

Analysis and Amelioration of Smoke Taint in Wine

*A thesis presented in fulfilment of the requirements
for the degree of Doctor of Philosophy*

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Abstract

The occurrence of smoke taint in wine is of worldwide concern for grape growers, winemakers and the wine industry. An improved understanding of the impact of bushfire smoke on grapes and wine is important to enable industry to overcome this challenge. Smoke taint occurs when vineyards are exposed to smoke from bushfires or prescribed burns and can result in wine which exhibits undesirable smoky and ashy aromas and flavours. The prior research summarised in Chapter 1 addresses many of the early knowledge gaps concerning the impact of smoke on grape and wine quality such as: the composition of smoke taint, including identification of several of the volatile compounds involved, and the complex sensory properties imparted to wine that cause the detrimental effects to wine quality. However, these studies do not offer industry many practical solutions to mitigate the incidence or severity of smoke taint.

This research reported in Chapter 2 describes several methods for ameliorating smoke taint in wine; i.e. the efficacy of (i) reverse osmosis (RO) and solid phase adsorption, and (ii) commercial fining agents, as treatments for smoke tainted wine. The ability of these methods to reduce the perception of smoke-related sensory attributes and concentrations of smoke-derived volatile phenols are described in two papers, which form the basis for this chapter on the amelioration of smoke taint in wine.

The studies reported in Chapter 3 describe the use of spectroscopy as a rapid analytical method for screening wines for smoke taint. The capability of spectroscopic techniques, in combination with chemometrics, to be used for the classification and discrimination of wine are also introduced. The need for rapid detection of smoke taint in grapes and wines was identified as a priority for industry following the demand for analysis of grapes and wine after a fire event. Winemakers operate under considerable time and resource constraints during vintage, thus rapid determinations of fruit quality, including the assessment of smoke exposure by fruit, are required. A predictive method employing mid-infrared (MIR) spectroscopy was developed by scanning control and smoke-affected wines, and applying multivariate data analysis techniques to the resulting data, to generate a calibration model for the classification of smoke tainted wines. Two-dimensional correlation spectroscopy (2D-COS) was also investigated as a novel method for characterising smoke taint in wines. Again, two papers are presented as the basis for a chapter concerning the spectroscopic analysis of smoke taint in wine.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name 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. In addition, I certify that no part of this work will, in the future, be used in a submission in my name for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint award of this degree.

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Publications

This thesis is in part a collection of manuscripts that were published in various refereed journals during candidature. The Journal of Agricultural and Food Chemistry; and Food Chemistry are two journals that research was published in. Other manuscripts were published in the Australian Journal of Grape and Wine Research.

A statement of authorship, signed by all of the authors listing individual contributions to the work is included at the beginning of each chapter.

Chapter 2.

- i) *Amelioration of Smoke Taint in Wine by Reverse Osmosis and Solid Phase Adsorption, Australian Journal of Grape and Wine Research, 2011, 17 (2), pp S41–S48*
- ii) *Amelioration of Smoke Taint in Wine by Treatment with Commercial Fining Agents, Australian Journal of Grape and Wine Research, 2012, 18 (3), pp 302-307*

Chapter 3.

- iii) *Classification of Smoke Tainted Wines Using Mid-Infrared Spectroscopy and Chemometrics, Journal of Agricultural and Food Chemistry, 2012, 60 (1), pp 52–59*
- iv) *Synchronous Two-Dimensional Correlation Spectroscopy (2D-COS) as a Novel Method for Screening Smoke Tainted Wine, Food Chemistry, 2013, 139 (1-4), pp 115-119*

An additional 3 related publications co-authored by the candidate are provided in the appendices.

Symposia

2011 Crush Grape and Wine Symposium, Adelaide, Australia, September 2011

Reverse osmosis-solid phase adsorption as an amelioration technique for reducing smoke taint in wine (oral presentation).

Fudge, A.L., Ristic, R., Wollan, D. and Wilkinson, K.L.

34th World Congress of Vine and Wine, Porto, Portugal, July 2011

Impact of smoke exposure on different grape varieties (poster presentation).

Ristic, R., Pinchbeck, K., **Fudge, A.**, Hayasaka, Y. and Wilkinson, K.

The effect of leaf removal and smoke exposure on Chardonnay wines (poster presentation). **Ristic, R.**, Pinchbeck, K., **Fudge, A.**, Hayasaka, Y. and Wilkinson, K.

9th Wartburg Symposium on Flavour Chemistry and Biology, Eisenach, Germany, April 2010

Identification of smoke derived volatiles in grapes and wine by GC-Olfactory (poster presentation).

Fudge, A., Boss, P. and Wilkinson, K.

23rd RACI 'Organic 08' Conference, Hobart, Australia, December 2008

Quantitative analysis of a potential precursor to cis-oak lactone, in oak extracts using liquid chromatography-tandem mass spectrometry based stable isotope dilution analysis (poster presentation).

Fudge, A.L., Elsey, G.M., Hayasaka, Y., and Wilkinson K.L.

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