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In this issue

TECHNICAL NOTES

Boosting floral aroma of wine with aromaless grape marc extracts

This article summarises the latest research on maximising grape-derived flavour in white wines, using aromaless compounds extracted from grape marc. Purified extracts from white grape marc were added to Riesling and Chardonnay wines at two points in the winemaking process. Chemical and sensory analysis showed increases in flavour compounds and ‘fruit’ and ‘floral’ characters, without addition of negative attributes such as bitterness.

Sooty mould trial update – sensory testing after two years

In 2017 the AWRI conducted a winemaking trial to investigate the effects of sooty mould on the composition, processing and sensory attributes of Shiraz wine. This article provides an update on trial results, following sensory analysis conducted after two years.

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Accumulation of volatile phenol glycoconjugates in grapes following grapevine exposure to smoke and potential mitigation of smoke taint by foliar application of kaolin

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Technical notes

Boosting floral aroma of wine with aromaless grape marc extracts

What is wine flavour? Where does flavour come from? Will everybody experience it in the same way? Can more of it be made? These are the questions at the centre of research on maximising grape-derived flavour and developing methods to make stylistic changes to wines using grape marc. This work has recently been published in the *Australian Journal of Grape and Wine Research* (Parker et al. 2019).

Wine flavour 101

We experience wine using many different senses, but the current work focuses on the aroma, taste and flavour of wine (disregarding colour and texture for now). While these sometimes get lumped together and used interchangeably, aroma is generally accepted to be the interaction of volatile compounds with our olfactory bulb (at the top of the nasal cavity) via sniffing. Tastes are the senses we experience on our tongue (e.g. sweet, salty, acid, bitter) and flavour is the experience of volatile compounds in the wine travelling from our mouth to the olfactory bulb via the back of the throat, in combination with tastes from the tongue. In the technical jargon, the movement of volatiles to the olfactory bulb via the back of the mouth is referred to as retro-nasal odour, while sniffing is ortho-nasal (Figure 1). In this article, just to avoid confusion, ortho-nasal is used to refer to detection via sniffing, while retro-nasal refers to detection during tasting via the back of the throat. Same compounds, same olfactory bulb, different routes!

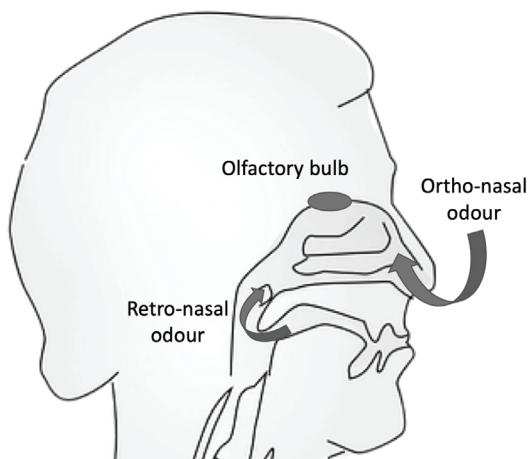


Figure 1. Schematic of ortho-nasal odour detection via the nose and retro-nasal odour detection via the back of the throat to the olfactory bulb at the top of the nasal cavity.

Wine flavour is very complex. The sheer number of chemical compounds present, the interactions between these compounds and with the background wine composition (such as sugar, acid, and alcohol) all contribute to determine what a wine will smell and taste like. This work has focused on a class of compounds called monoterpenes (e.g. linalool, nerol and geraniol), which give the characteristic 'floral' or 'citrus' notes of Riesling, Gewurztraminer or Muscat varieties. While these floral varieties have a much higher concentration of monoterpenes than non-floral varieties, all grape varieties contain monoterpenes to some extent. Most of the monoterpenes in grapes are in a form that is not aroma-active, with the monoterpenes bound to sugars as 'glycosides'. This bound form is how the grape stores compounds to help with solubility and transport. The combination of an aroma compound and a sugar renders the compound non-volatile, unable to move from the liquid phase to the headspace of a wine. It is thus unable to travel to the olfactory bulb; that is, the sugar renders the compound aromaless.

Grape glycosides and flavour

While the glycosides of monoterpenes do not impart flavour directly, they are important because, in wine, they slowly break down and release the aromatic monoterpenes. This can happen either microbiologically via the side-activity of yeast or other microorganisms during fermentation, or chemically through exposure to the acidic environment of wine. Either way, from the non-aromatic forms that predominate in grapes, these glycosides provide a pool of latent flavour that can evolve over time. Unfortunately, due to minimal skin contact being common in white winemaking, a significant proportion of the flavour potential of white grapes gets discarded within the grape marc. White grape marc of course also contains many other compounds that could increase undesirable wine flavour properties such as bitterness, for example, from phenolic glycosides.

Personal experience of flavour

Excitingly, the release of monoterpenes from their glycosides in wine is not the only route to floral flavour evolution. AWRI research has shown that glycosides can be broken down in the mouth when tasting wine, providing a burst of monoterpenes, and near-immediate perception of 'floral' flavour. The glycosides thus provide a reserve of flavour ready to be released at time of drinking. It is known, however, that within populations of people, the ability to detect floral notes from in-mouth hydrolysis differs widely between individuals. As such, the evolution of flavour from glycosides that are present in the wine is only a phenomenon for a portion of tasters. This is just another cog in the machine of wine flavour perception that tells us that everybody has a unique experience when tasting wine. The varying ability of individuals to perceive glycosides in-mouth, or any specific inability to detect specific flavour compounds, should be considered when developing a tasting panel, or indeed when making any wine production decisions based on sensory assessments.

One way to make experiencing the floral monoterpenes a more even playing field is to allow the glycosides to break down in wine. That can be achieved by promoting breakdown of the pool that inherently exists in wine already, or by adding extra glycosides that have been extracted from grape skins. However, for the monoterpene glycosides in grape marc to be useful in imparting floral flavour, without increasing bitterness, the desirable compounds first have to be separated from the undesirables.

Making more flavour

In 2016 half a tonne of Gewürztraminer marc was treated to extract glycosides. The resulting extract was purified to remove any potentially bitter phenolic species and to eliminate any non-glycoside odour-active compounds. What remained was a grape marc extract that contained a significant proportion of monoterpene glycosides but had no aroma.

This extract was used to supplement Riesling and Chardonnay wines at two different points in the winemaking process. The extract was added pre-ferment, when the activity of yeast during alcoholic fermentation was expected to result in hydrolysis and evolution of free monoterpenes, and/or pre-bottling, following which very slow hydrolysis was expected to occur in bottle. After three months in bottle, the wines were assessed by the AWRI sensory descriptive analysis panel and analysed for the presence of glycosides and free monoterpenes.

The verdict

Chemically, the addition of glycosides resulted in an increase in the concentration of glycosides in the wine, an obvious and expected outcome. Additionally, all the wines with added glycoside, regardless of variety, showed a significant increase in free monoterpenes such as linalool (see Figure 2 for the Chardonnay results), resulting from glycoside breakdown. In terms of concentration, the breakdown of glycosides to yield monoterpenes represented a small proportion of the total added glycoside pool. For example, the accumulated linalool in wines with added glycosides was approximately 40–60 µg/L, while the concentration of remaining glycosides was around 2 mg/L, or roughly 30 times higher. While monoterpenes were released, there was still a substantial source of potential flavour (locked up in glycosides) remaining in these wines.

Sensorially, the wines with added glycosides were judged to be much higher in ‘floral’ and ‘fruit’ characters which aligned with the increased presence of monoterpenes (Figure 3). While the pre-ferment addition yielded slightly higher concentrations of free monoterpenes, the sensory rating for key ‘fruit’ and ‘floral’ attributes was not observed to be significantly different between those two wines. Although, when it comes to floral aftertaste, the story is less simple. The increase in monoterpenes in wine was expected to result in a higher rating

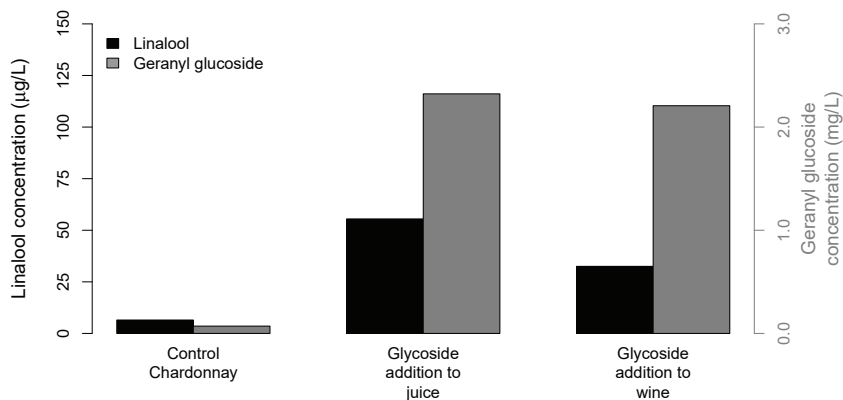


Figure 2. Monoterpene (linalool, black bar, left y-axis) and glycoside (geranyl glucoside, grey bar, right y-axis) concentrations three-months post-bottling in Chardonnay wines: control (no addition), with glycosides added pre-fermentation (to juice) and post-fermentation (to wine).

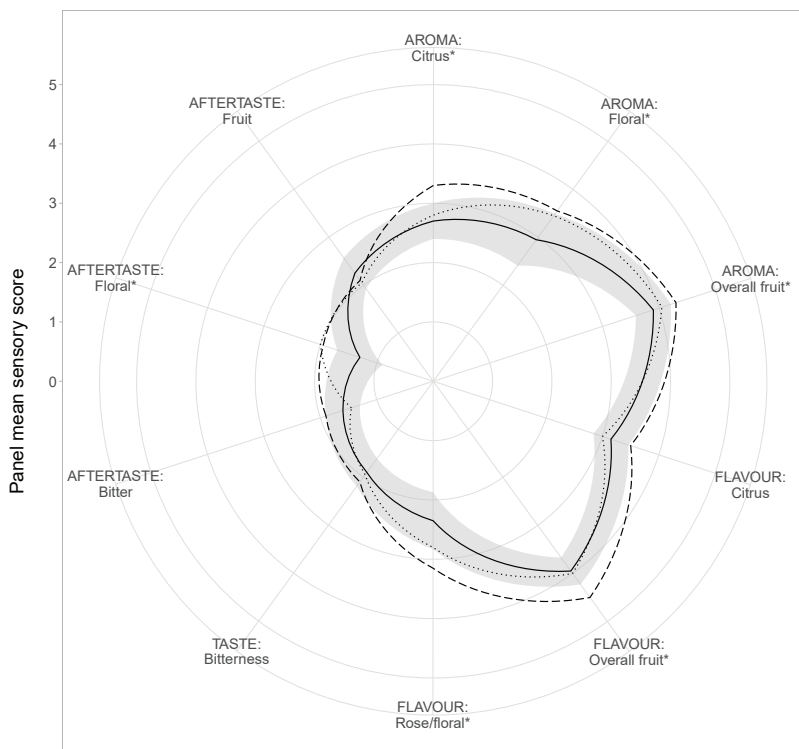


Figure 3. Radar plot showing the panel mean sensory score of key attributes for Chardonnay control (black line) with least significant difference (grey ribbon), pre-ferment addition of glycosides to Chardonnay (juice addition, dotted line) and post-ferment addition of glycosides to Chardonnay (wine addition, dashed line) from the descriptive analysis sensory assessment of wines. An asterisk denotes an attribute where a significant difference in panel intensity rating was observed for all Chardonnay and Riesling wines assessed.

of floral aftertaste simply due to their presence, but the scenario where glycosides were broken down in the mouth to yield a delayed flavour perception retro-nasally also had to be considered. There was evidence that those panellists known to be able to perceive flavour from monoterpene glycosides (approximately half the panel) rated 'fruit'/'floral' aftertaste higher than those who do not respond to glycosides. This indicates that the increased reserve of glycosides in the treated wines had an additional flavour effect for these individuals.

