Shiraz terroir – linking regional sensory characters to chemical and climate profiles

By Wes Pearson[1,2], Leigh Schmidtke[2], Leigh Francis[1], Sijing Li[2], John Blackman[2], Andrew Hall[2], Tom Carr[2] and Mark Krstic[1]

The concept of terroir can be broadly considered as the contributions of environmental, human and cultural factors to the unique characteristics of an agricultural product. In a collaborative study on Australian Shiraz terroir, AWRI and NWGIC scientists explored regional differences in sensory characteristics of Australian Shiraz wines from six regions. Links were then established between the regional sensory characters and chemical and climatic profiles. This new understanding has potential to both empower producers to enhance unique regional characters in their wines and improve regional communication and marketing efforts.

INTRODUCTION

Australia has the world's second largest area of Shiraz (syn. Syrah) vineyards (Robinson *et al.* 2012), with Shiraz accounting for nearly 30% of all vineyard area in Australia (Wine Australia 2019). There have been very few studies focusing on the regionality of Shiraz, with a relatively recent investigation (Johnson *et al.* 2013) providing data on wines from 10 Australian regions. Recent advances in rapid sensory descriptive methods (Varela and Ares 2012) have now made it possible to evaluate sufficient numbers of wines to assess the sensory differences between regions. This study aimed to evaluate the sensory profile of Shiraz wines from six Australian regions (Hunter Valley, Heathcote, Yarra Valley, Canberra District, Barossa Valley and McLaren Vale) and determine which sensory properties could be related to the wines' places of origin and climate.

IN BRIEF

- **Shiraz wines from six Australian regions were subjected to detailed sensory analysis to understand their unique regional characters.**
- **Selected wines from the regions underwent further sensory and chemical analysis to identify key compounds contributing to regional sensory characteristics.**
- **Sensory, chemical and climatic data were combined to understand how climate differences across regions affect composition and characteristics of Australian Shiraz.**
- **Producers now have a basis for enhancing desired regional characters and regions can better communicate their unique characteristics.**

REGIONAL SENSORY EVALUATIONS

A large number of samples from each region were characterised using the rapid sensory methodology Pivot© Profile (PP, Thuillier *et al.* 2015) using groups of local winemakers as judges. Their assessments were used to explore the diversity of sensory characters within each region, and to help select representative wines for a subsequent formal descriptive analysis study. Between 22 and 28 commercially-available Shiraz wines from the 2015 and 2016 vintages were chosen from each region.

An example of the PP results is shown in Figure 1 for 23 Yarra Valley Shiraz wines. The results are displayed to visualise the sensory differences between the samples and to show the attributes that were most related to the groups of wines.

Figure 1 represents a sensory 'fingerprint' of the region. Statistical cluster analysis was completed to separate the samples into groups based on their sensory attributes. This identified four clusters, with the largest cluster comprising 11 wines. Generally, the sensory characteristics of the Yarra Valley clusters ranged from higher tannin, high purple colour, concentrated and 'dark fruit' driven (the largest cluster 1) to more 'red fruit' and 'dark fruit', 'spice' and 'pepper' aromas, with more palate weight and some slightly faulty wines (cluster 2, five wines), 'red fruit', 'green' and 'spicy' wines (cluster 3, three wines), and 'oak-driven', 'brown', 'developed' and 'complex' wines (cluster 4, four wines). A similar approach was used for each of the six regions to identify wines that represented the range of sensory properties of the regions.

COMPARING WINES ACROSS REGIONS

After the PP evaluations, wines carefully selected from the clusters identified for each region were included in a comparative sensory descriptive analysis study using a trained AWRI panel. Twenty-two wines were selected, with four each from the Yarra Valley, Canberra District, McLaren Vale and Barossa Valley, and three wines from the Hunter Valley (upper and lower) and Heathcote. These wines ranged in price from $27 to $92 (median $35), with alcohol levels from 13.1 to 15.8% v/v (median 14.1%). All wines except two were from single vineyards.

