AWRI Australian Wine Research Institute

Fact Sheet
WINEMAKING

Pepper flavour in wine

Background

There are only a few major flavour compounds in wine that come directly from the grape berry. One of the most important to Shiraz wine flavour is the 'pepper' compound rotundone, which was identified in wine relatively recently.

Rotundone in wine

AWRI researchers originally pinpointed rotundone as the cause of black or white pepper flavour in Shiraz grapes, developed an analytical method to quantify it, and determined its potency. Rotundone has one of the lowest detection thresholds of any aroma compound, meaning that only a tiny amount (around 16 ng/L) is required to give a peppery character in red wine. This is equivalent to a few drops in an Olympic-sized swimming pool. Interestingly, around 25% of the population are blind to rotundone, unable to perceive it even at very high levels.

When looking beyond wine, AWRI researchers were the first to recognise rotundone as the impact aroma compound in peppercorns (*Piper nigrum)* and to identify it in many culinary herbs. Recent work, in collaboration with CSIRO, has involved mapping vineyards to assess spatial differences in rotundone, seeking to increase understanding of environmental factors affecting its formation.

Rotundone in the vineyard

While Shiraz is the main red wine variety where high concentrations of rotundone have been found, other varieties such as Gamay, Graciano, Duras and Durif can have substantial levels. It is generally not an important flavour compound in Cabernet Sauvignon, Merlot or Pinot Noir grapes, or

most white varieties. Rotundone is most prevalent in grapes from vineyards in cooler regions and in cooler seasons, with cool growing conditions from veraison to harvest likely to be important. There can be more than a 40-fold difference in rotundone between seasons for the same vineyard. Typically, later harvested grapes, most likely in cooler vintages, have a much higher concentration than earlier picked grapes.

In Shiraz berries rotundone has been found almost entirely in grape skins rather than in the pulp or seeds. Sun exposure on bunches is a major influence in reducing the level of rotundone. Shaded bunches, and berries on shaded parts of bunches or from less exposed rows, have the highest levels. Leaf removal around the bunch zone, especially at veraison, has a major effect on lowering rotundone concentration. Vine water status also has an effect, with wetter conditions enhancing its concentration in berries. Rotundone forms from another grape compound in the grape skin, α-guaiene, and this appears to be the key limiting factor. Environmental factors and viticultural management practices which encourage high grape α-guaiene are expected to result in 'peppery' grapes and wine, and it is likely possible to achieve expression of this desirable character in vineyards beyond typical cool climate sites.

Large differences within vineyards have been found, with considerable spatial variation, which can be stable across seasons depending on the site. Selective harvesting could be an option to separate sections of vineyards with higher and lower rotundone, with blending of wines to adjust the level of pepperiness then possible. Rotundone can be easily tasted in berries, but winemakers should ensure that they are not part of the population who are blind to this character.

Effects due to winemaking

Winemaking has only a small effect on rotundone, with extraction during fermentation on skins being the critical step. The techniques of extended maceration and pre-ferment maceration have only a marginal effect, if any. Rosé style wines have dramatically lower rotundone concentrations than equivalent wines fermented on skins. Rotundone is a very stable compound and is little affected by yeast. It remains at a constant level during post-fermentation processes and is largely unchanged in bottled wine over extended ageing periods.

Acknowledgement

This work was supported by Wine Australia, with levies from Australia's grapegrowers and winemakers and matching funds from the Australian Government. The AWRI is a member of the Wine Innovation Cluster in Adelaide, SA.

Further reading

Bramley, R.G.V., Siebert, T.E., Herderich, M.J., Krstic, M.P. 2017. Patterns of within-vineyard spatial variation in the 'pepper' compound rotundone are temporally stable from year to year. *Aust. J. Grape Wine Res.* 23(1): 42-47.

Herderich, M., Bramley, R., Vadakattu, G. Rotundone and its role in defining terroir in iconic Australian cool climate 'peppery' Shiraz. 2021. Final Report to Wine Australia. https://www.wineaustralia.com/getmedia/932f5d99-c1cc-4421-ae17-a9e55259a664/AWR-1701-4-4-4-Final-Report.pdf

Wood, C., Siebert, T.E., Parker, M., Capone, D. L., Elsey, G.M., Pollnitz, A.P., Eggers, M., Meier, M., Vössing, T., Widder, S., Krammer, G., Sefton, M.A., Herderich, M.J. 2008. From wine to pepper: rotundone, an obscure sesquiterpene, is a potent spicy aroma compound. *J. Agric. Food Chem.* 56 (10): 3738-3744.

Contact

For further information, please contact Markus Herderich.

Phone 08 8313 6600

Email Markus.Herderich@awri.com.au

Website
https://www.awri.com.au/research_and_development/2017-2025-rde-plan-projects/project-4-4-4/

Address Wine Innovation Central Building,
Corner of Hartley Grove & Paratoo Rd,
Urrbrae (Adelaide), SA 5064