In short

Purified grape marc extracts from white floral varieties can provide a source of latent additional 'fruit' and 'floral' flavour for wine, without increasing bitterness or other phenolic characters that could be associated with components of crude marc. The impact of timing of the addition (pre- or post-ferment) to a wine was not significant, meaning that marc extract additions to boost floral notes could be applied after a wine has been made, immediately prior to bottling. This work is ongoing, with a current focus on the speed of glycoside breakdown under different conditions, assessing non-floral grape varieties, and establishing an understanding of the 'shelf life' of the flavour effects, to maximise the overall flavour impact.

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Sooty mould trial update – sensory testing after two years

During the 2017 vintage, many grapegrowers in South Australia were affected by ‘sooty mould’, with significant quantities of grapes being rejected by wine producers. Sooty mould refers to a fungal infection where all parts of the vine can become blackened, as though they are covered with a layer of soot. The sooty mould fungi colonise areas of the vine where ‘honeydew’ has been excreted by sap-sucking insects such as scale and mealybug, with scale being the primary cause of the most severe outbreaks of sooty mould in 2017.

2017 winemaking trial

To investigate any impacts of sooty mould on the composition, processing, and sensory attributes of a Shiraz wine, the AWRI conducted a small-scale winemaking trial with sooty mould-affected and unaffected fruit from the Langhorne Creek region. In addition, a Langhorne Creek wine producer also conducted a trial with one-tonne lots of sooty mould-affected and unaffected Chardonnay and Shiraz grapes.

The results of the AWRI trial, and of sensory evaluation performed at the AWRI on wines from the one-tonne lot trial, have been previously reported (Godden 2017, Godden 2018a, Godden 2018b). In the chemical analysis conducted from crushing through to three weeks post-bottling, few analytical differences were seen between wines made with or without sooty mould-affected grapes. In addition, an experienced and trained sensory panel could not distinguish between the one-tonne lot sooty mould-affected and unaffected wines, or between the AWRI control wine and a wine made with the inclusion of 25% sooty mould-affected grapes, with sensory analysis conducted about four weeks after bottling. The only major difference seen between the wines in the AWRI trial was that the sooty mould-affected treatments (5% and 25% sooty mould-affected grape inclusion) produced up to 10% more lees than the control wines.

2019 sensory testing

An additional round of sensory difference testing was held in March 2019, with the aim of assessing any possible longer-term sensory impacts of sooty mould. An experienced and trained panel of 32 assessors conducted triangle difference testing on the one-tonne lot Chardonnay and Shiraz wines and the AWRI control and 25% sooty mould-affected Shiraz wines. Once again, the panel could not distinguish between each of the three pairs of wines, with the number of correct assessments for the three wines being 10, 10 and 11 respectively, equivalent to the number predicted by chance.

Conclusions

While the results of these trials indicate that sooty mould had little effect on the sensory or chemical attributes of the Chardonnay and Shiraz wines, caution should be exercised when interpreting the results. The sooty mould present on all three batches of fruit appeared to have dried out during an extended period of sunny and low humidity weather at the end of the 2017 vintage and had apparently ceased growing or spreading. In addition, few other moulds were present, and fruit for the AWRI trial was sorted to exclude bunches displaying defects other than sooty mould. It is possible, therefore, that different results might have been obtained if the sooty mould had been actively growing at the time of harvest. In addition, in many situations where sooty mould is present, other microorganisms might have also proliferated, which alone, or in combination with the sooty mould, could have a negative effect on wine quality. On the other hand, the absence of other defects suggests that the sooty mould alone, of the type present on the grapes used for these trials, may not have a negative effect on wine quality.

Acknowledgements

This work is supported by Australia's grapegrowers and winemakers through their investment body Wine Australia, and matching funds from the Australian Government. The AWRI is a member of the Wine Innovation Cluster in Adelaide.

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Highlights this issue

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Oenology

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Walton, S. Escaping the downward spiral: on not drinking. *The World of Fine Wine* 62, 136-143; 2018.

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Juice and wine handling

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Briscoe, S. Evolution of the basket press. *Wines & Vines* 99(12), 100-102; 2019.

Winemakers discuss their preference for basket presses; manufacturers reveal new press tech.

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240.04

Lasky, M.S. Winemaker trial: where whole clusters are placed in fermenter determines organoleptic qualities. *Wine Business Monthly* 25(12), 40-42; 2018.

Where you place whole clusters of grapes, Pinot Noir in this case, ostensibly will affect the perceived

tannin extraction, cause potential volatile acidity development and perhaps lend a more carbonic quality that's best avoided.

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Rand, M. Coups de foudre. *The World of Fine Wine* 62, 122-127; 2018.

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Todorov, K. Case studies: sanitation best practices for large wineries. *Wine Business Monthly* 25(12), 44-49; 2018.

Sanitation is like washing your dishes after you eat. You may not like it, but it's key. Key points addressed in this article are:

- Wineries continue to try to find ways to save water;
- Companies consider ultraviolet to sanitize tanks;
- Tanks cannot be sanitized if they are not cleaned first;
- Tartrate residue is sent off to be turned into cream of tartar and;
- Water is recycled and used for irrigation

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240.07

Vignault, A., Pascual, O., Jourdes, M., Moine, V., Fermaud, M., Roudet, J., Canals, J.M., Teissedre, P.-L., Zamora, F. Impact of enological tannins on laccase activity. *OENO one* 53(1), 27-38; 2019.

Aims: The aim of this research was to determine and quantify the ability of enological tannins to reduce laccase activity and, consequently, to protect wine color against enzymatic browning and/or oxidasic haze. **Methods and Results:** Botrytized grape juice with laccase activity was obtained by inoculating *Botrytis cinerea* in healthy mature grapes. Laccase activity was determined in grape juice before and after supplementation with enological tannins using the syringaldazine method. White micro-fermentations were performed in the presence or not of laccase activity and supplemented or not with enological tannins in order to determine how the color was affected. Similarly, red micro-fermentations were performed using white grape juice supplemented with malvidin-3-O-glucoside. All enological tannins inhibited laccase activity and protected the wine color. **Conclusion:** Supplementation with enological tannins is an interesting tool to inhibit laccase activity and protect the color of white wines from browning and the color of red wines from oxidasic haze. **Significance and impact of the study:** This is the first scientific study evidencing the inhibitory effect of enological tannins on laccase activity in winemaking conditions.

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Microbiology

240.08

Nardi, T., Panero, L., Petrozziello, M., Guaita, M., Tsolakis, C., Cassino, C., Vagnoli, P., Bosso, A. Managing wine quality using *Torulaspora delbrueckii* and *Oenococcus oeni* starters in mixed fermentations of a red Barbera wine. *European Food Research and Technology* 245(2), 293-307; 2019.

Abstract available online at <http://doi.org/c4dx>

240.09

Oro, L., Canonico, L., Marinelli, V., Ciani, M., Comitini, F. Occurrence of *Brettanomyces bruxellensis* on grape berries and in related winemaking cellar. *Frontiers in Microbiology* 10(415), 1-10; 2019.

The spoilage yeasts belonging to the genus *Dekkera* (anamorph *Brettanomyces*) are associated with the fermentation process and can be responsible for off-flavors in wine. *Brettanomyces bruxellensis* is difficult to isolate from natural environments because of its low diffusion, low presence on the grape surface and low competition capacity, slow growth, and VBNC (viable but not culturable) state, even when selective media are used. In this study, to investigate the origins and occurrence of *B. bruxellensis* in winemaking, a total of 62 samples from grapes, winery environment, and fermenting musts were taken through direct isolation with a selective medium. *B. bruxellensis* was not directly detected in the grape samples but was instead widely isolated from the winery environment samples. However, using a combination of enrichment and selective media, eight of fifteen grape samples were positive for *B. bruxellensis*. Analysis of the genetic traits of the isolates indicated a strict relationship among the strains from the vineyard and the winery. Isolates from the vineyard and the winery were both part of the more common and dominant biotypes suggesting that the vineyard may be the contamination source of *B. bruxellensis* in the winery environment. For this, grapes may represent the possible primary origin source from which a flow toward the winery environment originates. On the other hand, the wide occurrence of *B. bruxellensis* in winery indicates that this environment can be considered as the favorable ecological niche for colonization and diffusion of these yeast.

Full text available online at <http://doi.org/c4gb>

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Analysis and composition

240.10

Dragojlović, D., Philipp, C., Korntheuer, K., Bader, C., Patzl-Fischerleitner, E., Eder, R. Influence of nitrogen on glutathione content during and after alcoholic fermentation. *Mitteilungen Klosterneuburg Rebe und Wein* 68(4), 250-257; 2018.

Abstract not available for reproduction

240.11

Ristic, R., Wilkinson, K. Smoke taint in the bottle: how long will it last? *Australian & New Zealand Grapegrower & Winemaker* 660, 46-49; 2019.

Renata Ristic and Kerry Wilkinson, from the University of Adelaide and the Australian Research Council Training Centre for Innovative Wine Production, examine how smoke related compounds in wine may be positively affected by winemaking techniques.

© Reprinted with permission Ristic, R., Wilkinson, K. Smoke taint in the bottle: how long will it last? *Australian & New Zealand Grapegrower & Winemaker* 660, 46-49; 2019. Copyright 2019 Winetitles Media Pty Ltd.

240.12

Seabrook, A. White wine phenolics: what compounds are there and which ones cause problems? *Australian & New Zealand Grapegrower & Winemaker* 660, 53-54; 2019.

Technical manager for Laffort Australia, Alana Seabrook, highlights the main compounds that can negatively impact the quality of white wines.