Figure 2 shows the results of the quantitative sensory descriptive analysis study in the form of a Principal Component Analysis (PCA) map. The separation of the wines shows that along PC1 from left to right there is a general tendency of warm regions to cool regions. However, wines from the Hunter Valley, which would certainly be considered a

[1]The Australian Wine Research Institute, Urrbrae, South Australia
[2]National Wine and Grape Industry Centre, Charles Sturt University, School of Agricultural and Wine Science, Wagga Wagga, New South Wales

warm region (Iland *et al*. 2017), are situated to the right. This is likely a result of the fact that the two years chosen for this study (2015 and 2016) were both high rainfall vintages with earlier harvests in that region.

LINKING CHEMICAL COMPOSITION AND REGIONAL SENSORY CHARACTERISTICS

The 22 regional Shiraz wines were analysed for 69 different chemical measures. An analysis of variance was completed to assess which compounds differed across the regions. A PCA of the chemical data is shown in Figure 3 (see page 38), with the sensory attributes overlaid on the plot.

The Canberra District wines were rated relatively highly for the attribute 'floral' and were high in the monoterpene compounds citronellol, trans-geraniol, linalool and terpinolene, compounds noted for their floral aromas. The Yarra Valley wines were higher in ethyl cinnamate, ethyl dihydrocinnamate and dimethyl sulfide (DMS), which were related to the 'stalky' and 'cooked veg' attributes. The Barossa Valley wines were separated from wines from the other regions with higher concentrations of beta-damascenone, alpha- and beta-ionone, gamma-decalactone and phenyl ethyl acetate, which were linked to the 'dark fruit'/'fruity' sensory attributes. McLaren Vale wines were also higher in these compounds, together with higher colour density, pigmented tannin and several fermentation-derived esters.

The chemical compounds found to be associated with distinctive characteristics provide avenues to enhance or otherwise control sensory properties that give rise to regional differences. Viticultural or winemaking techniques are available that alter the concentration of many of the compounds identified, and the compounds can also be used as targets for experimental trials.

CLIMATIC FACTORS

In addition to the compositional and sensory evaluations, for each vineyard site season-specific climate indices including

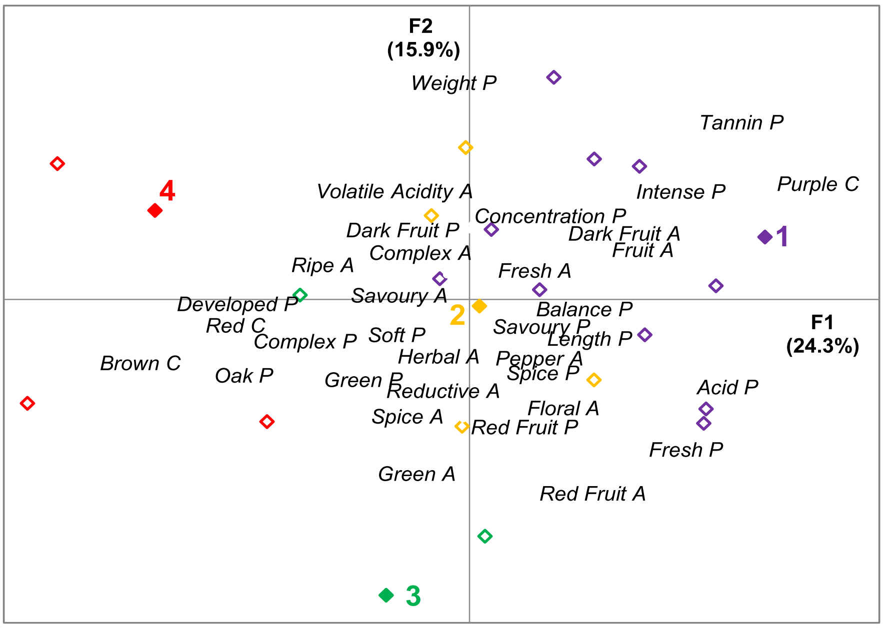

Figure 1. Pivot© Profile results summarising the sensory properties for the 23 Yarra Valley Shiraz wines. The four clusters of wines identified are shown in different colours. Wines with solid symbols were chosen for the multi-regional descriptive analysis evaluation. C = Colour; A = Aroma; P = Palate

