauvignon and Sauvignon Blanc wines. Other compounds found in Cabernet Sauvignon that can also be described as 'green' include:

- 1,8-cineole. This compound is responsible for 'eucalyptus'/'mint' aroma and flavour, and has been found in both Australian and international wines.
- Dimethyl sulfide. When found in higher concentrations, this compound can give a 'vegetal' aroma.
- 'C-6' compounds such as hexanol. These can contribute to 'fresh cut grass' aromas.

Other aromas associated with the variety that could be described as green are 'herbs' or 'herbaceous', 'leafy' and 'stalky'. The term 'green' is also used frequently to describe textural or structural elements in a wine. Terms like 'green tannin' or 'stemmy' can refer to astringency characteristics, while the term 'green' for palate characteristics can often refer to the acidity being high and out of balance.

Sensory descriptive analysis using a trained panel

The AWRI sensory team began by screening more than 40 commercially available Cabernet Sauvignon wines for the presence of various 'green' characters. Eighteen wines (from eight regions) were eventually chosen for the study, with retail prices ranging from $13 to $45. The

wines selected were not intended to be representative of their particular regions, but were chosen simply as examples of wines with clear differences in various 'green' characteristics. Some wines with no evident 'green' sensory properties were also included.

Nine trained and experienced panellists from the AWRI's sensory panel were used to complete the descriptive analysis. The panellists have extensive experience in wine evaluation, but no technical wine background, so are not subject to possible biases of technically trained judges, and use non-technical, consumer-based terminology to describe differences among wines.

The 'green' terms chosen by the panel to describe the wines were 'green stalks' (green stalks, leaves, green capsicum); 'fresh herbs' (dill, mint, other fresh herbs); 'eucalypt' (eucalyptus, dried herbs) and 'vegetal' (cooked vegetable) for aroma, and 'green stalks' and 'mint'/'herb' (mint, eucalypt, herbs) on the palate. Palate attributes such as 'acidity', 'astringency', 'bitterness' and 'viscosity' were also rated. The panel evaluated the wines against these terms in triplicate.

A Principal Component Analysis (PCA) plot of the data is shown in Figure 1. The main differences among the 18 wines can be seen from left to right, with those wines plotted to the far left of Figure 1 (Coonawarra_1, Yarra_1, Langhorne Creek_2, Margaret River_1 and Langhorne Creek_1) rated highly in 'green stalks' aroma and palate, as well as 'vegetal' aroma and 'bitterness'. These wines were also rated by the sensory panel as lower in 'dark fruit', 'viscosity', 'overall fruit flavour', and in oak-related attributes, which were especially high in Coonawarra_3, Clare_1 and Adelaide Hills_3 wines. There was also a clear separation of wines along the PC3 axis, with those wines plotted to the upper half of Figure 1 having higher scores

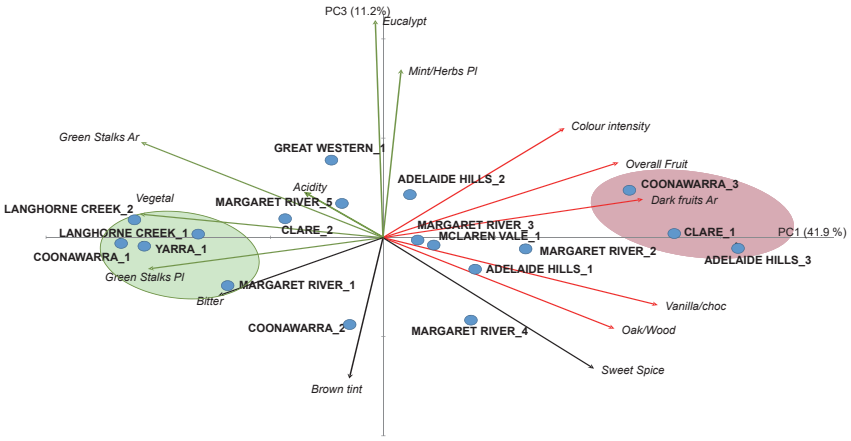

Figure 1. Principal component analysis plot of the sensory data for the 18 Cabernet Sauvignon wines, generated by the trained AWRI consumer-based sensory descriptive analysis panel.

for 'eucalypt' and 'mint'/'herbs'. The Great Western_1 wine had a high 'eucalypt' attribute rating, while also being relatively high in the 'green stalks', 'vegetal' and 'bitter' attributes, while the Coonawarra_3 wine, while rated highly in 'eucalypt' aroma, was rated low in the 'green stalks', 'vegetal' and 'bitter' attributes. These two wines, together with the Adelaide Hills_2 wine, had an elevated concentration of the compound 1,8-cineole (7–11 µg/L).

While the differences are not shown in Figure 1, the wines were also rated for astringency and acidity. These attributes were unrelated to the 'green' aroma/flavour terms and showed a weak relationship with bitterness. Some wines such as McLaren Vale_1 were rated high in astringency but were rated low in bitterness and the 'green' aroma attributes such as 'green stalks' and 'vegetal', while Clare_2 was high in astringency and also in bitterness.

Overall, the trained panel sensory data provides a meaningful quantitative profile of each wine, and shows that lower fruit flavour and viscosity are generally features of the wines that had stronger 'vegetal' and 'green stalks'/'capsicum' flavour and aroma. While the various attributes can be interpreted alone as providing different sub-components of the 'green' concept, relating this data to winemaker and consumer impressions was the next important step.