© Reprinted with permission Seabrook, A. White wine phenolics: what compounds are there and which ones cause problems? *Australian & New Zealand Grapegrower & Winemaker* 660, 53-54; 2019. Copyright 2019 Winetitles Media Pty Ltd.

240.13

Springer, A.E. Wine authentication: a fingerprinting multiclass strategy to classify red varieties through profound chemometric analysis of volatiles. *European Food Research and Technology* 245(1), 179-190; 2019.

Abstract available online at <http://doi.org/c4dw>

240.14

Ugolino, M., Wirth, J., Bégrand, S., Diéval, J-B., Pascal, C., Vidal, S. A novel electrochemical approach for rapid analysis of white grapes polyphenols and monitoring of pre-fermentative operations. *Internet Journal of Viticulture and Enology* 3(3), 1-7; 2019.

Full text available online at <https://bit.ly/2UdtB98>

240.15

Wilkinson, K., Ristic, R. Understanding the effects of smoke taint on fruit and wine. *Australian & New Zealand Grapegrower & Winemaker* 660, 42-44; 2019.

As the prospect of bushfires flaring up around vineyards looms as summer 2019 continues, this article explains what the markers are for smoke taint in grapes and wine.

© Reprinted with permission Wilkinson, K., Ristic, R. Understanding the effects of smoke taint on fruit and wine. *Australian & New Zealand Grapegrower & Winemaker* 660, 42-44; 2019. Copyright 2019 Winetitles Media Pty Ltd.

Marketing and packaging

240.16

Riley, L. Opening minds on closures. *Harpers Wine & Spirit* 174, 44-46; 2019.

Innovations in wine closures are coming thick and fast, driven by sustainability, convenience and quality control. This article looks at their impact.

Abstract available online at <https://bit.ly/2DakeSh>

© Reprinted with permission Riley, L. Opening minds on closures. *Harpers Wine & Spirit* 174, 44-46; 2019. Copyright 2019 William Reed Business Media.

240.17

Songa, G., Ciceri, A. Neuromarketing meets the art of labelling. How papers and finishing on labels affect wine buying decisions. *AAWE Working Paper* 235, 1-15; 2019.

The aim of the study is to scientifically explore the role of paper and embellishments of wine labels in driving consumers' visual behaviour on the shelf, their perception of the product and their purchase choices. Thirty labels were created combining six types of papers and six types of embellishments. Thirty target consumers explored the shelf first without any specific tasks, and then with the goal to choose a bottle of wine, while their visual behaviour were recorded through a wearable eye-tracker. Subsequently, the consumers were exposed to each single bottle. They had to watch each bottle for 15 seconds and then to handle it for the same amount of time. During this phase their visual behaviour and their brain activation were recorded respectively by a wearable eye-tracker glasses and an EEG headset. After the test, an in-depth interview was conducted to assess the rational perception, the expectations, the intention to buy and the willingness to pay for the wine bottles. Results highlighted the role of both paper and embellishment in enhancing label visual saliency and equity on the shelf and in influencing consumers' perception, expectation and purchase behaviour. Moreover, an interesting reciprocal influence of visual and tactile features on each other was found.

Full text available online at <https://bit.ly/2It9Qsg>

© Reprinted with permission Songa, G., Ciceri, A. Neuromarketing meets the art of labelling. How papers and finishing on labels affect wine buying decisions. *AAWE Working Paper* 235, 1-15; 2019. Copyright 2019 American Association of Wine Economists.

Environment

240.18

Ohmart, C. What is sustainable wine grapegrowing. *Wines & Vines* 99(12), 72-73; 2019.

Sustainable wine-grape growing is a journey, not a destination. In this article the author makes the case for why using this approach for growing wine grapes is so important. The article discusses some significant areas of tension in the wine industry that have come about as the sustainability movement has evolved, which may help growers better negotiate them.

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Sensory

240.19

Bodington, J., Malfeito-Ferreira, M. Do female and male judges assign the same ratings to the same wines? Large sample results. *Journal of Wine Economics* 13(4), 403-408; 2018.

Much research shows that women and men have different taste acuties and preferences. If female and male judges tend to assign different ratings to the same wines, then the gender balances of the judge panels will bias awards. Existing research supports the null hypothesis, however, that finding is based on small sample sizes. This article presents the results for a large sample; 260 wines and 1,736 wine-score observations. Subject to the strong qualification that non-gender-related variation is material, the results affirm that female and male judges do assign about the same ratings to the same wines. The expected value of the difference in their mean ratings is zero.

Abstract available online at <http://doi.org/c4dz>

© Reprinted with permission Bodington, J., Malfeito-Ferreira, M. Do female and male judges assign the same ratings to the same wines? Large sample results. *Journal of Wine Economics* 13(4), 403-408; 2018. Copyright 2018 American Association of Wine Economists.

Wang, Q.J, Prešern, D. Does blind tasting work? Investigating the impact of training on blind tasting accuracy and wine preference. *Journal of Wine Economics* 13(4), 384-393; 2018.

We analyzed data from Oxford University Blind Tasting Society's 2018 training season to assess whether blind tasting training improves accuracy. Over time, guesses for grape variety increased in terms of accuracy as well as within-group agreement. Moreover, for grape variety, location, and vintage, the chances of the most common within-group guess being correct were significantly higher than the underlying frequency distribution. Finally, we observed a shift in preference towards older wines, with those with little initial experience gaining a preference for greater acidity and alcohol, and decreasing their preference for oak. Our results have important implications for growing wine markets with an increasingly educated consumer population.

Abstract available online at <http://doi.org/c4d2>

© Reprinted with permission Wang, Q.J, Prešern, D. Does blind tasting work? Investigating the impact of training on blind tasting accuracy and wine preference. *Journal of Wine Economics* 13(4), 384-393; 2018. Copyright 2018 American Association of Wine Economists.

Viticulture

General

240.21

Aka, J., Ugaglia, A.A., Lescot, J-M. Pesticide use and risk aversion in the French wine sector. *Journal of Wine Economics* 13(4), 451-460; 2018.

This paper studies the risk attitudes of winegrowers in France. In French viticulture, most of the production is done under an appellation regime that constrains maximum authorized yields. We consider a *trans*-log cost function under the constraint of this maximum yield and estimate winegrowers' attitudes to risk. Our estimates are based on the European Farm Accountancy Data Network database (2005-2014) and data from the French National Institute of Origin and Quality. We find that winegrowers are risk averse. For the majority of winegrowers, risk aversion is declining with expected profit. In the Champagne region, however, where expected profits are far higher than in the other regions, we observe the reverse relation: winegrowers become more risk averse as expected profits rise.

Abstract available online at <http://doi.org/c4d3>

© Reprinted with permission Aka, J., Ugaglia, A.A., Lescot, J-M. Pesticide use and risk aversion in the French wine sector. *Journal of Wine Economics* 13(4), 451-460; 2018. Copyright 2018 American Association of Wine Economists.

240.22

Devaux, N., Crestey, T., Leroux, C., Tisseyre, B. Potential of Sentinel-2 satellite images to monitor vine fields grown at a territorial scale. *OENO one* 53(1), 51-58; 2019.

Aim: The aim of this short note is to provide first insights into the ability of Sentinel-2 images to monitor vine growth across a whole season. It focuses on verifying the practical temporal resolution that can be reached with Sentinel-2 images, the main stages of Mediterranean vineyard development as well as potential relevant agronomic information that can be seen on the temporal vegetation curves arising from Sentinel-2 images. **Methods and Results:** The study was carried out in 2017 in a production vineyard located in Southern France, 2 km from the Mediterranean seashore. Sentinel-2 images acquired during the whole vine growing cycle were considered, i.e. between the 3rd of March 2017 and the 10th of October 2017. The images were used to compute the classical normalized difference vegetation index (NDVI). Time series of NDVI values were analyzed on four blocks chosen for exhibiting different features, e.g. age, missing plants, weeding practices. The practical time lag between two usable images was closer to 16 days than to the 10 theoretical days (with only one satellite available at the date of the experiment), i.e. near 60% of the theoretical one. Results show that it might be possible to identify i) the main steps of vine development (e.g. budburst, growth, trimming, growth stop and senescence), ii) weed management and inter-row management practices, and iii) possible reasons for significant inter-block differences in vegetative expression (e.g. young vines that have recently been planted, low-productive blocks affected by many missing vines). **Conclusions:** Although this experiment was conducted at a time when

Sentinel-2b was not fully operational, results showed that a sufficient number of usable images was available to monitor vine development. The availability of two Sentinel satellites (2a and 2b) in upcoming seasons should increase the number of usable images and the temporal resolution of the time series. This study also showed the limitations of the Sentinel-2 images' resolution to provide within-block information in the case of small blocks or blocks with complex borders or both. **Significance and impact of the study:** This technical note demonstrated the potential of Sentinel-2 images to characterize vineyard blocks' vigor and to monitor winegrowers' practices at a territorial (regional) scale. The impact of management operations such as weeding and trimming, along with their incidence on canopy size, were observed on the NDVI time series. Some relevant parameters (slope, maximum values) may be derived from the NDVI time series, providing new insights into the monitoring of vineyards at a large scale. These results provided areas for further investigation, especially regarding the development of new indicators to characterize block-climate relationships.

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240.23

Gutiérrez, S., Tardaguila, J., Fernández-Navales, J., Diago, M.P. On-the-go hyperspectral imaging for the in-field estimation of grape berry soluble solids and anthocyanin concentration. *Australian Journal of Grape and Wine Research* 25(1), 127-133; 2019.

Background and Aims: Hyperspectral imaging (HSI) is used to assess fruit composition mostly indoor under controlled conditions. This work evaluates a HSI technique to measure TSS and anthocyanin concentration in wine grapes non-destructively, in real time and in the vineyard.

Methods and Results: Hyperspectral images were acquired under natural illumination with a VIS-NIR hyperspectral camera (400-1000 nm) mounted on an all-terrain vehicle moving at 5 km/h in a commercial Tempranillo vineyard in La Rioja, Spain. Measurements were taken on four dates during grape ripening in 2017. Grape composition was analysed on the grapes imaged, which was then used to develop spectral models, trained with support vector machines, to predict TSS and anthocyanin concentration. Regression models of TSS had determination coefficients (R^2) of 0.91 for a fivefold cross validation [root mean squared error (RMSE) of 1.358°Brix] and 0.92 for the prediction of external samples (RMSE of 1.274°Brix). For anthocyanin concentration, R^2 of 0.72 for cross validation (RMSE of 0.282 mg/g berry) and 0.83 for prediction (RMSE of 0.211 mg/g berry) was achieved. Spatial-temporal variation maps were developed for the four image acquisition dates during ripening. **Conclusions:** These results suggest that potential for on-the-go HSI to automate the assessment of important grape compositional parameters in vineyard is promising. **Significance of the Study:** The on-the-go HSI method described in this study could

be automated and provide valuable information to improve winery and vineyard decisions and vineyard management.

