The influence of Cabernet Sauvignon grape maturity on the concentration and extraction of colour and phenolic compounds in wine

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Summary

Extended maturation of wine grapes is employed to achieve optimum berry flavour development and phenolic maturity for the desired wine style. While it has been suggested that fruit maturity may also influence the extraction efficiency of colour and mouthfeel compounds from grapes into wine during processing, this has not been thoroughly evaluated.

One aim of this research was to determine the impact of grape harvest date on the colour metrics and phenolic compounds in wines made from grapes harvested beyond historic or traditional maturity levels. To investigate this, berry phenolic composition and concentration were measured over two seasons (2008 and 2009) throughout post-veraison maturity of *Vitis vinifera* L. cv. Cabernet Sauvignon grapes, along with the composition and concentration of colour and phenolics in the wines produced from these grapes.

The data did not support the notion of increased extractability of phenolic compounds with grape maturity. However, the relative wine phenolic concentrations themselves might be more commercially relevant than extractability. Based on the 2008 grape and wine phenolic data, concentrations in wine appeared directly related to the grape concentrations. Unfortunately, the trends were not as clear in 2009. Grape malvidin-3-glucoside and polymeric tannin concentrations increased with ripening and the wine concentrations trended similarly. Grape caftaric acid, catechin, epicatechin, and B2 dimer concentrations declined with ripening, and this was reflected in their concentrations in the wine.

Phenolic compounds were measured as they are known to provide colour, astringency and bitterness to wines. Descriptive analysis was performed in order to determine how grape ripeness affected the wines made from these grapes. Principal component analysis of the sensory data differentiated the wines by harvest week; however, the phenolic compounds measured did not fully explain the changes in wine sensory properties. Prediction models of sensory attributes describing colour and astringency were reasonable in 2008, but not 2009. This was likely due to the weaker chemical concentration trends in 2009. Additional metrics are likely needed to explain the complex nature of the wine.

Harvesting grapes at higher maturities also results in increased alcohol concentrations in the resulting wines. This can result in wines which possess undesirable sensory aspects such as excessive alcohol, as well as stuck fermentations due to alcohol inhibition of yeast growth. In some cases, incoming must may be diluted with water to adjust the final alcohol content of the wine to approximately 14% (v/v). To test the impact of dilution, wines were made from Chardonnay and Zinfandel grapes harvested at high sugar levels. The pre-fermentation sugar concentrations were lowered with water or dealcoholized wine, and compared to wines made with no sugar adjustment. The concentration of both the phenolic and aroma compounds of these wines was assessed and correlated to sensory data. Using PCA, the Chardonnay control wines were separated from the treatment wines based on phenolic chemistry and descriptive analysis, but the aroma compound concentrations were not diluted by the water or dealcoholized wine addition. In Zinfandel, PCA of the phenolic compound concentrations did not separate the control and water added treatment; however, the aromas were more similar between the control and dealcoholized wine treatment. Sensorially, the Zinfandel control wines could be separated from the treatments, which also differed from one another.

Declaration

I, Cynthia C. Yonker (Cyd), certify that this work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief contains no material previously published or written by another person except where due reference has been made in the text.

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Statement of the contributions of jointly authored papers

1. Yonker, C.C., Ford, C.M., Dry, P.R., Dokoozlian, N.K. Fruit maturity influences the extraction of berry polyphenol compounds into Cabernet Sauvignon (*Vitis vinifera* L.) wines. Manuscript in preparation for submission to *Australian Journal of Grape and Wine Research*.

Author Contributions: CCY produced wines, conducted HPLC analysis, analysed the data and drafted/constructed the manuscript. CMF, PRD and NKD contributed to the research ideas and the editing of the manuscript.

2. Yonker, C.C., Bastian, S.E.P., Ford, C.M., Johnson, T.E., Dokoozlian, N.K. Impact of fruit maturity on polyphenol compounds in Cabernet Sauvignon (*Vitis vinifera* L.) wines and correlations to sensory perception. Manuscript in preparation for submission to *Australian Journal of Grape and Wine Research*.

Author Contributions: CCY produced wines, conducted HPLC analysis, assisted with sensory panel, analysed the data, and drafted/constructed the manuscript. SEPB and TEJ conducted wine sensory analysis. SEPB, CMF and NKD contributed to the research ideas and the editing of the manuscript. TEJ led descriptive analysis panel and assisted with sensory data analysis and editing of the manuscript.

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Author Contributions: CCY produced wines, conducted HPLC analysis, assisted with sensory panel, analysed the data, and drafted/constructed the manuscript. SEPB and TEJ conducted wine sensory analysis. SEPB, CMF and NKD contributed to the research ideas and the editing of the manuscript. TEJ led descriptive analysis panel and assisted with sensory data analysis and editing of the manuscript.

The following authors agree that the Statement of the contributions of jointly authored papers accurately describes their contribution to research manuscripts 1, 2, and 3 and give consent to their inclusion in this thesis.

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Abbreviations

Abs420	absorbance at 420nm
Abs520	absorbance at 520nm
ANOVA	analysis of variance
AU	absorbance units
AWRI	Australian Wine Research Institute
BSA	berry sensory analysis
Con	experimental control (Chapter 4)
CRP	caftaric reaction product
DA	descriptive analysis
DAL	dealcoholized wine added to must pre-fermentation (Chapter 4)
DAP	diammonium phosphate
DE	diatomaceous earth
EI	extractability index
ETc	estimated daily water requirement
ETo	daily reference evapotranspiration value
FTIR	Fourier transform infrared spectroscopy
GAE	gallic acid equivalent

GC-MS	gas chromatography-mass spectrometry
GRP	grape reaction product
HPLC	high performance liquid chromatography
Hunter a	colour measured from green (-) to red (+)
Hunter b	colour measured from blue (-) yellow (+)
Hunter L	colour measured from black (0) to white/clear (100)
ITV	Institute Technique de la Vigne et du Vin
Kc	seasonal crop coefficient
LSD	least significant difference
mDP	mean degree of polymerization
MFA	multiple factor analysis
PB	dealcoholized wine added post-fermentation (Chapter 4)
PCA	principal component analysis
PLS	partial least squares
PLSR	partial least squares regression
RS	reducing sugar
SA	saignee followed by water addition to must pre-fermentation (Chapter 4)
SPME	solid phase micro-extraction

TA	titratable acidity
TSS	total soluble solids
UV	ultraviolet
VA	volatile acidity
WA	water added to must pre-fermentation (chapter 4)
YAN	yeast assimilable nitrogen

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