Projective mapping

Twenty wine professionals participated in a projective mapping exercise, with each judge producing maps in duplicate. Panellists were mainly selected from the winemaking community of McLaren Vale, with three AWRI staff with winemaking backgrounds and two Treasury Wine Estates winemakers also part of the panel. All judges had at least six years of professional experience in the wine industry. The wines used for this exercise were the same 18 commercial Cabernet Sauvignon wines that were evaluated by the AWRI descriptive analysis panel. The judges were asked to evaluate each wine, identified only by a three-digit code, and then place it on a 60 cm × 90 cm 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. Panellists were also asked to write comments beside the wines describing the characteristics responsible for the wine being placed where it was. Once all of the maps were completed the coordinate 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. To be included in the data analysis an attribute had to have been used at least four times by the panellists; this reduced the number of terms to 52. Some of the terms used by the panellists were slightly different in syntax, but were interpreted to

have a very similar meaning, and therefore some terms were combined. For example, the terms 'tannic', 'tannin' and 'high tannin' were combined into the single term 'tannin'.

The plot of the winemakers' map in Figure 2 shows only 28% of the variance with the first two factors, with the third and fourth dimensions showing an additional 10% and 8% respectively. This indicates variability in the way the winemakers generated the maps, which is not unexpected in this type of sensory exercise.

The wines Coonawarra_3, Clare_1 and Adelaide Hills_3 were positioned to the right of the map in Figure 2, indicated as having 'full body', 'oak', 'complex' and 'dense' characteristics. Interestingly, the wines Yarra_1, Margaret River_1, Langhorne Creek_2 and Coonawarra_1, which were rated by the AWRI sensory panel as highest in 'green stalks', 'vegetal' and 'bitterness', were also grouped together by the winemakers to the left of Figure 2, and described as having 'green tannin', 'simple', 'green', 'light', and 'herbal' characteristics, amongst other terms.

This map allowed links to be made between the descriptors used by winemakers and those from the trained panel. Results indicated, for example, that the term 'green tannin' used by winemakers for these Cabernet Sauvignon wines related to low flavour intensity and viscosity, and high 'bitterness', 'vegetal' and 'capsicum-like' flavour. The 'eucalypt' or 'mint' attributes did not relate to perception of 'green' characters by the winemakers. It is noteworthy that the term 'bitterness' was not used by the winemaker panel.

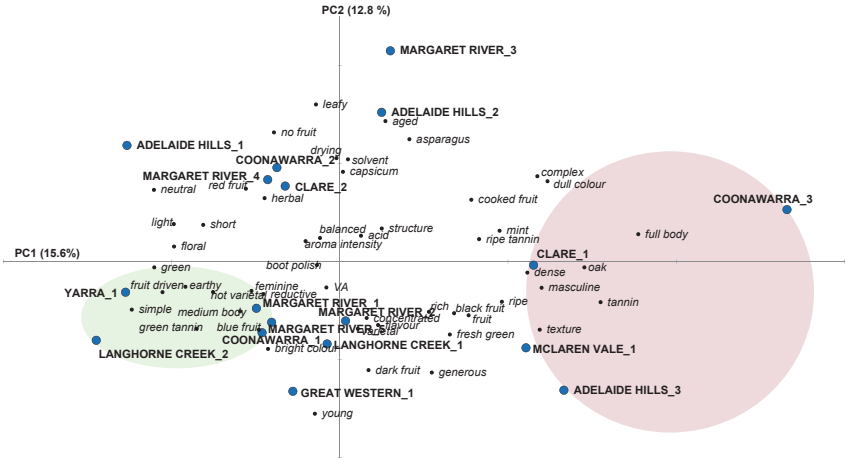

Figure 2. Plot of the projective mapping data and descriptors generated by 20 experienced winemakers for the 18 Cabernet Sauvignon wines.

Extensive chemical data have been obtained on these wines, and the wines described by the winemakers as having 'green tannin' were found to be higher in specific tannin composition measures and lower in anthocyanin pigment. Further data analysis will shed greater light on the compounds that contribute to 'green tannin', and other 'green' characteristics.

Consumer preference

A consumer tasting was conducted by 113 individuals from the AWRI's Adelaide-based untrained consumer panel. Six wines were chosen from the eighteen wines in the study based on the results from the two previous sensory assessments. Consumers were asked to indicate how much they liked each of the wines under blind conditions using a nine point hedonic scale and how likely they would be to purchase the wine. Consumers' demographic data and information on their wine drinking and purchasing habits were also collected.

The Margaret River_4 and Adelaide Hills_1 were the most liked wines, while Margaret River_1 was the least liked. Margaret River_1 was one of the wines indicated by winemakers as having 'green tannin', and was characterised by the trained sensory panel as being higher in 'vegetal', 'green stalks', 'acidity', 'astringency' and 'bitterness' than the other wines tasted by the consumers. The well-liked Margaret River_4 and Adelaide Hills_1 wines were both high in 'red fruit', 'dark fruit' and 'oak' attributes, and relatively low in 'acidity', 'bitterness' and 'astringency'. The results suggest that regular red wine consumers respond negatively to wines with 'green' characteristics.

Conclusion

This study has shown that relating the winemaker viewpoint of wine sensory properties to data from a 'trained consumer' sensory descriptive analysis panel and preference data from untrained consumers gives a highly useful insight into wine characteristics. While further studies are planned, notably with Shiraz wines, the results to date have allowed some delineation of what winemakers really mean by the terms 'green' or 'green tannin', allowing AWRI researchers to progress efforts to chemically define this important suite of characteristics. The consumer responses give insight into acceptable levels of key sensory attributes and causative compounds. The ability to measure the components that cause 'green' attributes will provide a great advantage in controlling these flavours in the future.

Wes Pearson, Senior Scientist, *wes.pearson@awri.com.au;*
Alice Barker, Sensory Analyst; Dimitra Capone, Research Scientist;
Keren Bindon, Senior Research Scientist; Patricia Williamson, Senior Sensory Scientist;
Leigh Francis, Research Manager – Sensory and Flavour