Abstract available online at <http://doi.org/c3bs>

© Reprinted with permission Gutiérrez, S., Tardaguila, J., Fernández-Novales, J., Diago, M.P. On-the-go hyperspectral imaging for the in-field estimation of grape berry soluble solids and anthocyanin concentration. Australian Journal of Grape and Wine Research 25(1), 127-133; 2019. Copyright 2019 Australian Society of Viticulture and Oenology.

240.24

Hughes, N. Older vines, better wines? *Decanter* 44(6), 84-88; 2019.

It's one of the oldest wine aphorisms that's generally assumed to be true - but is it necessarily so? Natasha Hughes MW investigates whether age really does come before beauty in the vineyard, and recommends eight old-vine wines that you can test the theory with.

© Reprinted with permission Hughes, N. Older vines, better wines? *Decanter* 44(6), 84-88; 2019. Copyright 2019 TI Media Limited.

Physiology and biotechnology

240.25

Abeyasinghe, S.K., Greer, D.H., Rogiers, S.Y. The effect of light intensity and temperature on berry growth and sugar accumulation in *Vitis vinifera* 'Shiraz' under vineyard conditions. *Vitis* 58(1), 7-16; 2019.

Temperature and light are key climatic factors which affect grapevine physiology in the growing season. Our aim was to investigate the interactive effects of temperature and light intensity on reproductive growth responses of 'Shiraz' vines in vineyard conditions. Well-watered vines were covered with no shade, light, medium and heavy shade covers in a vineyard over three consecutive seasons. Several heat events, i.e., air temperatures exceeding 40 °C for several days, occurred in two of the seasons. Heavy shade reduced canopy temperatures by 3.2-6 °C in the cooler season and by 4-6 °C in the warmer seasons, relative to air temperature and compared with the open canopy. The onset of berry growth was delayed by the heavy shade but the rate of sugar accumulation was not affected. During the season with the most severe heat events, berry dry matter accumulation was significantly higher in the shaded treatments compared to the unshaded vines. The hypothesis was confirmed that medium and heavy shade conferred high levels of protection on the berry ripening process from high summer temperatures and the concurrent exposure to light intensities.

Full text available online at <http://doi.org/c3zh>

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240.26

Fahey, D.J., Rogiers, S.Y. Di-1-*p*-menthene reduces grape leaf and bunch transpiration. *Australian Journal of Grape and Wine Research* 25(1), 134-141; 2019.

Background and Aims: Di-1-*p*-menthene, a film-forming antitranspirant, is reported to impede transpiration by acting as a physical barrier to water vapour loss from plant tissues. We tested this assumption on grapevine leaves across a range of temperature as well as on the bunch rachis and berries at several developmental stages. **Methods and Results:** Gas exchange of Shiraz leaves was monitored at 20, 25, 30 and 35°C under controlled conditions after treatment with 1 and 2% di-1-*p*-menthene. Transpiration, photosynthesis and stomatal conductance were reduced at each temperature, but instantaneous water use efficiency (CO₂ fixation relative to water loss) was improved only at 25 and 30°C. There was no further reduction in water use or improved water use efficiency with the application of a 2% over 1% emulsion. The antitranspirant was most effective when applied to the underside of the leaves, forming a physical barrier over the stomatal cavity without reduction in stomatal aperture. Di-1-*p*-menthene also curtailed bunch water loss in Merlot by lowering transpiration of both the rachis and berries at the fruitset, peppercorn, pea size and veraison stages, and at 20 and 25°Brix. Increasing the concentration of the antitranspirant from 1% to 2 or 3% added some benefit; however, this was dependent on the developmental stage. Both leaf and berry temperature was elevated by the spray application. Di-1-*p*-menthene did not interfere with flowering or promote fruit abortion when applied prior to capfall. **Conclusion:** Di-1-*p*-menthene maintains berry turgidity through effects on both the canopy and the bunches themselves. **Significance of the Study:** The antitranspirant, di-1-*p*-menthene, may provide protection against desiccation under field conditions and this will have implications for yield and berry composition.

Abstract available online at <http://doi.org/c2pm>

© Reprinted with permission Fahey, D.J., Rogiers, S.Y. Di-1-*p*-menthene reduces grape leaf and bunch transpiration. *Australian Journal of Grape and Wine Research* 25(1), 134-141; 2019. Copyright 2019 Australian Society of Viticulture and Oenology.

Climate and soils

240.27

Danenberg, E. How is climate change affecting Australian vineyards and what are growers doing to respond? *Australian & New Zealand Grapegrower & Winemaker* 661, 18-21; 2019.

The author talked to vigneronns from warm and cool climate areas to find out how climate change is affecting their vines and how they're adapting to the changing conditions.

© Reprinted with permission Danenberg, E. How is climate change affecting Australian vineyards and what are growers doing to respond? *Australian & New Zealand Grapegrower & Winemaker* 661, 18-21; 2019. Copyright 2019 Winetitles Media Pty Ltd.

240.28

Davis, R.E., Dimon, R.A., Jones, G.V., Bois, B. The effect of climate on Burgundy vintage quality rankings. *OENO one* 53(1), 59-73; 2019.

Aim: Based on consensus rankings from prominent rating authorities, we examined the importance of a suite of climatic variables, organized by winegrape phenological stage, in distinguishing between high- and low-ranked vintages in Burgundy. **Methods and Results:** Vintage ratings of Burgundy wines acquired from 12 sources were evaluated to develop consensus rankings for red and white wines from 1961-2015. Climate variables (air temperature, precipitation, degree-day accumulations, etc.) were organized by mean phenological stage and compared between good and poor vintages using Mann-Whitney U tests and multivariate stepwise discriminant function analysis. High temperatures, particularly during the growing season, were found to be the most consistently important climatic factor in distinguishing good-quality vintages from poor-quality vintages. The best red vintages had a greater diurnal temperature range during the growing season, whereas the top white vintages were not distinguished by unusually warm conditions, but the bottom-ranked white vintages were particularly cool and wet. The impact of rainfall varied across the growing season, with top-ranked Burgundy wines benefitting from rainfall during the bud break period and dry conditions during the ripening phase. **Conclusions:** The most important climatic factor in distinguishing between top- and bottom-ranked vintages is growing season temperature, especially high diurnal temperature range (for reds) and high average maximum temperatures (for whites). Good Burgundy vintages are more likely when there is ample rainfall during the bud break period in April and dry conditions during the *véraison* and ripening phases. **Significance and Impact of the Study:** As viticulturalists adapt to regional climate trends, a better understanding of how specific climate variables affect wine quality becomes increasingly important in viticulture management.

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240.29

Jarvis, C., Darbyshire, R., Eckard, R., Goodwin, I., Barlow, S. Climate drivers El Niño–Southern oscillation and Indian ocean dipole and what they mean for winegrape maturity. *Australian & New Zealand Grapegrower & Winemaker* 661, 26-27; 2019.

Climate drivers like the El Niño–Southern Oscillation and the Indian Ocean Dipole have a significant effect on temperatures across many of Australia's wine regions. But do they also affect maturity timing and, if so, how? Researchers from the New South Wales Department of Primary Industries, Agriculture Victoria and the University of Melbourne reveal the results of their efforts to answer this question.

© Reprinted with permission Jarvis, C., Darbyshire, R., Eckard, R., Goodwin, I., Barlow, S. Climate drivers El Niño–Southern oscillation and Indian ocean dipole and what they mean for winegrape maturity. *Australian & New Zealand Grapegrower & Winemaker* 661, 26-27; 2019. Copyright 2019 Winetitles Media Pty Ltd.

240.30

Jarvis, C., Darbyshire, R., Goodwin, I., Barlow, E.W.R., Eckard, R. Advancement of winegrape maturity continuing for winegrowing regions in Australia with variable evidence of compression of the harvest period. *Australian Journal of Grape and Wine Research* 25(1), 101-108; 2019.

Background and Aims: Grapevine phenology is closely linked with growing season temperature. Rising temperature related to anthropogenic climate change has the potential to advance winegrape ripening. This study updated and validated previous research that considered changes to the timing of winegrape maturity and to the warming temperature of the growing season as well as added several new vineyard data sets. Length of the harvest period was assessed to determine if time between harvests of different cultivars has shortened. **Methods and Results:** Vineyard records from 31 vineyard blocks in 13 Australian wine regions, in conjunction with gridded temperature data, were used to assess changes to maturity timing and mean growing season temperature. Trends towards earlier maturity were evident as were increases to mean growing season temperature for all vineyard blocks and regions considered. Trends varied in magnitude as well as by cultivar and region. Compression of the harvest period occurred for half of the regions studied. **Conclusions:** Winegrape maturity in Australia has continued to advance in line with warming temperature, which has implications for grape composition and wine quality. Compression of the harvest period was found in some cases, though varied by region and cultivars grown. **Significance of the Study:** This study validated the trend towards earlier winegrape maturity with continued warming temperature and extended a valuable phenological data set. In light of record warming, earlier maturity is becoming the new norm. The method used to investigate compression of the harvest period in this study is applicable to other winegrowing regions worldwide.

Abstract available online at <http://doi.org/c2pn>

© Reprinted with permission Jarvis, C., Darbyshire, R., Goodwin, I., Barlow, E.W.R., Eckard, R. Advancement of winegrape maturity continuing for winegrowing regions in Australia with variable evidence of compression of the harvest period. *Australian Journal of Grape and Wine Research* 25(1), 101-108; 2019. Copyright 2019 Australian Society of Viticulture and Oenology.

240.31

Jobin-Poirier, E., Pickering, G., Plummer, R. Doom, gloom, or boom? Perceptions of climate change among Canadian winegrowers. *International Journal of Wine Research* 11, 1-11; 2019.

Background: Climate change (CC) could have both positive and negative consequences for the Canadian and global wine industries. Understanding how winegrowers perceive CC, however, can provide insight into how to better assist the industry to cope with the impacts of a changing climate. **Material and Methods:** An online survey of 122 Canadian winegrowers was conducted to understand knowledge, beliefs, environmental values, and perceptions towards CC and its impact on the Canadian wine industry. Environmental values (New Environmental Paradigm score), subjective and objective CC knowledge, CC skepticism and uncertainty, belief in anthropogenic CC, and perceptions of the impacts of CC were measured using established tools. **Results:** Overall, results show that Canadian winegrowers have a relatively low level of CC skepticism, a medium level of CC scientific knowledge, a pro-ecological (as opposed to anthropological) worldview,

and generally believe that CC is caused by a mix of anthropogenic and natural forces. Moreover, a majority of respondents (60%) believe that CC has both positive and negative consequences on their vineyard and winery operations, while 8% think that climate change has no consequence on their operations. An extended growing season for grapes, the improvement of grape and wine quality, and the possibility to grow varieties that are not currently viable were the main beneficial consequences of CC reported by participants, while an increase in both disease and pests in the vineyard were the most commonly identified disadvantages. Finally, no association was observed between CC skepticism, knowledge, environmental values, and the perception of CC consequences. **Conclusion:** Our findings inform communication strategies for the wine industry around CC, and provide important baseline information on winegrowers' perceptions that inform wider efforts to improve the capacity of the industry to develop and adapt to the consequences of CC.

