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REGIONALITY IN AUSTRALIAN SHIRAZ: SENSORY PROFILES OF WINES FROM SIX REGIONS AND THEIR ASSOCIATIONS WITH CHEMICAL, GEOGRAPHICAL AND CLIMATIC ELEMENTS

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Abstract

Aim: Regional characters relating to Shiraz in Australia are not well documented. This study aimed to characterize the sensory, chemical and climate profiles of wines from various Australian Shiraz producing regions.

Methods and Results: Sets of wines (22 to 28) from six prominent Australian Shiraz producing regions were assessed by groups of regional winemakers using a rapid sensory method called Pivot© Profile (PP) to obtain biplots of their sensory characteristics. Three or four samples from each region were selected using Agglomerative Hierarchical Clustering (AHC) analysis of the PP data resulting in a subset of twenty-two wines, which were then assessed using sensory descriptive analysis. A comprehensive chemical profile was also undertaken, including monoterpenes, norisoprenoids, low molecular weight sulphur compounds, oak volatiles, esters, and non-volatile compounds. Seventeen season-specific climate indices were also complied for each sample. Multivariate analyses (Principal Component Analysis and Partial Least-Squares Regression) showed that wines with stalky/cooked vegetal sensory attributes had higher cinnamate esters and dimethylsulfide, relating to a later budbreak and harvest day; wines with higher monoterpenes were associated with floral aroma; higher solar radiation was linked to higher tannin and colour density values, norisoprenoid and phenylethyl acetate concentrations and an association with dark fruit/dried fruit and tannin/colour attributes.

Conclusions: Distinctive sensory and chemical fingerprints exist for the specific regions studied, and the climatic profiles were strongly associated with key compounds influencing sensory differences.

Significance and Impact of Study: Relating multiple site- and season-specific climate measures to chemical composition and characteristic sensory attributes of regional Australian Shiraz wines can help grape growers, winemakers and wine marketers better understand and promote the effect of place on their wines.

Keywords: Wine regionality, Australian Shiraz, wine sensory profile, wine chemical profile, wine climate profile

Introduction

Terroir can be considered to be the influence of place on the sensory characteristics of a particular product. In the world of wine this concept is championed, with wines exhibiting what is believed to be terroir-based characters generally being the most sought after and expensive wines available. Explaining terroir using scientific means has been a goal for researchers for decades, and the difficulty in doing so is well documented (Matthews, 2015; Trubek, 2008).

One of the major problems with previously completed studies in this space is the difficulty in obtaining a sample set that is trusted to be representative of the place being studied (Maitre *et al.*, 2010). Related to this, simply obtaining a very large sample set and undertaking a rigorous sensory profile using sensory descriptive analysis is not an option, as it is well known that one of the challenges in completing sensory analysis studies is the limited number of wines that can be assessed in one investigation (Stone *et al.*,1974; Lawless and Heymann 2010). Accordingly, most previous 'terroir' related sensory studies have included only a small number of wines from different regions or sub-regions, with consequent concerns regarding the representativeness of the study wines. This is especially true when commercially produced wines are studied, with variable viticultural and winemaking practices which can obscure region-specific effects (Cadot *et al.*, 2012). Consequently, a different method of sample selection must be employed in order to obtain a representative sample set, but not have an over-abundance of samples.

Shiraz is Australia's most prolific wine grape variety, with substantial plantings in every wine producing region. There have been limited investigations into the sensory differences linked to region of origin of Australian Shiraz. This study attempted to evaluate terroir on a broad scale, implicating the sensory attributes that are unique to the many different Shiraz producing regions across Australia, and their associations with chemical composition and climatic indices.

Pivot Profile Sensory Evaluation of Wines from Six Australian Regions

Wines evaluated were all Shiraz/Syrah and contained 100% fruit originating from within each of the six selected region's respective boundaries. Wines were all sourced through normal commercial channels, with a retail price of between $15 - $90AUD. Wines were all from the 2015 or 2016 vintages. Where possible, wines from single vineyards were selected over multi-site blends.