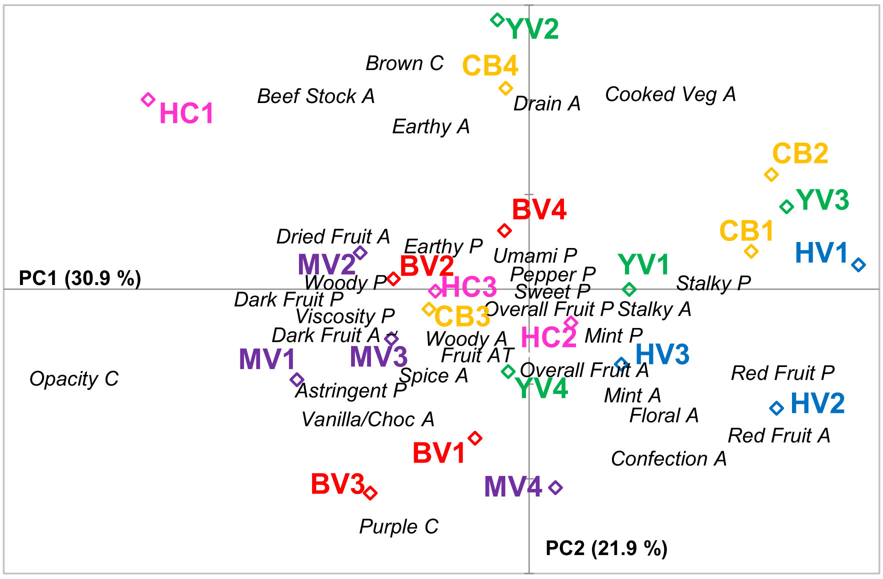

Figure 2. Sensory properties of Shiraz wines from each of the six regions from the sensory descriptive analysis study. HC: Heathcote; YV: Yarra Valley, HV: Hunter Valley; CB: Canberra; BV: Barossa Valley; MV: McLaren Vale. The letter C after an attribute = Colour, A = Aroma and P = Palate

maximum and minimum temperatures, rainfall, evaporation, radiation, and vapour pressure (at 9am) were acquired from the SILO climate database (Jeffrey *et al*. 2001).

Growing degree days (GDD), growing season temperature (GST), harvest day and budbreak day strongly separated the regions/sites. The sites for the Canberra and Yarra Valley wines were associated with higher values for the harvest and budbreak measures and lower GDD and GST measures. The sites for the Hunter Valley wines were linked to higher GDD and GST values, and lower harvest and budbreak day values. The Barossa and McLaren Vale sites were found to sit somewhere between these two groups. The Heathcote wines showed some variability, with two sites climatically similar to the Yarra and Canberra sites and the third site more similar to the Barossa and McLaren Vale sites.

