Authentication of Cabernet Sauvignon wines from different regions of Australia

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Introduction

- Wine authentication is an extensive concept that includes verifying wine age, geographical origin, varietal differences, and wine production practices that alter wine composition.
- A robust analytical method to determine the geographical origin of Australian wine is urgently needed for use within the supply chain to guarantee the provenance indicated on the label and provide an assurance of quality.
- This project aims to understand the compositional characters that are inherent in varietals from Australian wine regions.

Material and Methods

- Cabernet Sauvignon wines of 2015 vintage from Coonawarra (n=30), Margaret River (n=19), and Yarra Valley (n=21) were benchmarked against Bordeaux wines (n=10).
- Principal component analysis (PCA) and support vector machine discrimination analysis (SVMDA) were performed for data interpretation.

ICP-MS analysis

- Dilution of wine samples 10-fold with 2% HNO_3
- Oxygen, helium and without gas conditions were applied
- Total of 65 elements were analysed

A-TEEM analysis

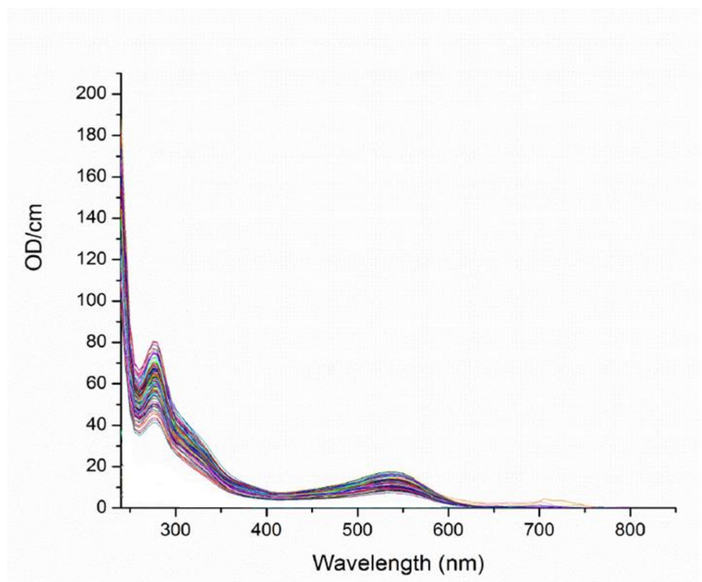
- Wine samples were diluted 200-fold in 50% ethanol and adjusted to pH 2 (HCl)
- UV-vis and fluorescence spectra acquired and measures determined:

Absorbance: hue and intensity

Transmittance: CIE chromaticity

Excitation emission matrix (EEM): phenolic composition

Together, the data (Figure 1) were applied to evaluate regional or varietal markers as previously proposed.[1]



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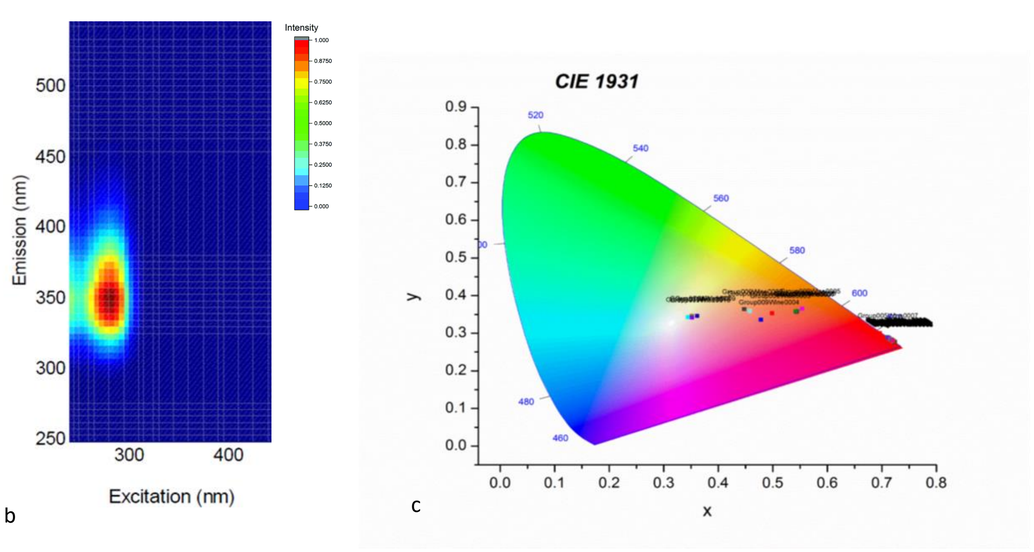