Wines chosen from each of the six regions (Barossa Valley, McLaren Vale, South Australia; Yarra Valley and Heathcote, Victoria; and Canberra District and Hunter Valley, New South Wales) were initially evaluated using the Pivot© Profile (PP) rapid sensory methodology (Thuillier *et al.,* 2015). 145 wines in total were studied. Judges for the PP evaluations were experienced professional winemakers from the respective regions. The Pivot Profile sensory assessments of commercially produced wines from the six regions highlighted the range and variability of sensory properties within each region. It also provided firm indications of the characteristics responsible for regional differences, despite a range of sensory properties represented within each region. Statistical cluster analysis was then applied to each of the six sample sets and 22 wines were chosen that represented the diversity of attributes from the six regions.

Sensory Attributes, Chemical Composition and Climate Measures of Representative Wines from the Regions

Table 1 provides information regarding the wines selected for further study.

Table 1: Details for the wines selected from the six PP studies: origin, vintage, price and alcohol concentration. From Pearson *et al.* (2020).

Region	Sub-Region	Vintage	Price (AUD)	Alc (% v/v)	Single Vineyard?
Barossa Valley	Rowland Flat	2016	30	14.0	Y
	Krondorf	2015	35	14.0	Y
	Eden Valley	2015	70	14.9	N
	Eden Valley	2015	35	14.7	Y
McLaren Vale	Seaview	2015	28	14.9	Y
	McLaren Vale	2015	28	14.2	Y
	McLaren Flat	2016	25	14.6	Y
	Blewitt Springs	2016	29	14.3	Y
Heathcote	Mount Ida	2015	78	15.9	Y
	Redesdale/Mia Mia	2015	30	14.1	Y
	East Mount Camel	2016	30	14.4	Y
Hunter Valley	Hermitage Rd	2016	35	13.7	Y
	Pokolbin	2016	65	13.8	Y
	Pokolbin	2015	50	13.7	Y
Canberra	Murrumbateman	2016	27	14.3	Y
	Murrumbateman	2016	36	13.9	N
	Lake George	2015	45	14.6	Y
	Majura Valley	2015	34	14.0	Y
Yarra Valley	Coldstream	2015	90	13.0	Y
	Healesville	2015	35	14.2	Y
	Gembrook	2015	40	13.7	Y
	Dixons Creek	2015	52	14.0	Y

Sensory descriptive analysis was completed on the 22 wines using a highly trained sensory panel who assessed the wines in duplicate. Chemical analyses for known key volatile aroma compounds important to Shiraz flavour, as well as numerous non-volatiles were completed in triplicate on separate bottles for all analytes and were completed within approximately one month of the sensory analysis.

