Revealing the Barossa zone sub-divisions through sensory and chemical analysis of Shiraz wine

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Abstract

The Barossa zone is arguably one of the most well-recognised wine-producing regions in Australia and internationally; known mainly for the production of distinct Shiraz wines. However, within the broad Barossa geographical delimitation, a variation in terroir can be perceived and expressed as sensorial and chemical profile differences. This study aimed to explore the sub-division classification across the Barossa region using chemical and sensory measurements. Shiraz grapes from 4 different vintages (2018, n = 69; 2019, n = 72; 2020, n = 79; 2021, n = 64) and different vineyards across the Barossa were harvested and made using a standardised small-lot winemaking procedure. The analysis involved a sensory descriptive analysis with a highly trained panel. The datasets were combined and analysed through an unsupervised, clustering analysis. The number of sub-divisions based on the measurements was identified and characterised by their sensory and chemical profile and some consistencies were seen between the vintages. Preliminary analysis of the sensory results showed that in most vintages, two major groups could be identified characterised by one group showing a fruit-forward profile and another displaying savoury characters. This study provides a robust and comprehensive basis to determine the distinctive terroir characteristics which exist within the Barossa wine-producing region.

Introduction

Wine typicity and the expression of terroir are characteristics that enable a wine able to convey regional individuality making it recognisable and identifiable (Cadot *et al.*, 2010; Cadot *et al.*, 2012; Souza Gonzaga *et al.*, 2021). Those characteristics are influenced by environmental conditions, viticulture and winemaking protocols that change depending on the wine-producing region and can be embodied by differences in the sensory and chemical profiles of the wine (Drappier *et al.*, 2019; Souza Gonzaga *et al.*, 2021).

The Barossa Zone is a region in South Australia with a long history of producing high-quality wines. Previously, this geographical region was formerly characterised and divided into six sub-regions, including Central Grounds, Eastern Edge, Northern Grounds, Southern Grounds, Western Ridge and Eden Valley (Robinson & Sandercock, 2014). Although it is a region that has been used to examine various terroir features, including viticultural management and soil characteristics (Wolf *et al.*, 2003; Zhou *et al.*, 2021), there is no comprehensive study that substantiates this sub-division through differences in the sensory profile.

This study aimed to characterise the expression of terroir through an extensive set of data that included a sensory descriptive analysis over four vintages. The data were analysed through an unsupervised clustering methodology to understand how the previous sub-division is translated into the characteristics of the final product. The exploration of distinct profiles arising from the Barossa wine-producing region will provide producers with

valuable information about their wine's regional potential, assisting with tools to increase the knowlegde of their target market and reputation.

Materials and methods

Wine samples

Shiraz grapes from the Barossa Zone were harvested through 2018, 2019, 2020 and 2021 vintages from different vineyards within the six sub-regions (Central Grounds – CG, Eastern Edge – EE, Northern Grounds – NG, Southern Grounds – SG, Western Ridge – WR, and Eden Valley – EV) and were used to make wine through a standardised protocol. For each vineyard, grapes were harvested in triplicate and the wines were made following the procedure outlined below.

The research Shiraz wines (2018, n = 66; 2019, n = 72; 2020, n = 79; 2021, n = 64) were produced from 50kg hand-harvested fruit by the WIC Winemaking Services at the University of Adelaide. A 15ºC cool room was used throughout fermentation. The must was inoculated with Maurivin PDM yeast with 50mg/L of added SO_2. Targeting for 14.2ºBé, a dilution with acidified water was used when Baume was higher than 15ºBé. The must was also hand plunged twice every day until pressing time. Malolactic fermentation was initiated two days post yeast inoculation through the addition of Pinnacle MaloSafe malolactic bacteria. The ferments were then moved to a 20ºC cool room and remained there until primary and secondary fermentation was finished. Upon the completion of both fermentations, the wines were acid adjusted and dosed with SO_2 and moved to a 0ºC cool room for cold settling and stabilisation. Cellar brightness was achieved through a series of racking procedures prior to bottling. Wine samples were bottled in 750mL punted claret bottles with screw cap closure.

