'Tropical' thiols are important contributors to the flavour of Chardonnay wines

The world's great Chardonnay wines can have quite subtle, multi-layered flavour characteristics. Generally, Chardonnay is not considered a highly aromatic variety, being commonly described in textbooks as a neutral cultivar, one that allows winemakers the freedom to influence flavour and style through a wide range of options in the vineyard and winery. The relatively restrained and diverse flavours of Chardonnay have made it a difficult variety to study scientifically. In comparison the flavour chemistry of other commercially important varieties such as Riesling and Sauvignon Blanc is increasingly well understood – with 'floral'/'citrus' monoterpenes and 'passionfruit'/'pungent' polyfunctional thiols (a type of sulfur-containing compound) being key contributors respectively. The AWRI has three current projects which specifically aim to shed more light on the aroma compounds of Chardonnay. One project has focused on the 'stone fruit' attributes of Chardonnay, which can also be seen in varieties such as Viognier. Another is investigating multiple vineyards from within one region, assessing fruit and wine composition and links to wine sensory properties and grade. A further project has taken the tack of assessing the highly potent polyfunctional thiols and addressing whether they are important to Australian Chardonnay wines.

Polyfunctional thiols are well known to provide the basis of the flavour of many Sauvignon Blanc wines, especially those with a clear 'tropical fruit' or 'box hedge' character. These thiols are extremely potent, contributing to flavour in the low nanogram/litre range. The most important are 3-mercaptohexan-1-ol (3-MH), 3-mercaptohexyl acetate (3-MHA) and 4-mercapto-4-methylpentan-2-one (4-MMP). Benzyl mercaptan (BM), is also involved, contributing 'struck flint'/'smoky'/'mineral' aroma notes. A common feature of many thiol compounds is that the nature of the aroma they contribute changes with concentration. For example, in Sauvignon Blanc wines at low levels 3-MH or 3-MHA can give a general enhancement of fruit, while at moderate levels these compounds can contribute to a clear 'tropical fruit' character, and at higher concentrations this can change to result in a pungent 'box hedge' aroma. The Chardonnay thiol project has assessed whether these compounds contribute to flavour for Chardonnay wines, and if so which sensory properties are influenced.

Survey of thiols in Australian Chardonnay wines

The thiol concentration of 106 commercial Chardonnay wines of different styles (both oaked and unoaked), sourced from across Australian wine producing regions, was determined. The wines encompassed a wide price range, from $4 to $120 retail – median price $19 – with most between $14 and $35. The wines were selected taking into account sales data to include

some of the largest selling Australian brands, and were from currently available vintages, mostly 2012 and 2013, with some older examples.

Surprisingly, the concentration of the 'tropical fruit' thiols 3-MH and 3-MHA was above the sensory detection threshold (determined in model wine) for all of the wines analysed, and the concentrations for some of the wines were comparable to the levels found in highly aromatic Sauvignon Blanc wines. Figure 1 shows the results broken down by region. There was a trend for Western Australian wines to have a higher level of 3-MH, while Tasmanian wines analysed were generally higher in 3-MHA, but overall there was little obvious difference among states. There was no significant relationship of these two thiols' concentration with variables such as price or the mean January temperature of the growing region.

The concentration of the 'struck flint' thiol, BM, was also found to be surprisingly high for these wines, with only six wines having no detectable amount, and all others being above the reported threshold level. Interestingly, many of the Tasmanian wines had the highest concentration of this compound, more than 100 times the sensory threshold of 0.3 ng/L (determined in model wine).

Determining the contribution of thiols in wines made from Chardonnay juices under controlled conditions

One aspect of investigating commercial wines is the likelihood that they include some percentage of other grape varieties at levels (<15%) that do not need to be disclosed on

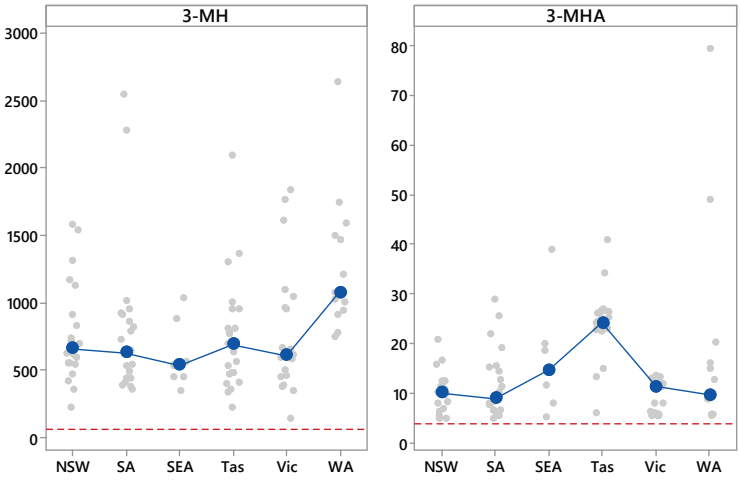

Figure 1. Concentration (ng/L) of the thiol compounds 3-MH and 3-MHA for a set of 106 commercial Chardonnay wines, grouped by state (SEA: South Eastern Australia). The median values are shown by the connected symbols and the individual wines are shownby the grey symbols. The sensory threshold for each compound is shown as the dashed line.