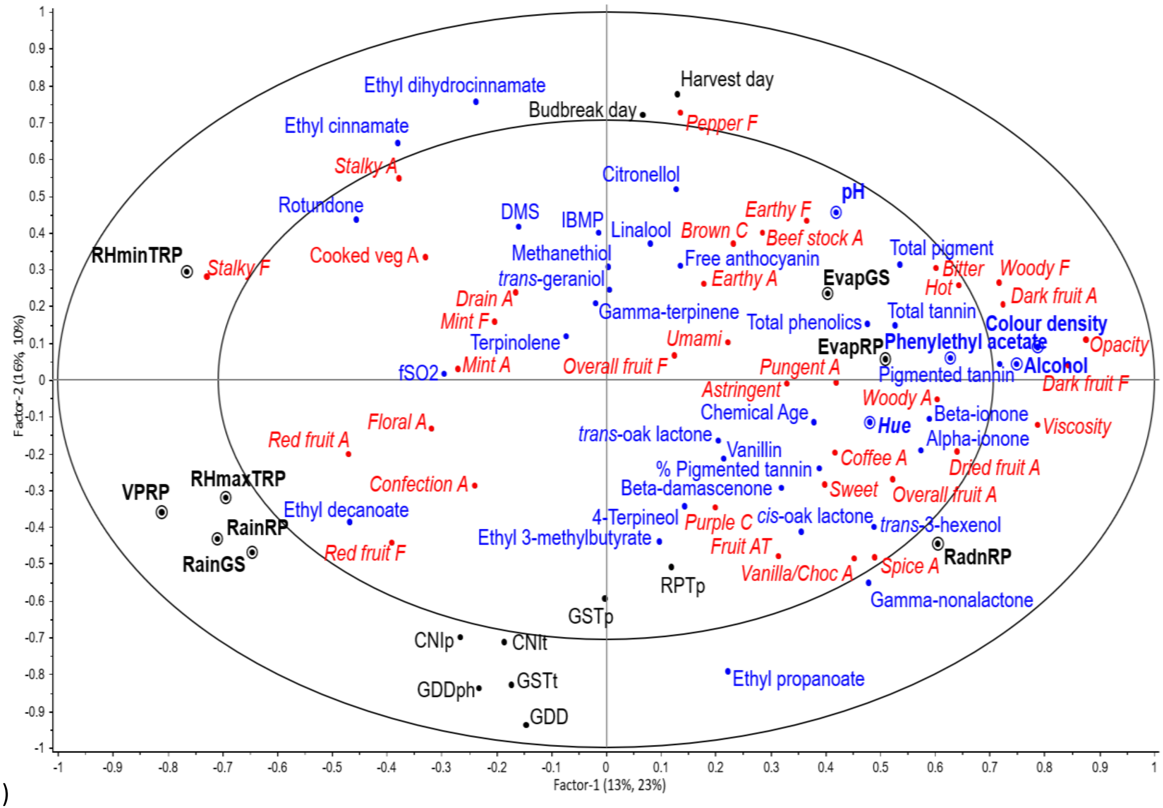
In addition, for each vineyard site climate indices including maximum and minimum temperatures, rainfall, evaporation, radiation, and vapour pressure (at 9 am), for the period July 1 1999 to June 20 2019 were acquired from the SILO climate database (Jeffrey *et al.,* 2001). Table 2 shows the climate metrics and their associated descriptions.

Table 2: Viticultural climate metrics calculated for each vineyard site of the study.

Metric Code	Metric Description
GDD	Total growing degree days from 1 September to 31 May for 20-year period up to 30 June 2019
GDDph	Growing degree days (phenological), total GDD between estimated budbreak and estimated maturity
Budbreak day	Estimated budbreak, days after 30 June
Harvest day	Estimate maturity (harvest) date, days after 30 June
GSTt	Growing season temperature (traditional), i.e. average temperature between 1 Oct and 30 Apr
GSTp	Growing season temperature (phenological), i.e. average temperature between estimated budbreak and estimated maturity
CNIt	Cool night index (traditional), i.e. average minimum temperature of March
CNIp	Cool night index (phenological), i.e. average minimum temperature of 15 days preceding estimated maturity
RPTp	Ripening period temperature (phenological), i.e. average temperature of 30 days preceding estimated maturity
RainGS	Total rain during growing season, mm
RainRP	Total rain during ripening period, mm
EvapGS	Total evaporation during growing season, mm
EvapRP	Total evaporation during ripening period, mm
RadnRP	Average solar radiation during ripening period, MJ/m^2
VPRP	Average vapour pressure during ripening period, hPa
RHmaxTRP	Average daily relative humidity at the day's maximum temperature during ripening period, %
RHminTRP	Average daily relative humidity at the day's minimum temperature during ripening period, %

Growing season is the period between estimated budbreak and estimated maturity. Ripening period is the period from 30 days prior to estimated maturity date to maturity date. Note that cool night index was calculated using a 15-day period preceding estimated harvest date, as preliminary analyses indicated this produced a stronger predictor than if using a 30-day period.