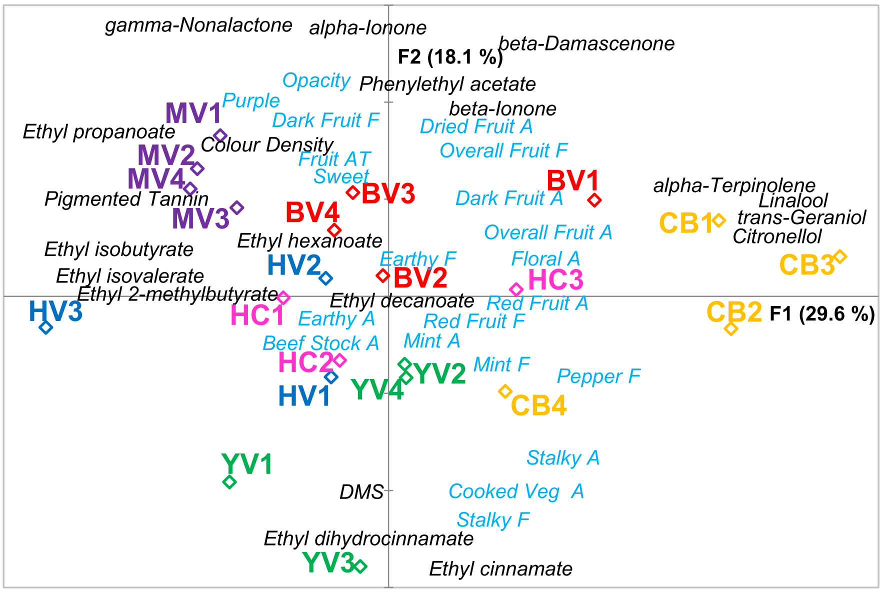

Figure 3. PCA biplot of the chemical measures for the 22 wines with the sensory attributes overlaid. HC: Heathcote; YV: Yarra Valley, HV: Hunter Valley, CB: Canberra; BV: Barossa Valley; MV: McLaren Vale. The letter C after an attribute = Colour, A = Aroma and P = Palate

Some of the other important climate measures that differentiated the sites were rainfall, evaporation and radiation during the ripening period (RP) and/or growing season (GS). The Hunter Valley sites all had higher rainfall measures while the Barossa and McLaren Vale sites were higher in radiation and evaporation measures, and had lower rainfall. The Yarra and Canberra regions were intermediate in these measures, with again one Heathcote site similar to the McLaren Vale and Barossa vineyards and two more closely related to the Yarra and Canberra sites.

Another notable element regarding the climate data collected from these sites for the 2014-15 seasons was the comparison of these values to the 20-year means, which highlighted the effect of climate change in this rather short period of time. For example, every site in the set had an earlier harvest day than the 20-year mean. Growing season temperature also showed an increase from the mean for 21 of the 22 sites. The measures GDD and radiation also followed this trend, with 20 of the 22 sites showing increases. This agrees with Australian Bureau of Meteorology data that confirms the spring of 2014 and 2015 to be the first and third warmest over a 20-year period for south eastern Australia, with rainfalls the third and second lowest recorded.

TYING IT ALL TOGETHER

The final step of the analysis was to apply a partial least squares regression model to

Another notable element regarding the climate data collected from these sites for the 2014-15 seasons was the comparison of these values to the 20-year means, which highlighted the effect of climate change in this rather short period of time.

the data to evaluate the chemical and climate indices that related to the sensory attributes of the wines. The model highlighted the strong influence of the climate factors, with 13 of the 17 climate indices related to specific sensory properties. Figure 4 summarises the compositional measures that were associated with the climate indices, and in turn the related sensory attributes.

As shown in Figure 4, the Hunter Valley wines were rated highly for 'red fruit' and 'confectionary' sensory attributes and these descriptors were positively associated with higher rainfall and relative humidity indices, as well as generally lower concentrations of most of the chemical measures than the other regions.

The 'stalky', 'cooked veg' and 'pepper' sensory attributes, rated highly in the Yarra Valley wines, were related to the volatile compounds ethyl cinnamate, ethyl dihydrocinnamate and DMS. The levels of these compounds were most associated with the climate measures budbreak day and harvest day, signifying later dates for these phenological indicators. They were also negatively associated with GDD, GST and cool night indices. 'Black pepper' flavour was somewhat associated with rotundone concentration and was also strongly negatively associated with GDD.

The wines from the Canberra District, rated high for 'floral' aroma and flavour, had relatively high concentrations of several monoterpene compounds which had an association with the cool night indices.