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Figure 1: a. Absorbance spectrum b. EEM Molecular fingerprint c. Chromaticity, of the analysed samples

Results and Discussion

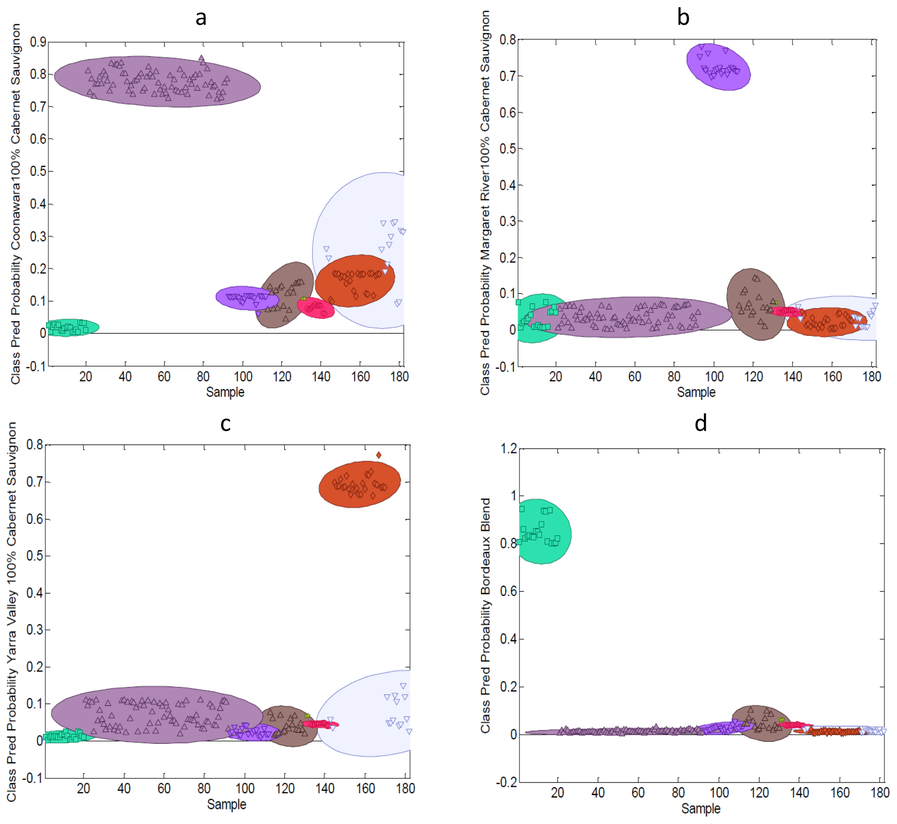

Figure 2: Class prediction probability of SVMDA with 99% confidence intervals for
a) Coonawarra, b) Margaret River, c) Yarra Valley, and d) Bordeaux.

- In A-TEEM analysis, wine samples were classified into 6 groups relating to their geographical origin as well as variety (Table 1).
- SVMDA is an effective method in this analysis, assigning models unique to each class (Figure 2) as the loadings have a higher granularity for component classification.[2]
- Confusion matrix of SVMDA (Table 1) has shown overall high prediction ability, with >90% correct classification overall. It is interesting that Bordeaux blends were perfectly classified, yet poorer performance for Yarra valley and Margaret River blends were observed. Also Coonawarra that were misclassified were deemed to be Yarra Valley 100% CS.
- However, the model could have been improved with the addition of extra samples.