The technique of partial least squares regression was applied to evaluate the chemical and climatic measures that were associated with the sensory differences among the wines, and to provide a visualisation of the differences between the wines from the six regions. Figure 1 shows the results of the PLS.



a)

b)

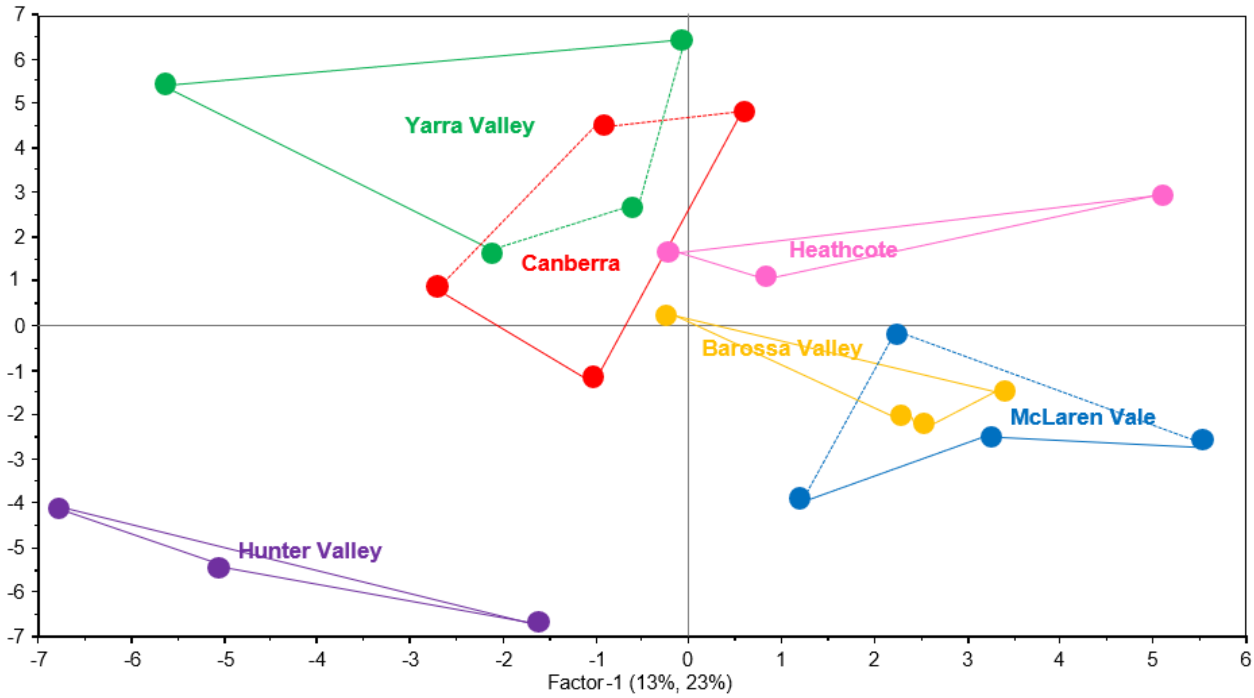


Figure 1: a) Partial Least-Squares Regression correlation loadings plots of factors 1 and 2 from a four-factor model for sensory attributes (red text, italics) as y variables, and chemical compounds (blue text) and climate measures (black text) as x variables. Measures in bold with circles surrounding the dots signify significant variables as indicated by an uncertainty test. All sensory attributes have been included but only important compositional measures have been included in the biplot. The proportion of the X-variance explained by the factors is denoted by the first value in parentheses and the proportion of Y-variance by the second value. b) The loadings plot for factors 1 and 2 for the samples included in the PLS-R analysis, colour coded by region of origin.

The biplot highlights the influence of the climatic indices on the model, with 13 of the 17 climatic indices being strongly associated with the sensory differences among the wines, and also related to many of the chemical variables.

The Hunter Valley wines were distinctive in being rated highly in red fruit and confectionary sensory attributes and were well separated from the wines of the other regions. These sensory descriptors were positively associated with the rainfall and relative humidity indices, as well as with generally low concentration of most of the chemical measures.