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240.32

Logan, S. How does Shiraz feel the heat? Australian & New Zealand Grapegrower & Winemaker 661, 35; 2019.

The impact of heatwaves on the physiology and composition of Shiraz grapes is the focus of a nearly completed investigation being carried out by a researcher from the National Wine and Grape Industry Centre (NWGIC).

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240.33

Mick, H. Vines and grapes put to the test with elevated temperature and CO₂ exposure. Australian & New Zealand Grapegrower & Winemaker 661, 22-23; 2019.

Advancing harvest dates have affected winegrape production in many regions of Australia, leading to a greater focus on the potential impact of a changing climate on industry. With continued rises in atmospheric temperature predicted for the decades ahead, research to date has focussed mainly on how warmer conditions might modify vine growth and fruit production and quality. But a comprehensive new study undertaken in Victoria's North-West has gone a step further by adding to the mix the tandem effect of elevated carbon dioxide (CO₂). Hans Mick reports on the trial and its findings.

© Reprinted with permission Mick, H. Vines and grapes put to the test with elevated temperature and CO₂ exposure. Australian & New Zealand Grapegrower & Winemaker 661, 22-23; 2019. Copyright 2019 Winetitles Media Pty Ltd.

240.34

Shabram, P.L. The limitations of the Winkler Index. *Wines & Vines* 99(12), 108-111; 2019.

The Winkler Index or Winkler Scale is a standard for describing regional climates for viticulture in the United States. Developed by A.J. Winkler and M.A. Amerine at the University of California, Davis in the first half of the 20th century, the index was constructed to correlate wine quality with climate, focusing on California viticulture. Wine-producing regions of California were broken into five climatic regions using heat summations above 50° F, or growing degree days (GDD). Heat summations are a way of looking at accumulated temperatures over a given time period. Despite the common usage of the Winkler Index, the classifications offer greater uncertainty than the system suggests.

© Reprinted with permission Shabram, P.L. The limitations of the Winkler Index. *Wines & Vines* 99(12), 108-111; 2019. Copyright 2019 Wine Communications Group, Inc.

Vineyard management systems

240.35

Buesa, I., Caccavello, G., Basile, B., Merli, M.C., Poni, S., Chirivella, C., Intrigliolo, D.S. Delaying berry ripening of Bobal and Tempranillo grapevines by late leaf removal in a semi-arid and temperate-warm climate under different water regimes. *Australian Journal of Grape and Wine Research* 25(1), 70-82; 2019.

Background and Aims: Climate change is advancing grape ripening and decoupling sugar and phenolic maturity, impacting wine typicity. The aim of this study was to test whether late leaf removal (LLR) under different watering regimes delayed harvest of two Spanish red cultivars in a semi-arid and temperate-warm climate. **Methods and Results:** In two trials carried out in Eastern Spain with the Bobal and Tempranillo cultivars, vines were partially defoliated above the bunch zone shortly before veraison under rainfed and deficit irrigation conditions during two seasons. The rate of grape ripening in both cultivars was significantly affected by LLR under either watering regime, consequently delaying harvest. Vine water status and leaf photosynthetic rate were improved by LLR. The reduction in leaf area-to-fruit ratio resulting from the LLR treatments was found to be more limiting for the accumulation of anthocyanin than for TSS. Consequently, LLR negatively affected wine colour intensity. In addition, yield was constrained by LLR in Tempranillo due to a reduction in bunch and berry mass. **Conclusions:** The reduction in the rate of accumulation of grape TSS provoked by LLR did not necessarily result in a more balanced berry maturity. The effectiveness of the LLR technique appears to depend on its final impact on leaf area-to-fruit ratio and vine water status, the cultivar photosynthetic compensation capacity and the environmental conditions. **Significance of the Study:** Late leaf removal might not

be effective for coupling anthocyanin and TSS in berries under moderate water stress conditions, given the observed reductions in red wine colour.

Abstract available online at <http://doi.org/c2pp>

© Reprinted with permission Buesa, I., Caccavello, G., Basile, B., Merli, M.C., Poni, S., Chirivella, C., Intrigliolo, D.S. Delaying berry ripening of Bobal and Tempranillo grapevines by late leaf removal in a semi-arid and temperate-warm climate under different water regimes. *Australian Journal of Grape and Wine Research* 25(1), 70-82; 2019. Copyright 2019 Australian Society of Viticulture and Oenology.

240.36

Gambetta, J., Holzapfel, B., Schmidtke, L. What is the best time to remove leaves to minimise sunburn? *Australian & New Zealand Grapegrower & Winemaker* 661, 28-30; 2019.

The authors are from the National Wine and Grape Industry Centre and are evaluating three different timings of defoliation in Chardonnay vines grown around Orange in New South Wales.

© Reprinted with permission Gambetta, J., Holzapfel, B., Schmidtke, L. What is the best time to remove leaves to minimise sunburn? *Australian & New Zealand Grapegrower & Winemaker* 661, 28-30; 2019. Copyright 2019 Winetitles Media Pty Ltd.

240.37

Martínez de Toda, F., García, J., Balda, P. Preliminary results on forcing vine regrowth to delay ripening to a cooler period. *Vitis* 58(1), 17-22; 2019.

The most important climate-change-related effect on wine grapes is the advance in the harvest period. The increase of temperature during the whole growing season, and consequently, the warmer conditions over ripening, lead to the production of unbalanced wines with high alcohol levels, low acidities, a modified varietal aroma and a lack of color. One of the strategies to mitigate these unpleasant effects consists on delaying the berry ripening to cooler conditions. With the aim of delaying the grape ripeness more than two months, the study of a technique consisting on forcing vine regrowth has been studied. This technique consists on cutting the green shoots off, between the second and the third node of each shoot and at different phenological stages (from state G to state K, according to the Baillod and Baggioioli system, 1993); leaves and lateral shoots of the first and second nodes are removed as well. Depending on the phenological stage of vines during the forcing treatment, the fruit ripening was shifted from one month to more than two months, i.e. this practice was effective to shift harvest time from the warm August to the cooler October and November. Forced vines produced smaller berries with lower pH and higher acidity and anthocyanins concentration, compared to non-forced vines. This treatment is an effective technique to restore the anthocyanin-to-sugar ratio decoupled by climate warming.

Full text available online at <http://doi.org/c3zj>

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240.38

Silvestroni, O., Lanari, V., Lattanzi, T., Palliotti, A., Vanderweide, J., Sabbatini, P. Canopy management strategies to control yield and grape composition of Montepulciano grapevines. *Australian Journal of Grape and Wine Research* 25(1), 30-42; 2019.

Background and Aims: Higher temperature during the season is forcing growers in Central Italy to explore ways to reliably control vine yield and grape ripening, while maintaining grape composition. The most common approaches include altering winter pruning, shoot thinning (St), leaf removal and bunch thinning. These studies, however, rarely evaluated these practices in concert and over multiple seasons. **Methods and Results:** From 2009 to 2013, five treatments were applied to *Vitis vinifera* L. cv. Montepulciano: winter pruning only (Wp, Control); Wp plus St; St plus pre-flowering defoliation (St + Dpa); St plus pre-veraison defoliation (St + Dpv); and St + Dpv plus bunch thinning (St + Dpv + Bt) applied prior to veraison. Effects on canopy architecture, yield, ripening and berry composition were measured. Compared to Wp, St, St + Dpv and St + Dpv + Bt treatments reduced leaf area and leaf layer number in the fruiting zone, while St + Dpv + Bt reduced yield. No treatment slowed ripening. The treatment St + Dpa reduced yield and the incidence of *Botrytis cinerea*, and improved fruit composition, but increased TSS in berries. All treatments were ceased after 2013 and the vines were pruned in winter only. The treatment St + Dpa imposed in 2013 had a strong carry-over effect on yield but not TSS in 2014. **Conclusions:** Shoot thinning alone reduced canopy density but failed to reduce yield or improve fruit composition. Both the St + Dpv and St + Dpv + Ct treatments provided a more open fruit zone, had no effect on yield and increased TSS in fruit at harvest. Shoot thinning plus pre-flowering defoliation decreased yield and improved berry composition in a Mediterranean climate; however, given its observed carry-over effects on yield this approach should be applied only in alternate years, suggesting the need for further research exploring additional viticultural practices. **Significance of the Study:** Despite some benefits of St, defoliation and bunch thinning on their own or even in concert, no combination tested was consistently effective for controlling vine yield and grape ripening, while maintaining grape composition.

Abstract available online at <http://doi.org/gfgpr7>

© Reprinted with permission Silvestroni, O., Lanari, V., Lattanzi, T., Palliotti, A., Vanderweide, J., Sabbatini, P. Canopy management strategies to control yield and grape composition of Montepulciano grapevines. *Australian Journal of Grape and Wine Research* 25(1), 30-42; 2019. Copyright 2019 Australian Society of Viticulture and Oenology.

240.39

Smith, M. Yield AI taking the guesswork out of growing. *Australian & New Zealand Grapegrower & Winemaker* 661, 31-34; 2019.

Harnessing the combined effect of big data and artificial intelligence is allowing viticulturists to better manage crop production while also helping to produce more sustainable outcomes. Mark Smith looks at how one state-of-the-art management system has been developed and how it's being utilised in the vineyard.

© Reprinted with permission Smith, M. Yield AI taking the guesswork out of growing. *Australian & New Zealand Grapegrower & Winemaker* 661, 31-34; 2019. Copyright 2019 Winetitles Media Pty Ltd.

240.40

Stef, C. Cordon trellising: the benefits of gentle pruning. *La Vigne* 314, 32-33; 2018.

[French] Abstract not available for reproduction

240.41

Tian, T., Gu, S. Improving fruit anthocyanins in 'Cabernet Sauvignon' by shifting fruit ripening and irrigation reduction post veraison in warmer region. *Vitis* 58(1), 23-31; 2019.