There was an overlap of Barossa and McLaren Vale wines, with wines from these regions found to be generally higher in tannin and colour measures, norisoprenoids, several esters and oak volatiles. The radiation and evaporation climate indicators were

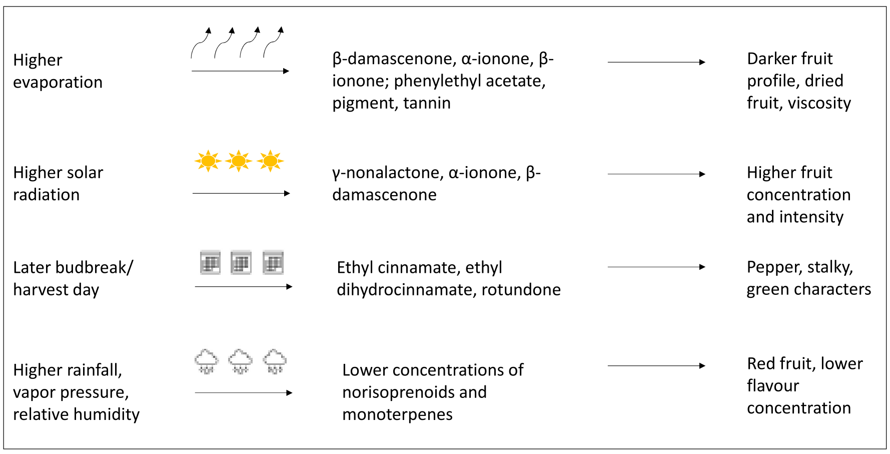

Figure 4. Schematic of climate indicators leading to higher chemical compositional measures, in turn linked to particular wine sensory attributes.

associated with the norisoprenoid compounds and the 'dark fruit' and 'dried fruit' sensory characters.

The Heathcote samples were scored higher for 'hotness', 'dark fruit', opacity (colour intensity), and a savoury 'beef stock' aroma. The Heathcote samples were also higher in alcohol, with evaporation measures relating to the observed sensory attributes.

CONCLUSION

The investigation allowed an understanding of the range of sensory properties of Australian Shiraz, and which sensory characteristics are related to region of origin. The results showed that Australian Shiraz wines can exhibit sensory profiles that represent the place they come from. Understanding these regional sensory characters assists grapegrowers, winemakers and wine marketers in knowing what sensory attributes are expected from a wine from these regions. Reliable sensory descriptions help in aligning the different sectors of the wine industry to be able to communicate clearly, including between growers and winemakers; within wine companies; amongst wineries within a region; and for websites, retail sales personnel and customers. With a knowledge of an established sensory profile, and with causative chemical compounds known, grapegrowers and winemakers can strive to maintain or enhance the regional characters found in their grapes. Wine marketers and sales professionals can also use the sensory information to help tell the stories of their regional wines to their customers.

REFERENCES

Iland, P.G.; Gago, P.; Caillard, A. and Dry, P.R. (2017) Australian Wine: styles and tastes – people and places. Adelaide: Patrick Iland Wine Promotions Pty Ltd.

Jeffrey, S.J.; Carter, J.O.; Moodie, K.B. and Beswick, A.R. (2001) Using spatial interpolation to construct a comprehensive archive of Australian climate data. Environ. Model. Softw. 16(4):309-330.

Johnson, T.E.; Hasted, A.; Ristic, R. and Bastian, S.E.P. (2013) Multidimensional scaling (MDS), cluster and descriptive analyses provide preliminary insights into Australian Shiraz wine regional characteristics. Food Qual. Pref. 29:174-185.

Robinson, J.; Harding, J. and Vouillamoz, J. (2012) Wine Grapes. New York: HarperCollins Publishers. 1241pp.

Thuillier, B.; Valentin, D.; Marchal, R. and Dacremont, C. (2015) Pivot© Profile: A new descriptive method based on free description. Food Qual. Pref. 42:66-77.

Varela, P. and Ares, G. (2012) Sensory profiling, the blurred line between sensory and consumer science. A review of novel methods for product characterisation. Food Res. Int. 48:893-908.

Wine Australia (2019) Providing insights on Australian Wine. Variety snapshot 2019 - Shiraz. Available from: https://www.wineaustralia.com/getmedia/ebf6c25d-1ad7-4b87-9cf9-181664da91aa/Shiraz-snapshot-2018-19.pdf

This article is an adaptation of a paper first published in the Proceedings of the 17th Australian Wine Industry Technical Conference. Material from that article is reproduced here with permission from the publisher, AWITC Inc. WVJ