Sensory analysis

The wine samples were assessed using the sensory Descriptive Analysis (DA) methodology (Lawless & Heymann, 2010). The wine tasting was performed by 12 highly trained panellists. Each panellist was trained during 10 x 2 hours sessions that involved getting familiar with aroma, flavours, taste, and mouthfeel attributes that are present in the sample set and being able to identify, detect and assess the intensity of those attributes. The formal assessments of the samples started once panel performance was assessed and determined that panellists reached a suitable level of consensus. A total of 30mL wine aliquots per sample was served using black 215mL ISO wine tasting glasses with a random 4-digit code, at room temperature, and covered with a petri dish. The assessment was performed in individual isolated temperature control sensory booths with each sample evaluated twice in duplicate and randomised order of serving. Panellists used a 100cm continuous scale to determine the intensity of 17 aroma, 17 flavour, 3 taste, 4 mouthfeel, and 2 aftertaste attributes.

Statistical Analysis

The raw data of each vintage were separately analysed through two-way ANOVAs using panellist as random factor and sample as fixed factors. The data of each vineyard triplicate the average was calculated and with significantly different attributes ($\alpha = 0.05$), an agglomerative hierarchical clustering analysis (AHC) was performed using Ward's method, Euclidean distance, and automatic truncation. Significantly different attributes ($\alpha = 0.05$) were also presented in a spider plot in order to investigate the drivers for each clustering result from AHC.

Results and discussion

Clustering analysis

Through AHC it was possible to investigate the different groups arising from the sensory data collected through DA (Figure 1). As shown in Figure 1a the dataset from the 2018 vintage was divided into three clusters. The blue cluster was a mix of wines coming from Northern Grounds, Southern Grounds, Eden Valley, and Western Ridge whereas, the red cluster had a bigger presence of Southern Grounds samples, and the green cluster was dominated by Eden Valley and Eastern Edge samples. In Figure 1b the dataset of vintage 2019 was separated into two groups, the blue cluster with a predominance of Eden Valley samples and the red cluster representing more Central Grounds and Eastern Edge. In Figure 1c samples from vintage 2020 were also separated into two groups with a smaller group (in blue) containing Eden Valley and Eastern Edge and a bigger group (in red)

containing the rest. For vintage 2021 (Figure 1d) the same cluster number was seen, although the clusters were mixed, with no major representation of a single sub-region.