In warmer regions, forcing vines to regrow and shifting fruit ripening to the cooler portion of the growing season can increase the concentration of total fruit anthocyanins (TFA) in red winegrapes, but the effect on anthocyanin composition remains unclear. Additionally, irrigation reduction post veraison was reported to improve fruit anthocyanins in cool and temperate regions with low precipitation, whereas this response has not been previously examined in forced vines grown in dry and warm regions. Experiments were conducted with 'Cabernet Sauvignon' (*Vitis vinifera* L.) over two consecutive years in Fresno, California, to investigate the effect of shifting fruit ripening on the concentration and composition of fruit anthocyanins as well as the influence of post-veraison irrigation reduction on fruit anthocyanins of forced vines. Vines under conventional practices (non-forced) were used as the control. Forcing treatment included removing primary leaves, clusters, and laterals, as well as hedging primary shoots, in mid-June. Control vines were irrigated at 80 % crop evapotranspiration (ET_C) post veraison, whereas forced vines were irrigated at 40, 60, 80, or 100 % ET_C post veraison. Results suggest that forcing vines to regrow and shifting fruit ripening led to a significant increase of TFA, primarily non-acylated anthocyanins, during fruit ripening and at harvest over two years. Forcing treatment also altered composition of fruit anthocyanins at harvest, with increased proportions of TFA comprised by the glucosides of delphinidin and petunidin but the decreased proportion of the glucosides of malvidin. This study demonstrates that forcing vines to regrow and shifting fruit ripening in the warmer region can lead to a more balanced profile of fruit anthocyanins, with improved non-acylated derivatives and altered relative abundance of the glucosides of five anthocyanidins. Reducing irrigation post veraison, however, had only a minor effect on fruit anthocyanins in forced vines.

Full text available online at <http://doi.org/c3zk>

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240.42

Wine Australia Stay cool over summer. *R&D at Work* February, 1; 2019.

Abstract not available for reproduction

Full text available online at <https://www.wineaustralia.com/news/articles/stay-cool-over-summer>

Pests and diseases

240.43

Peschiutta, M.L., Brito, V.D., Ordano, M.A., Zygodlo, J.A. Efficacy of selected volatile compounds for organic vine mealybug control. *Vitis* 58(1), 1-6; 2019.

Planococcus ficus (Signoret) (Hemiptera: Pseudo-coccidae) constitutes a high impact pest in vineyards. Synthetic insecticides are inefficient to control the mealybug population and they affect human health and the environment. The insecticidal properties of eight volatile compounds against vine mealybugs and their grapevine leaf phytotoxicity in laboratory conditions were evaluated. 2-decanone, 3-decanone, α -methyl cinnamaldehyde and cinnamaldehyde produced a higher percentage of mealybug mortality in relation to control at a fumigant dose of 300 $\mu\text{L}\cdot\text{L}^{-1}$ air. The 3-octanone, cinnamyl chloride, 1-octen-3-ol and 3-octanol were not effective against *P. ficus*. Cinnamaldehyde and α -methyl cinnamaldehyde produced a low acetylcholinesterase inhibition (IC_{50} = 2.67 $\mu\text{L}\cdot\text{L}^{-1}$ and 9.10 $\mu\text{L}\cdot\text{L}^{-1}$, respectively), whereas 2-decanone and 3-decanone did not cause enzyme inhibition. Cinnamaldehyde was not phytotoxic for grapevine leaves; therefore, this compound was selected for a contact application to improve its effectiveness, resulting in a LC_{50} of 394.36 $\mu\text{L}\cdot\text{L}^{-1}$ solution. The results demonstrated the potential of cinnamaldehyde to be developed as a non-phytotoxic natural insecticide for the control of vine mealybugs in vineyards.

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Vine improvement and varieties

240.44

De la Fuente Lloreda, M. Use of hybrids in viticulture. A challenge for the OIV. *OENO one* 52(3), 231-234; 2018.

Sustainable viticulture is one of the main challenges for our sector, and one possible solution is the use of resistant hybrids. The OIV, as an intergovernmental organisation, works in this area with a goal of harmonising definitions for all grapevine materials, including hybrids. It should be noted that hybrids are commonly used in non-European countries, and not only for research purposes. Some project resolutions have been discussed in the past and some of them are being developed by the OIV. However, before going deeper into the harmonisation processes, some genetic aspects should be defined in order to establish an international scientific consensus. Once this is accomplished, the OIV could then discuss the pressing issue of labelling or regulations on the denomination of varieties and also of the wines produced for the entire vitivinicultural sector. Full text available online at <http://doi.org/cv8q>

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240.45

Faulkner, J. The Italian connection. *Halliday*. April/May, 38–45; 2019.

Italian white varieties might just be the ideal wines for Australia's climate, lifestyle and tastes, as well as our desire for something a little different.

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240.46

Garner, M. Northern star. *Decanter Italy*, 24–30; 2019.

Pinot Bianco seems an unlikely variety to be a local hero, but the results prove its superstar status in northeastern Italy, as Michael Garner explains.

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240.47

Gellie, T. Vying for Verdejo. *Decanter* 44(6), 66–70; 2019.

Rueda's signature white wine grape is already proving itself in terms of both quality and versatility, but there are stylistic questions to be resolved. The author charts the way forward for the region and recommends a dozen of its best wines.

© Reprinted with permission Gellie, T. Vying for Verdejo. *Decanter* 44(6), 66–70; 2019. Copyright 2019 TI Media Limited.

240.48

Gilby, C. Balkan intrigue. *Decanter* 44(5), 62–67; 2019.

There's no getting away from it, this area is rather complex: regions, dialects, grape names, politics... Focusing on the reds, the author gives an expert introduction to the six main wine nations to the East of the Adriatic, highlighting the top producers and recommending a dozen of the best wines in the region.

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240.49

Gutiérrez-Gamboa, G., Moreno-Simunovic, Y. Terroir and typicity of Carignan from Maule Valley (Chile): the resurgence of a minority variety. *OENO* one 53(1), 75–93; 2019.

Carignan is one of those minor cultivars that have had a major resurgence in the Chilean wine industry, and its production is sold at a price well above the national average. This variety, together with other autochthonous grapevine varieties, makes up a unique heritage in Chilean winemaking, which has given a new identity to the country on the world wine scene. Chilean viticulture is based on the production of the most recognized grapevine varieties such as Cabernet Sauvignon, Merlot, Chardonnay and Sauvignon Blanc. However, this has caused a massive loss of minority and autochthonous grapevine varieties in certain wine growing regions. Thus, this review summarizes the effects of terroir of the Maule Valley on the typicity of Carignan. Carignan grapevines growing in the sites closer to the Pacific Ocean, such as Truquilemu and Ciénaga de Name, present a high concentration of several amino acids and volatile compounds in grapes and wines, while Carignan grapevines growing in the sites further East, towards the Andes Mountains, provide grapes and wines with a high alcohol and phenolic concentration. Therefore, Maule Valley provides unique edaphoclimatic conditions that allow differences in the composition and style of the Carignan wines.

Full text available online at <http://doi.org/c4gd>

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240.50

Honan, D. The winemaker's wine. *Halliday*. April/May, 52–54; 2019.

Northern Italy's Nebbiolo grape is one of the world's most captivating. To help explain its overwhelming appeal, we talk to some of the people making it here.

© Reprinted with permission Honan, D. The winemaker's wine. *Halliday*. April/May, 52–54; 2019. Copyright 2019 Hardie Grant Publishing.

240.51

Hulme, S. Taming the beast. *Decanter Italy*, 78–82; 2019.

Producers in the small Montefalco Sagrantino DOCG in Umbria have developed an approachable modern style for their notoriously tannic native Sagrantino grape. The author charts their progress and recommends eight wines to try.

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240.52

Martinson, T., Cadle-Davidson, L. The phenotyping bottleneck: how grape breeders link desired traits to DNA markers. *Wines & Vines* 99(12), 142–145; 2019.

Before inexpensive DNA sequencing was available, grape breeders had to rely solely on traits observed in the field (phenotypes) to decide which new seedlings produced through crosses to keep and which to discard. For disease resistance, this meant tossing out any plants that showed powdery mildew or downy mildew infections at the seedling stage during the first year of growth. Although they kept those that didn't show any symptoms, this method of field phenotyping didn't help them much in determining which and how many genes were involved and whether or not the trait would survive a subsequent round of breeding intact. DNA markers and more extensive use of mapping populations have changed all that.

© Reprinted with permission Martinson, T., Cadle-Davidson, L. The phenotyping bottleneck: how grape breeders link desired traits to DNA markers. *Wines & Vines* 99(12), 142–145; 2019. Copyright 2019 Wine Communications Group, Inc.

240.53

McCoy, E. The *Decanter* interview: Carole Meredith. *Decanter* 44(5), 40–43; 2019.

Plant geneticist Dr Carole Meredith helped to change the way that winemakers think about the history of grapes – and now she is growing her own in Napa Valley. Elin McCoy meets her.

© Reprinted with permission McCoy, E. The *Decanter* interview: Carole Meredith. *Decanter* 44(5), 40–43; 2019. Copyright 2019 TI Media Limited.

240.54

Philipp, C., Eder, P., Scheiblhofer, H., Eder, R. Technological influences on pear aroma of Austrian Pinot Blanc wines. *Mitteilungen Klosterneuburg Rebe und Wein* 68(4), 258–276; 2018.

[German] Abstract not available for reproduction

240.55

Regner, F., Reichl, M., Zöch, B., Eisenheld, C., Hofstetter, I., Christina, W., Rockenbauer, A. Evaluation of different rootstocks on a heavy mar soil in combination with the grape variety 'Grüner Veltliner'. *Mitteilungen Klosterneuburg Rebe und Wein* 68(4), 277–292; 2018.

[German] Abstract not available for reproduction

240.56

Rodríguez-Lorenzo, M., Cibrián, J.F., Sagüés, A., Abad, F.J., Martínez-Zapater, J.M., Ibáñez, J. Intra-varietal diversity for agronomic traits in 'Garnacha Blanca'. *Vitis* 58(1), 33–35; 2019.

'Garnacha Blanca' is a somatic variant derived from 'Garnacha Tinta', an old variety with large genetic and phenotypic variability. In this work we have studied for two years the phenotypic variation existing in 'Garnacha Blanca' for yield and quality related traits in accessions from 14 sampling locations of ancient vineyards in the Ebro Valley, Spain. The results showed high variability among the accessions in many of the traits studied in 'Garnacha Blanca'. Different accessions could be distinguished both years using several traits, including two important traits in terms of quality and yield: bunch compactness and yield per plant. A large environment effect, intrinsic to the 'Garnacha' group, enhances phenotypic variation among years, what requires increasing the number of bunches and years for clonal characterization in this variety. The dimensions of the berry showed the least variability, while traits related to bunch architecture like bunch length were discriminant and also stable.

Full text available online at <http://doi.org/c3zm>

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240.57

Sarrazin, C. Clonal selection and visual selection: the two go hand-in-hand. *La Vigne* 314, 30–31; 2018.

[French] Abstract not available for reproduction

240.58

Traucki, D. The Fiano fellowship. *WBM: Australia's Wine Business Magazine* January/February, 50–51; 2019.

