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!

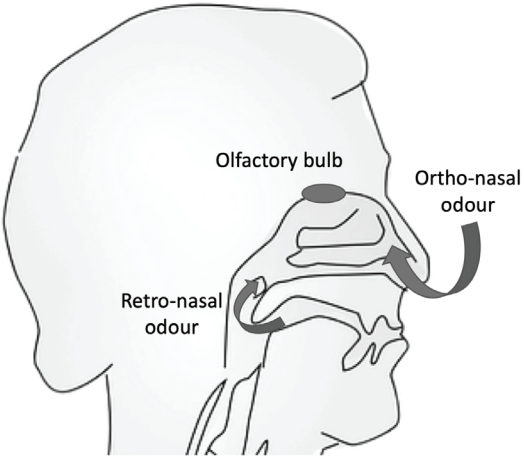

Figure 1. Schematic of ortho-nasal odour detection via the nose and retro-nasal odour detection via the back of the throat to the olfactory bulb at the top of the nasal cavity.

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

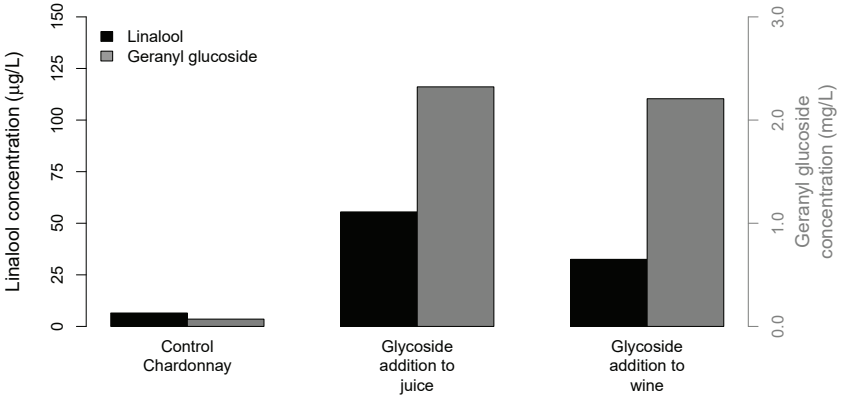

Figure 2. Monoterpene (linalool, black bar, left y-axis) and glycoside (geranyl glucoside, grey bar, right y-axis) concentrations three-months post-bottling in Chardonnay wines: control (no addition), with glycosides added pre-fermentation (to juice) and post-fermentation (to wine).

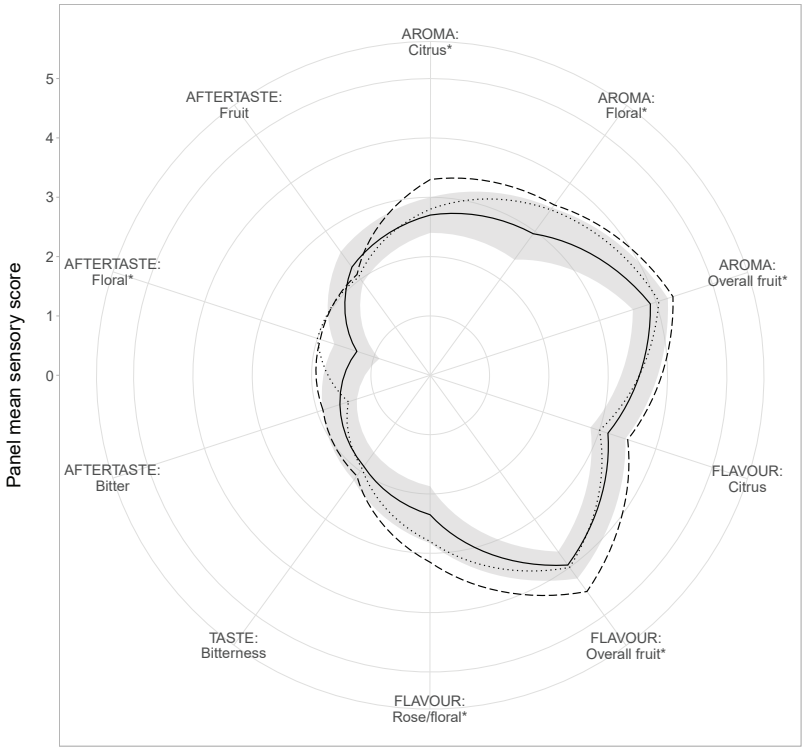

Figure 3. Radar plot showing the panel mean sensory score of key attributes for Chardonnay control (black line) with least significant difference (grey ribbon), pre-ferment addition of glycosides to Chardonnay (juice addition, dotted line) and post-ferment addition of glycosides to Chardonnay (wine addition, 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.

References and further reading

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