the label. There would also be large variations in winemaking practices across the wines studied. To assess the role of the thiol compounds in Chardonnay in more detail, a set of 16 Chardonnay juices was sourced from multiple regions across Australia, from hand-harvested grapes at a target soluble solids level. Wines were made from these juices under standardised conditions with no oak influence. Juices were obtained from the Hunter Valley, Margaret River (two vineyards), Riverland, McLaren Vale, Padthaway, Rutherglen, Great Southern (two vineyards), Adelaide Hills, Yarra Valley, Orange, Mornington Peninsula, Great Western, Tumbarumba, and Coal River Valley. The wines were profiled by a trained sensory panel, and 71 key aroma compounds were analysed, including the thiols. Once again, the results of the chemical analysis showed a surprisingly high level of these thiols, with an even wider concentration range than the commercial wine survey. The concentration of 3-MH in each wine was well above the sensory threshold (up to 80 times) and the concentration of 3-MHA was above threshold in all but one of the wines (up to 50 times threshold in two wines).

Several important sensory properties of the wines as quantified by the sensory panel were linked closely to the concentration of the thiols, with both 3-MH and 3-MHA concentration relating strongly to the 'passionfruit' intensity in the set of wines (Figure 2), while the 'box hedge' and 'struck flint' characters were associated with the presence of 4-MMP and benzyl

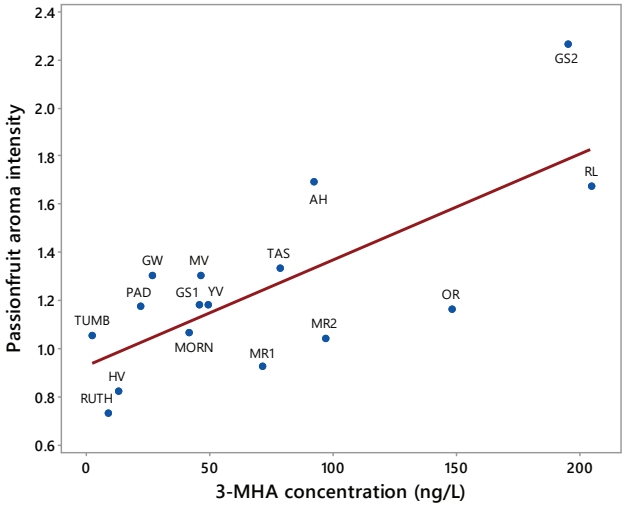

Figure 2. Relationship between 3-MHA concentration and 'passionfruit' aroma intensity score from a trained sensory panel, for a set of 16 wines made from juices sourced from vineyards across a wide range of regions of origin. RUTH: Rutherglen; HV: Hunter Valley; TUMB: Tumbarumba; PAD: Padthaway; GW: Great Western; MORN: Mornington; GS: Great Southern; MV: McLaren Vale; YV: Yarra Valley; MR: Margaret River; TAS: Tasmania (Coal River Valley); AH: Adelaide Hills; OR: Orange; RL: Riverland. The regression line is shown, R^2= 0.53 (P<0.01).

mercaptan respectively. Once again there was no clear connection with warm or cool climate origin, with a Great Southern juice and a Riverland juice giving rise to wines with the highest thiol concentrations. Note that the wines should not be considered representative of the different regions, as only a single juice was obtained from each region in most cases. The intention of this investigation was to achieve a diverse range of wines, not to define differences between regions. As a final aspect of this study, a group of 156 white wine consumers gave liking scores for a subset of these wines, and those wines with higher thiol concentration were found to be well liked by two identified clusters of consumers, comprising 60% of the total number of consumers tested.

Conclusion

This study has shown that Chardonnay as a variety can derive some of its flavour from the thiol compounds previously thought to be mainly involved in Sauvignon Blanc flavour, and that these compounds are much more prevalent and important for Chardonnay aroma than previously thought. With concentrations comparable to those observed in Sauvignon Blanc wines, the fact that most Chardonnay wines do not taste highly aromatic is likely due to the complex interactions among the multitude of aroma compounds present in Chardonnay wine, suppressing the strong 'passionfruit' or 'box hedge' characters that are so evident in many Sauvignon Blanc wines. In addition, while the thiol compounds may be partially suppressed by other volatile compounds, and in commercial wines by oak volatiles and other flavours introduced by lees contact, barrel fermentation, and malolactic fermentation, the sensory study showed that they certainly make a contribution to the overall aroma and flavour properties of unwooded wines. From previous research into thiol compounds at the AWRI, variables such as post-harvest skin contact, including time from machine harvesting to delivery at the winery, and choice of yeast strain can have a large effect on their levels in finished wines, allowing the dialling up or down of their concentration by wine producers in a fairly simple, efficient manner. This research has shown that thiols and their precursors in grapes are important components to consider in viticultural and winemaking trials for Chardonnay, being well accepted by the majority of white wine consumers, and may provide a target for winemakers and viticulturists in optimising wine style.

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