When Dan Traucki first wrote about Fiano in WBM five years ago, there were only 32 wineries producing it. Now there are 100 and the future looks bright.

© Reprinted with permission Traucki, D. The Fiano fellowship. *WBM: Australia's Wine Business Magazine* January/February, 50–51; 2019. Copyright 2019 Madigan Media.

240.59

VCR : Vivai Cooperativi Rauscedo The disease-resistant varieties. *Cahiers Techniques VCR* (3rd Edition) 3rd Edition, 8–9; 2018.

This booklet presents information on 10 disease-resistant grape varieties developed in Italy through a collaboration between Vivai Cooperativi Rauscedo, the University of Udine and the Institute of Applied Genomics. These varieties have recently been assessed for their grapegrowing and winemaking performance.

Full text available online at <https://bit.ly/2RjvddW>

240.60

Scholasch, T. Irrigation strategies: maintain natural grapevine mechanisms through a drought. *Wine Business Monthly* 25(12), 66–73; 2018.

We discuss how irrigation frequency affects root architecture, vine water use regulation and ultimately fruit ripening dynamics. We report results from continuous vine water use measurements by using sap flow and obtained over various vineyards and multiple years to illustrate how irrigation frequency can impact water deficit profile between two watering events and during the season. Our data suggests that under more frequent irrigations, vine water use tends to drop more substantially once the effect of water applied disappears. However, under the same growing conditions, applying larger volumes less frequently leads to a more moderate vine water deficit profile over the season. In turn, applying longer intervals between irrigations can have positive effects on berry volume and berry sugar accumulation rate. We discuss some practical consequences related to irrigation volume and frequency and the need to systematically relate irrigation strategies to their effects on plant water use and fruit indices.

Full text available online at <https://bit.ly/2WSbgk1>

© Reprinted with permission Scholasch, T. Irrigation strategies: maintain natural grapevine mechanisms through a drought. *Wine Business Monthly* 25(12), 66–73; 2018. Copyright 2018 Wine Communications Group, Inc.

240.61

Theodorou, N., Nikolaou, N., Zioziou, E., Kyraleou, M., Kallithraka, S., Kotseridis, Y., Koundouras, S. Anthocyanin content and composition in four red winegrape cultivars (*Vitis vinifera* L.) under variable irrigation. *OENO one* 53(1), 39–51; 2019.

Aim: The aim of this study was to determine and compare anthocyanin content and profile under variable irrigation regimes in four red grape cultivars (*Vitis vinifera* L.), the Greek indigenous cvs. Agiorgitiko and Xinomavro, alongside Syrah and Grenache noir. **Methods and Results:** Three irrigation treatments were applied in a 6-year-old vineyard comprising all four varieties in a block design, starting at bunch closure (E-L 32) through harvest of 2012 and 2013: full irrigation (FI) at 100% of crop evapotranspiration (ET_c), deficit irrigation (DI) at 50% of ET_c and non-irrigated (NI). The identification of the compounds was performed by HPLC. Results showed that, under the hot summer conditions of the Greek climate, the four cultivars had a similar response regarding vigor and yield parameters, with values increasing with water supply. Anthocyanin concentration was maximized under non-irrigated conditions in all cultivars, but anthocyanin profile and relative distribution of individual anthocyanins among irrigation treatments showed a strong cultivar effect. **Conclusion:** Xinomavro seemed to favor the synthesis of more stable forms of anthocyanins under limited water supply (acylated over non-acylated and tri-oxygenated & methoxylated on the B-ring over di-oxygenated & hydroxylated) while Agiorgitiko had an opposite behavior, which might

imply a need for a different irrigation strategy. **Significance and impact of the study:** To the best of our knowledge, this is the first comparative report of anthocyanin composition and profile in berry skin, under contrasting water status, for the two most important red winegrapes of Greece.

Full text available online at <http://doi.org/c4gg>

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240.62

Vilanova, M., Rodríguez-Nogales, J.M., Vila-Crespo, J., Yuste, J. Influence of water regime on yield components, must composition and wine volatile compounds of *Vitis vinifera* cv. Verdejo. Australian Journal of Grape and Wine Research 25(1), 83–91; 2019.

Background and Aims: Available soil water is an important factor determining grapevine yield and grape composition. The aim of this study was to determine the impact of water availability on the yield components and the composition of must and wine of *Vitis vinifera* L. cv. Verdejo. **Methods and Results:** The irrigation strategies [rainfed (R0), drip irrigated at 25% ETo (R25) and 50% ETo (R50) applied weekly from the end of the vegetative main shoot growth until harvest] were imposed on white Verdejo grapevines over three consecutive seasons (2012–2014). The 50% ETo treatment resulted in the highest yield. Increasing water availability also reduced the concentration of volatile phenols in all seasons, and of the C₆ compounds in 2014 alone. The highest concentration of five individual volatile compounds was associated with the lowest water availability (R0). **Conclusions:** High water availability increased yield and its components, mainly in the wettest season. Volatile compounds in wine were modified by water regime, with their concentration increased by the most severe deficit irrigation regime (R0). The effect of the year on must and wine composition was greater than the in-season effects of water availability treatment. **Significance of the Study:** This study has described the effect of soil water availability on yield and its components and the composition of must and wine of Verdejo.

Abstract available online at <http://doi.org/gfpfpt>

© Reprinted with permission Vilanova, M., Rodríguez-Nogales, J.M., Vila-Crespo, J., Yuste, J. Influence of water regime on yield components, must composition and wine volatile compounds of *Vitis vinifera* cv. Verdejo. Australian Journal of Grape and Wine Research 25(1), 83–91; 2019. Copyright 2019 Australian Society of Viticulture and Oenology.

Wheeler, S.A., Marning, A. Turning water into wine: exploring water security perceptions and adaptation behaviour amongst conventional, organic and biodynamic grape growers. *Land Use Policy* 82, 528–537; 2019.

Australian irrigators regularly experience drought conditions, placing water security as a critical issue facing agriculture, especially for permanent plantings such as grapes. This study explores irrigators' water security perceptions and their water management adaptation behaviour using in-depth interviews and surveys with 37 conventional, organic and biodynamic grape growers in South Australia. Conventional growers' water adaptation behaviour was primarily reliant on activities external to the vineyard (e.g. upgrading irrigation infrastructure); whereas alternative (i.e. certified organic/biodynamic) growers' water security actions were based largely on internal vineyard activities (e.g. agro-ecological methods). Conventional growers often named governance and district physical capital as influencing their adaptive capacity to water scarcity, while alternative growers focussed more on the role of human, social, and farm soil and land capital in influencing their farm adaptive capacity. Two-thirds of surveyed alternative growers converted away from conventional production at the end of the Millennium Drought, naming water security issues as their main reason. Overall alternative growers perceived higher water security and less water vulnerability due to higher soil water retention. Findings suggest a need for current Murray-Darling Basin water policy to seriously reconsider the approach of primarily investing money in irrigation infrastructure to save water and to focus more on agro-ecological methods.

Abstract available online at <http://doi.org/c4f9>

© Reprinted with permission Wheeler, S.A., Marning, A. Turning water into wine: exploring water security perceptions and adaptation behaviour amongst conventional, organic and biodynamic grape growers. *Land Use Policy* 82, 528–537; 2019. Copyright 2019 Elsevier Ltd.

AWRI publications

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van der Hulst, L., Munguia, P., Culbert, J.A., Ford, C.M., Burton, R.A., Wilkinson, K.L. Accumulation of volatile phenol glycoconjugates in grapes following grapevine exposure to smoke and potential mitigation of smoke taint by foliar application of kaolin. *Planta* 249(3), 941–952; 2019.

Main Conclusion: The accumulation of volatile phenol glycoconjugates in smoke-exposed grapes was monitored following grapevine exposure to smoke, with different glycoconjugate profiles observed for fruit sampled 1 and 7 days after smoke exposure, and at maturity. Foliar application of kaolin reduced the concentration of volatile phenol glycoconjugates in smoke-exposed fruit, but efficacy depended on the rate of application and extent of coverage. Smoke taint can be found in wines made from grapes exposed to smoke from bushfires or prescribed burns. It is characterized by objectionable smoky and ashy aromas and flavors, which have been attributed to the presence of smoke-derived volatile phenols, in free and glycoconjugate forms. This study investigated: (1) the accumulation of volatile phenol glycoconjugates in grapes following the application of smoke to Sauvignon Blanc, Chardonnay and Merlot grapevines at approximately 10 days post-veraison; and (2) the potential mitigation of smoke taint as a consequence of foliar applications of kaolin (a clay-based protective film) prior to grapevine smoke exposure. Varietal differences were observed in the glycoconjugate profiles of smoke-exposed grapes; the highest glycoconjugate levels were found in Merlot grapes, being pentose-glucosides of guaiacol, cresols, and phenol, and gentiobiosides of guaiacol and syringol. Changes in volatile phenol glycoconjugate profiles were also observed with time, i.e., between fruit sampled 1 day after smoke exposure and at maturity. The application of kaolin did not significantly affect the glycoconjugate profiles of Sauvignon Blanc and Chardonnay grapes, but significantly lower volatile phenol glycoconjugate levels were observed in Merlot fruit that was treated with kaolin prior to smoke exposure. The potential for control and smoke-exposed grapes to be differentiated by measurement of spectral reflectance was also demonstrated.

Abstract available online at <http://doi.org/c3qr>

© Reprinted with permission van der Hulst, L., Munguia, P., Culbert, J.A., Ford, C.M., Burton, R.A., Wilkinson, K.L. Accumulation of volatile phenol glycoconjugates in grapes following grapevine exposure to smoke and potential mitigation of smoke taint by foliar application of kaolin. *Planta* 249(3), 941–952; 2019. Copyright 2019 Springer Nature.

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Day, M.P., Schmidt, S.A., Pearson, W., Kolouchova, R., Smith, P.A. Effect of passive oxygen exposure during pressing and handling on the chemical and sensory attributes of Chardonnay wine. *Australian Journal of Grape and Wine Research* 25(2), 1–16; 2019.

Background and Aims: The significance of oxygen in winemaking has been well established, but knowledge gaps exist regarding the extent and impact passive oxygenation has on chemical and sensory properties during the initial stages. **Methods and Results:** Using in-press oxygen monitors, controlling oxygen exposure during the earliest stages of grape processing was shown

to be highly effective. This work demonstrated that pressing management has far more impact on wine composition than handling management; the earliest and highest exposure to oxygen has the most profound impact on the composition of the resulting wine compared to the lower levels of repeated exposure typical of normal handling procedures. Furthermore, control of oxygen exposure during post-pressing operations offers the possibility of modulating specific classes of compounds, described in sensory analysis as floral and confection. **Conclusions:** Significant modulation of aromatic, phenolic and protein profiles of wine occurred through controlling oxygen exposure during the earliest stages of grape processing. **Significance of the Study:** This work shows the possible stylistic potential and limitations of oxygen control, albeit with investment in press technology. The understanding of the relative influence of processing variables assessed in this work can be immediately applied by winemakers.