Table 1: Confusion matrix of SVMDA (autoscale pre-processing with PCA data reduction)

	Coona*1	Marga*2	Yarra*3	Borde*4	Marga*5	Yarra*6
Predicted as Coonawarra100% CS	67	0	4	0	3	1
Predicted as Margaret River100% CS	0	20	0	0	0	0
Predicted as Yarra Valley 100% CS	5	0	22	0	0	0
Predicted as Bordeaux Blend	0	0	0	20	1	0
Predicted as Margaret River Blend	0	0	0	0	14	0
Predicted as Yarra Valley Blend	0	0	0	0	0	13
Predicted as Unassigned	0	0	0	0	0	0
Correct Classification %	93.06	100	84.60	100	77.78	92.86

Key:
Coona*1= Coonawarra 100% Cabernet Sauvignon
Marga*2 = Margaret River 100% Cabernet Sauvignon
Yarra*3 = Yarra Valley 100% Cabernet Sauvignon
Borde*4 = Bordeaux Blend
Marge*5 = Margaret River Blend
Yarra*6 = Yarra River Blend
CS = Cabernet Sauvignon

- From ICP-MS analysis, significantly discriminating elements were selected by one-way ANOVA and subjected to PCA (Figure 3).
- Elements that are responsible for specified regions could be identified. However, regional classification was less prominently resolved.
- Further analysis of multi-element data in combination with isotope analysis is proposed.

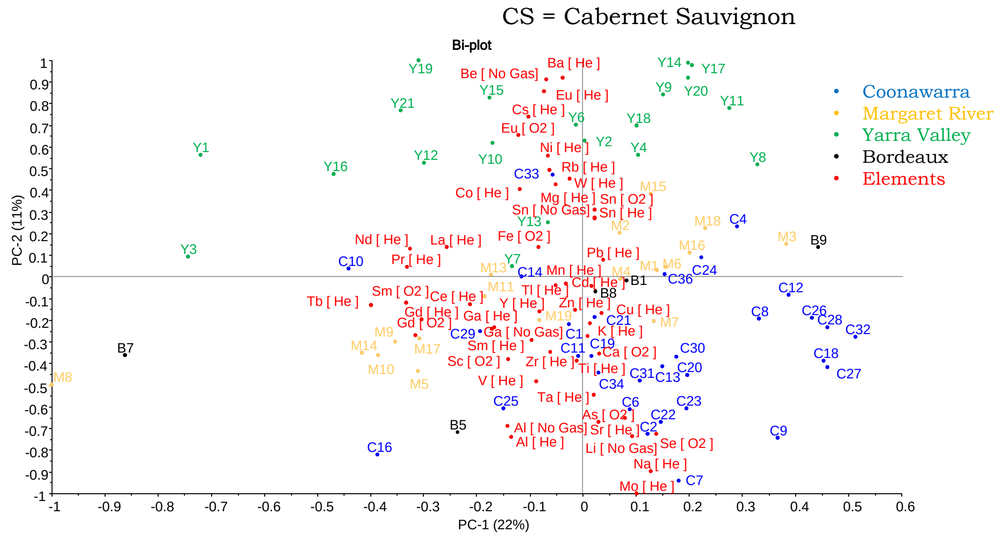

Figure 3: PCA of significant elements from ICP-MS analysis

Conclusions and Future Work

- ATEEM analysis and suitable modelling allowed effective and sensitive differentiation of classes, which shows that this could be applied for both geographical and varietal authentication of Australian Cabernet Sauvignon wine.
- The next step will involve hundreds of wine samples from the 2019 vintage for ATEEM analysis.
- Identification of potential chemical markers by different methods is planned. Data fusion of the data blocks with chemometrics will be further explored to derive a robust method for authentication.

References

1. Gilmore, A.; Akaji, S.; Csatorday, K., Spectroscopic Analysis of Red Wines with A-TEEM Molecular Fingerprinting. Readout 2017, 2 (49), 41-48.

2. Ríos-Reina, R.; Elcoroaristizabal, S.; Ocaña-González, J. A.; García-González, D. L.; Amigo, J. M.; Callejón, R. M., Characterization and authentication of Spanish PDO wine vinegars using multidimensional fluorescence and chemometrics. Food Chemistry 2017, 230, 108-116.

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