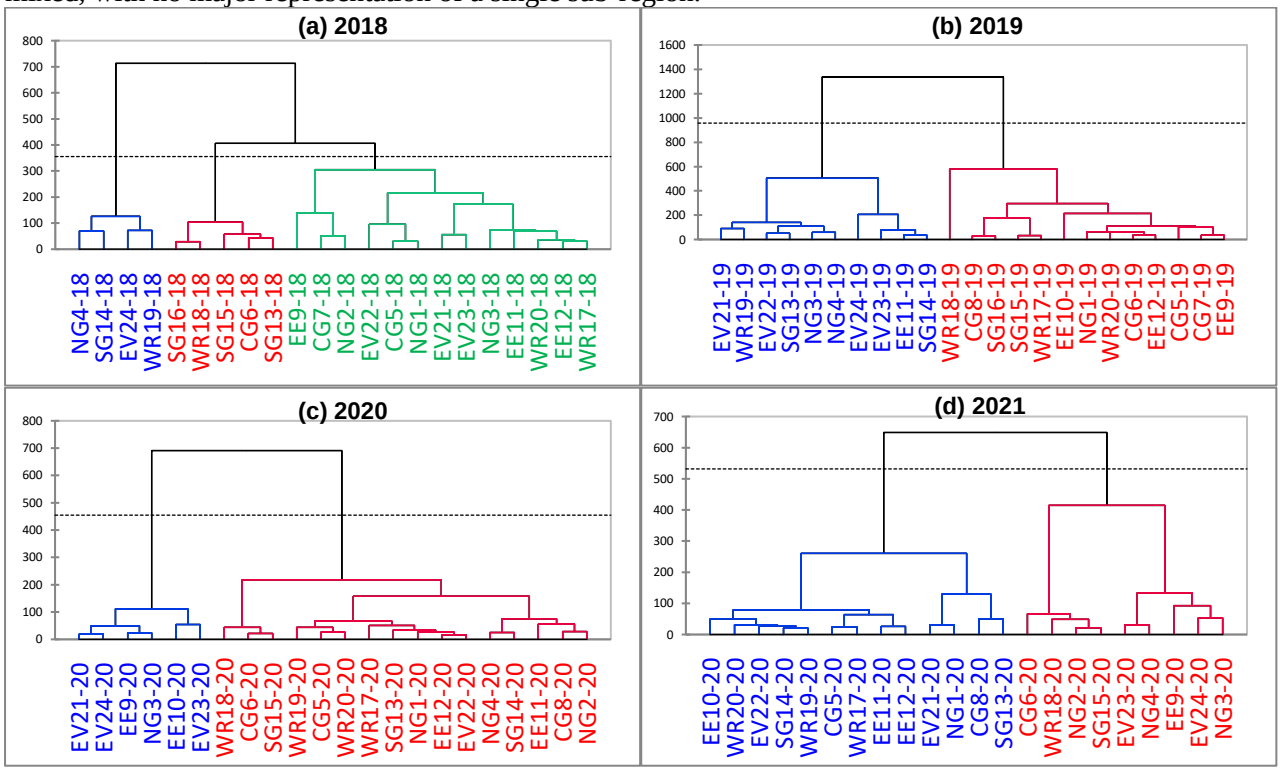

Figure 1. Agglomerative hierarchical clustering of the significantly different sensory data ($\alpha = 0.05$) representing (a) vintage 2018, (b) vintage 2019, (c) vintage 2020, (d) vintage 2021, where each colour represents a cluster.

Spider Plot

The investigation of the sensory profile of each cluster is important to understand what are the drivers for the division of the samples and whether there is any influence of the previously set sub-division (Figure 2).

In Figure 2a is possible to see that for 2018 vintage the blue cluster had a presence of green, minty and savoury characters, red cluster present a sour, astringent, rough, and heated mouthfeel, lastly the green cluster had an overall fruity and dark fruit attributes. For 2019 vintage (Figure 2b) the blue cluster had a presence of cooked vegetables, savoury attributes and non-fruity aftertaste, while the red cluster was composed by wines with a fruit forward profile with a higher astringency and sour taste. Figure 2c (vintage 2020) showed blue cluster with a cooked vegetables, savoury and earthy profile, while red cluster with a higher overall fruit flavour, higher astringency, sourness, heat, roughness, mouthfeel and full-body. For vintage 2021 (Figure 2d) the blue cluster presented a cooked vegetables, savoury, chemical/medicinal profile, while red cluster showed again a presence of rough, astringent, heated, and sour profile, with also minty and green flavours.

Assessing Figures 1 and 2 together there appears to be a greater difference in the sensory profiles of Eden Valley wines when compared to the other sub-regions, displaying a savoury, cooked vegetables profile. This result is also corroborated by Danner *et al.* (2020) who found that independent of winemaking practices Eden Valley showed more differences in the sensory profile when compared to other sub-regions. This difference can also be explained by the fact that Eden Valley is the sub-region with highest average altitude in the Barossa Zone (Robinson & Sandercock, 2014).

To understand even further the drivers for the Barossa Zone subdivision it is also important to correlate the sensory characters highlighted by this analysis with their chemical drivers and eventually connect the sensory typicity with each terroir aspect (i.e. environmental conditions, viticultural and winemaking practices).