Abstract available online at <http://doi.org/c4gm>

© Reprinted with permission Day, M.P., Schmidt, S.A., Pearson, W., Kolouchova, R., Smith, P.A. Effect of passive oxygen exposure during pressing and handling on the chemical and sensory attributes of Chardonnay wine. *Australian Journal of Grape and Wine Research* 25(2), 1–16; 2019. Copyright 2019 Australian Society of Viticulture and Oenology.

2073

Parker, M., Barker, A., Black, C.A., Hixson, J., Williamson, P., Francis, I.L. Don't miss the marc: phenolic-free glycosides from white grape marc increase flavour of wine. *Australian Journal of Grape and Wine Research* 25(2), 1–12; 2019.

Background and Aims: Grape glycosides are an important source of wine flavour, especially for 'floral' cultivars. This study tested whether phenol-free glycosides from marc could be a latent source of flavour in white wine without affecting bitterness. **Methods and Results:** Glycosides were extracted from Gewürztraminer marc with water followed by a polymeric resin adsorption and purification step, which removed phenolic substances. The glycosides were added at single and double the concentration of that in the grapes to Riesling and Chardonnay juices prior to fermentation, and to wines at bottling. The addition of phenolic-free glycosides significantly increased the concentration of monoterpenes and monoterpene glycosides, resulting in an increase in fruity and floral aroma, flavour and aftertaste attributes, as determined by sensory descriptive analysis, while not significantly altering the bitterness or astringency. The timing of the addition had only a minor effect. Consumer liking data on a subset of the wines indicated that a double addition of glycosides was not well accepted, although a cluster of consumers liked the Riesling with a single addition of glycosides. **Conclusions:** Phenol-free glycosides extracted from marc can increase floral and fruity flavour in Riesling and Chardonnay wines, without altering bitterness or astringency. **Significance of the Study:** Adding phenol-free glycosides from grape marc can enhance wine flavour and persistence. The relatively simple extraction method allows utilisation of marc as a source of flavour at a production scale.

Abstract available online at <http://doi.org/c4gk>

© Reprinted with permission Parker, M., Barker, A., Black, C.A., Hixson, J., Williamson, P., Francis, I.L. Don't miss the marc: phenolic-free glycosides from white grape marc increase flavour of wine. *Australian Journal of Grape and Wine Research* 25(2), 1–12; 2019. Copyright 2019 Australian Society of Viticulture and Oenology.

Taylor, A., Barlow, N., Day, M.P., Hill, S., Martin, N., Patriarca, M. Atomic spectrometry update: review of advances in the analysis of clinical and biological materials, foods and beverages. *Journal of Analytical Atomic Spectrometry* 34(3), 426–459; 2019.

This update covers publications from the second half of 2017 to the middle of 2018. Techniques and applications relevant to clinical and biological materials, foods and beverages are discussed in the text, presenting key aspects of the work referenced, while the tables provide a summary of the publications considered. Original approaches to sample extraction reported include using deep eutectic solvents, protonated triethylamine carbonate which converts to the immiscible triethylamine by addition of NaOH, a switchable hydrophilic solvent and new solid phase materials. The ingenuity of analytical scientists is illustrated by the development of an apparatus for sequential determination of Cd and Hg in foods by VG-AFS. Different parts of the equipment perform sample destruction, separation of Cd from Hg, vaporisation, trapping, volatilisation and measurement. Other new devices include a microwave plasma torch linear ion trap mass spectrometer suitable for field analysis of water and tandem LA-LIBS with ICP-MS. Various applications with single particle or single cell ICP-MS, particularly associated with nanoparticles, follow from work we have included in our recent Updates. Growing interest in clinical exposure to Gd is noted while work relating to Cu metabolism in Wilson's disease provides new information for a disorder that has already been studied for many decades. Following from new food safety regulations, concentrations of Cd in cocoa are being investigated. Higher concentrations are seen in S American products although, having been consumed for centuries, whether or not there is any harm seems questionable. Encouraging for those who enjoy caviar is a study suggesting that samples from the polluted Caspian Sea may not contain high concentrations of toxic elements.

Abstract available online at <http://doi.org/c3qp>

© Reprinted with permission Taylor, A., Barlow, N., Day, M.P., Hill, S., Martin, N., Patriarca, M. Atomic spectrometry update: review of advances in the analysis of clinical and biological materials, foods and beverages. *Journal of Analytical Atomic Spectrometry* 34(3), 426–459; 2019. Copyright 2019 Royal Society of Chemistry.

2075

Cordente, A.G., Borneman, A.R., Bartel, C., Capone, D., Solomon, M., Roach, M., Curtin, C.D. Inactivating mutations in *Irc7p* are common in wine yeasts, attenuating carbon-sulfur β -lyase activity and volatile sulfur compound production. *Applied and Environmental Microbiology* 85(6 e02684–18), 1–14; 2019.

During alcoholic fermentation of grape sugars, wine yeasts produce a range of secondary metabolites that play an important role in the aroma profile of wines. In this study, we have explored the ability of a large number of wine yeast strains to modulate wine aroma composition, focusing on the release of the “fruity” thiols 3-mercaptohexan-1-ol (3-MH) and 4-mercapto-4-methylpentan-2-one (4-MMP) from their respective cysteinylated nonvolatile precursors. The role of the yeast gene *IRC7* in thiol release has been well established, and it has been shown that a 38-bp deletion found in many wine strains cause them to express a truncated version of *Irc7p*

that does not possess cysteine-S-conjugate β -lyase activity. In our data, we find that *IRC7* allele length alone does not fully explain the capacity of a strain to release thiols. Screening of a large number of strains coupled with analysis of genomic sequence data allowed us to identify several previously undescribed single-nucleotide polymorphisms (SNPs) in *IRC7* that, when coupled with allele length, more robustly explain the ability of a particular yeast strain to release thiols from their cysteinylated precursors. We also demonstrate that allelic variation of *IRC7* not only affects the release of thiols but modulates the formation of negative volatile sulfur compounds from the amino acid cysteine. The results of this study provide winemakers with an improved understanding of the genetic determinants that affect wine aroma and flavor, which can be used to guide the choice of yeast strains that are fit for purpose. **Importance:** Volatile sulfur compounds contribute to wine aromas that may be considered pleasant, such as “tropical,” “passionfruit,” and “guava,” as well as aromas that are considered undesirable, such as “rotten eggs,” “onions,” and “sewer.” During fermentation, wine yeasts release some of these compounds from odorless precursor molecules, a process that is most efficient when performed by yeasts that express active forms of the protein Irc7p. We show that most wine yeasts carry mutations that reduce activity of this protein, affecting the formation of volatile sulfur compounds that impart both pleasant and unpleasant aromas. The results provide winemakers with guidance on the choice of yeasts that can emphasize or deemphasize this particular contribution to wine quality.

Abstract available online at <http://doi.org/c3rb>

© Reprinted with permission Cordente, A.G., Borneman, A.R., Bartel, C., Capone, D., Solomon, M., Roach, M., Curtin, C.D. Inactivating mutations in Irc7p are common in wine yeasts, attenuating carbon-sulfur β -lyase activity and volatile sulfur compound production. *Applied and Environmental Microbiology* 85(6 e02684–18), 1–14; 2019. Copyright 2019 American Society for Microbiology.

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Essling, M. Ask the AWRI: leafroll viruses – what you need to know. *Australian & New Zealand Grapegrower & Winemaker* 662, 35–36; 2019.

The AWRI has been approached by regions with concerns about grapevine leafroll virus type 3 (GLRaV-3). As reports of virus-affected vines become more frequent in Australia, there is a need to better understand the insect vectors involved in their spread and the levels of virus infection at which action needs to be taken. To date, most research has been undertaken in countries which have a longer history of problems caused by viruses, including New Zealand, South Africa and the United States. The findings from this work provide useful guidelines; however, because the growing conditions, virus virulence and insect vectors in those countries may be different, Australian research is also needed.

© Reprinted with permission Essling, M. Ask the AWRI: leafroll viruses – what you need to know. *Australian & New Zealand Grapegrower & Winemaker* 662, 35–36; 2019. Copyright 2019 Winetitles Media Pty Ltd.

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Nordestgaard, S. Latest advances in grape sorting technology. *Australian & New Zealand Grapegrower & Winemaker* 662, 50–55; 2019.

In the June and July 2015 issues of the *Grapegrower & Winemaker*, the Australian Wine Research Institute's senior engineer Simon Nordestgaard summarised developments in destemming and sorting equipment. Following a visit to the 2018 edition of Vinitech-Sifel in Bordeaux, he provides the following update on grape sorting, including information on densimetric sorting systems and equipment aimed at larger wineries and vineyards.

© Reprinted with permission Nordestgaard, S. Latest advances in grape sorting technology. *Australian & New Zealand Grapegrower & Winemaker* 662, 50–55; 2019. Copyright 2019 Winetitles Media Pty Ltd.

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Johnson, D. Seventeen times with feeling. *WBM: Australia's Wine Business Magazine* March/April, 6; 2019.

The 17th Australian Wine Industry Technical Conference will be held in Adelaide in just a few months. Thinking about that, this will be the 17th time since 1970 that the Australian grape and wine industry has taken the time to come together in one place – to hear the latest technical and business content and to discuss the issues that affect our industry's future.

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Visalakshan, R.M., MacGregor, M.N., Cavallaro, A.A., Sasidharan, S., Bachhuka, A., Mierczynska-Vasilev, A.M., Hayball, J.D., Vasilev, K. Creating nano-engineered biomaterials with well-defined surface descriptors. *ACS Applied Nano Materials* 1(6), 2796–2807; 2018.

Abstract available online at <http://doi.org/c4ds>

AWRI events calendar

July 2019

4 July — AWRI Pinot Noir Symposium, Marnong Estate, Mickleham VIC

21–24 July — 17th Australian Wine Industry Technical Conference and Trade Exhibition, Adelaide

September 2019

10 September — AWRI Rutherglen seminar

11 September — AWRI Bendigo seminar

12 September — AWRI Avoca/Pyrenees seminar

October 2019

15 October — AWRI Orange seminar

16 October — AWRI Southern Highlands seminar

17 October — AWRI Canberra seminar

November 2019

12 November — AWRI Clare seminar

13 November — AWRI Barossa seminar

14 November — AWRI McLaren Vale seminar

*** Details subject to change without notice.** Please visit the AWRI website to view the current copy of this calendar at https://www.awri.com.au/industry_support/courses-seminars-workshops/events. All information was accurate at time of compilation.

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