The Yarra Valley wines were situated to the left upper quadrant of the Figure 1, being rated highly in stalky, cooked veg and pepper sensory attributes, which were related to two cinnamate compounds and DMS and also associated with the climate indices Budbreak day and Harvest day, signifying later times for these phenological indices, and were negatively associated with GDD, GSTt and CN indices. Black pepper flavour was weakly associated with the potent grape derived compound rotundone and was strongly negatively associated with GDD. The wines from Canberra were also rated highly in the 'green' characters and pepper flavour, as well as floral, confection and red fruit, and had relatively high concentration of several monoterpene compounds, which were positively related to the distinctive floral character of wines from this region. The floral sensory attribute was linked to the cool night indices.

There was a degree of overlap between the Barossa and McLaren Vale wines with these wines generally high in colour and tannin indices, norisoprenoids, several esters and oak volatiles, with stronger dried fruit, spice, vanilla, and perceived viscosity. The radiation and evaporation climate indicators were associated with the norisoprenoid compounds and related to the dark fruit and dried fruit sensory characters.

The Heathcote wines were notable for high sensory scores for hotness, dark fruit, opacity (colour intensity), as well as a savoury 'beef stock' aroma, and were higher in alcohol, with evaporation measures related to these sensory differences.

Overall, the climate parameters were shown to have a strong influence on how the wines from these diverse regions were separated. The correlative relationships between the climate indices for the vineyard sites for each of the wines and the volatile and non-volatile chemical composition, and consequent sensory properties of the wines, provide targets for further experiments. Some of these relationships match well to existing knowledge regarding influences on berry metabolites, such the effect of sun exposure on norisoprenoids, or cooler climates being related to the concentration of the black pepper rotundone compound, but others require confirmation.

Conclusion

Understanding regional characteristics in Australian Shiraz wines, whether chemical, climatic, or sensory characteristics, will lead to a more complete appreciation of what it means for a wine to come from a particular place. Evaluating the comprehensive chemical profile of a large, diverse and representative sample set of wines from specific regions allowed understanding of the chemical fingerprint of wines from a particular region and also the implications of that chemical fingerprint on the resulting sensory profile. These parameters can help regional wine producers identify and potentially enhance sensory characteristics identified as regionally specific, and better understand the climate influences that promote them.

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References

Cadot, Y., Caillé, S., Thiollet-Scholtus, M., Samson, A., Barbeau, G., Cheynier, V., 2012. Characterisation of typicality for wines related to terroir by conceptual and by perceptual representations. An application to red wines from the Loire Valley. Food Quality and Preference, 24: 48-58.

Jeffrey, SJ., Carter, JO., Moodie, KB., Beswick, AR., 2001. Using spatial interpolation to construct a comprehensive archive of Australian climate data. Environmental Modelling and Software, 16(4): 309-330.

Lawless, HT., Heymann, H., 2010. Sensory Evaluation of Food. Principles and Practices, 2nd Edition. Springer: New York.

Maitre, I., Symoneaux, R., Jourjon, F., Mehinagic, E., 2010. Sensory typicality of wines: how scientists have recently dealt with this subject. Food Quality and Preference, 21: 726-731.

Matthews, M., 2015. *Terroir and Other Myths of Winegrowing*. University of California Press: Oakland, California.

Pearson, W., Schmidtke, LM., Francis, IL., Carr, BT., Blackman, JW., 2020. Characterising inter- and intra-regional variation in sensory profiles of Australian Shiraz wines from six regions. Australian Journal of Grape and Wine Research, 26(4): 372-384.

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

Trubek, AB., 2008. *The Taste of Place: A Cultural Journey into Terroir*. University of California Press: Berkeley, California.

Stone, H., Sidel, J., Oliver, S., Woolsey, A., Singleton, RC., 1974. Sensory evaluation by quantitative descriptive analysis. Food Technology, 8: 24-32.