Conclusion

It is possible to conclude from this analysis that the previously defined Barossa Zone sub-regionality might not be substantiated by the sensory profile of the wines. Three of the four vintages showed a sub-division of only 2 clusters, however, there was not a very clear consistency of the sub-region dominance in a cluster from vintage

to vintage. Eden Valley showed a difference in 2019, 2018, and 2020 vintages which might indicate a significant segregation of those samples with the rest of the sub-regions, showing a savoury and cooked vegetables profile. Additionally, the investigation of the comprehensive results of this project will aid in further development of an analytical and data-driven approach for the Barossa Zone classification and sub-division.

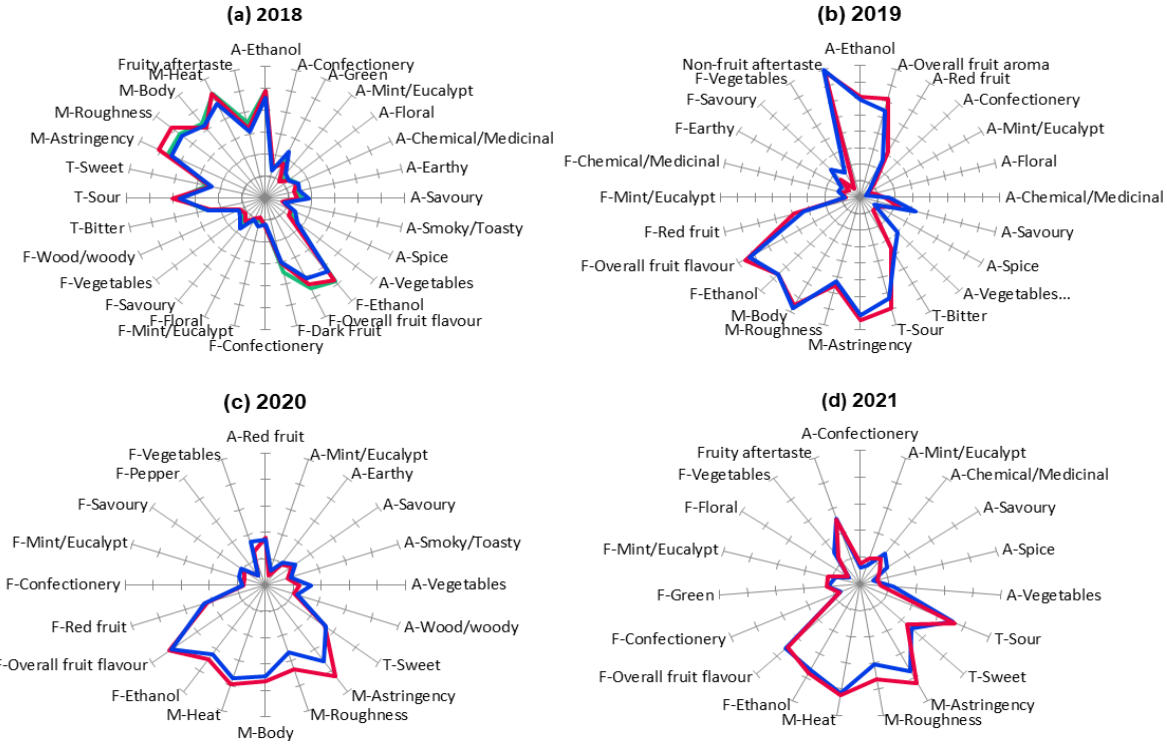

Figure 2. Spider plot of the significantly different sensory data ($\alpha = 0.05$) and the AHC clustering, representing (a) vintage 2018, (b) vintage 2019, (c) vintage 2020, (d) vintage 2021, where each colour represents a cluster and the colours corresponds to the clusters in Figure 1.

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