Technical notes

How good is the grape and wine community at identifying wine taints and faults?

Introduction

Winemakers strive to make the best possible wines from the fruit they have available. However, there is always a risk that something will go wrong in the vineyard or in the winemaking process, leading to negative attributes that can dominate wine aroma or flavour. Common examples include 'smoky' characters from bushfires, 'Band-Aid' or 'barnyard' characters from *Brettanomyces* spoilage and 'reductive' characters that can develop during bottle ageing.

Different people can perceive wine taints and faults in different ways, and each person has their own aroma detection thresholds for different taint or fault compounds. In some cases, the person assessing the wine may suffer from a specific anosmia, which is the lack of ability to detect an odour. Data collected through the AWRI's Advanced Wine Assessment Course (AWAC) from 2006-11 indicates that compounds such as 2,6-dichlorophenol ('plastic', 'antiseptic'), indole ('mothball') and 2-acetyltetrahydropyridine ('mousy', 'malty biscuit') are completely undetectable to a significant proportion of assessors (20%, 7% and 25% respectively). While winemakers may be highly sensitive to many off-flavours, due to genetic variability it is likely that even a highly experienced winemaker will be blind to or lack sensitivity to some specific fault or taint compound(s).

The ability to correctly identify a taint or fault in a wine depends on a number of factors, including wine style, age, variety and the presence of contributing or confounding aroma compounds. It is essential that people who are called upon to assess the quality of wine are able to accurately recognise the common wine faults and taints that occur in wines. Wine faults are generally defined as off-aromas or flavours that are related to grapegrowing and winemaking processes. Wine taints are defined as odours, flavours or aftertastes that originate from an external source.

Common taints and faults

Table 1 lists 12 common wine taint and fault compounds, along with the typical characteristics they exhibit, their source(s) and odour detection thresholds (where data is available).

These compounds are implicated in the most common taints and faults investigations conducted by the AWRI's helpdesk, as shown in Figure 1. Investigations related to taints and faults typically account for 50-60% of the total handled by that team on a yearly basis.

Most winemakers would be acutely aware of the importance of early detection of the major taint and fault compounds that can occur during the winemaking process. However, not all producers have formal training and awareness programs to promote the accurate identification of taints and faults by their winemaking teams.

Table 1. Common winemaking taint and fault compounds, their recognised aroma attributes, sources and odour detection thresholds.

Fault/taint compound	**Attribute(s)**	**Common source(s)**	**Odour detection threshold**	**Comments**
2,4,6-Trichloroanisole (TCA)	 *Musty*	The main compound responsible for cork taint. Generally formed as a result of moulds growing on cork.	1-3 ng/L	The aroma threshold can be influenced significantly by wine style and variety. Has a strong suppression effect on other odour compounds.
Acetaldehyde	 *Bruised apple*	Acetaldehyde levels increase as wines age and if wine in tanks is left on ullage with minimal protection from oxygen.	100-125 mg/L	Formation of SO_2 during fermentation can increase acetaldehyde, as can increases in pH and fermentation temperature.
Geosmin	 *Earthy, peaty*	Formed from metabolites of soil bacteria and algae. Has also been reported as a metabolite of *Botrytis cinerea* and other fungi.	25 ng/L	The earthy characteristic of this compound can sometimes be confused with cork taint.
Hydrogen sulfide	 *Rotten egg*	Excreted by yeast when under stress during alcoholic fermentation.	1.1-1.6 μg/L	H_2S levels in red wine can be affected by aeration of must during fermentation. In white winemaking the formation of excess H_2S can be minimised by either settling, centrifuging or filtering the must before fermentation.
Indole	 *Mothball, farmyard*	Grapes can accumulate indole derivatives in their bound, glycosidic form, which might later be hydrolysed, or broken down, during fermentation or wine ageing.	25 μg/L	Indole has been implicated in the phenomenon known as untypical (UTA) or atypical (ATA) ageing.

Fault/taint compound	Attribute(s)	Common source(s)	Odour detection threshold	Comments
Isovaleric acid	 *Sweaty, cheesy*	May be formed by *Brettanomyces* yeasts or other contaminant organisms during maturation of wine, or as a result of spoilage after bottling.	30-35 µg/L	At low levels this compound can contribute to wine complexity but at higher concentrations it can impart a 'cheesy' or 'sweaty sock' aroma.
Methanethiol (MeSH)	 *Rotten vegetable, drain*	Methionine is the main source of this during fermentation. Post-bottling, methyl thioacetate and dimethyl disulfide can degrade to liberate MeSH.	1.8-3.1 µg/L	A key compound in 'reductive' off-flavour in wines. Methanethiol produced during fermentation can remain in wine either in its free form or bound to metal ions, especially copper.
2,6-Dichlorophenol	 *Plastic, antiseptic*	An environmental contaminant that can be generated by the reaction of phenol with chlorine from sterilising agents. Can also be generated when wood is treated with hypochlorite.	32 ng/L	This is one of the more potent and sensorially important chlorophenol compounds.
4-ethyl phenol	 *Barnyard, medicinal*	The major spoilage compound associated with the growth of *Dekkera/Brettanomyces* yeast in wine. Widely recognised as a marker compound for the presence of this yeast.	100-500 µg/L	The sensory perception threshold depends heavily on the style and variety of the wine. Heavy use of oak can influence the aroma threshold.
Dimethyl sulfide	 *Blackcurrant, canned corn*	Formed during the maturation of wine in the bottle. The main precursor to DMS is S-methylmethionine.	25 µg/L	At low concentrations DMS tends to contribute 'blackcurrant' character to wines. At higher concentrations, the aroma appears more like 'canned corn' or 'cooked vegetable'.
Guaiacol	 *Smoky*	Associated with high toast levels in oak barrels. Bushfires and controlled burning of bushland can increase guaiacol levels in grapes and impart 'smoky' characters in the resulting wine.	15-25 µg/L	Can be present in glycoside-bound forms, some of which may be hydrolysed during fermentation. Residual glycosides in wine may be detected retro-nasally as an 'ash' character, due to breakdown from enzymes present in the mouth.
2-Acetyltetrahydro pyridine (ACTPY)	 *Mousy, malty biscuit*	Usually of microbial origin with, most strains of lactic acid bacteria (LAB) capable of producing the compound. More likely to occur in wines with low SO_2 concentration.	1.6 µg/L (in water)	Mousy taint is rarely detected by aroma as ACTPY is not volatile at wine pH. There is considerable variation in the sensitivity of individuals to this compound.

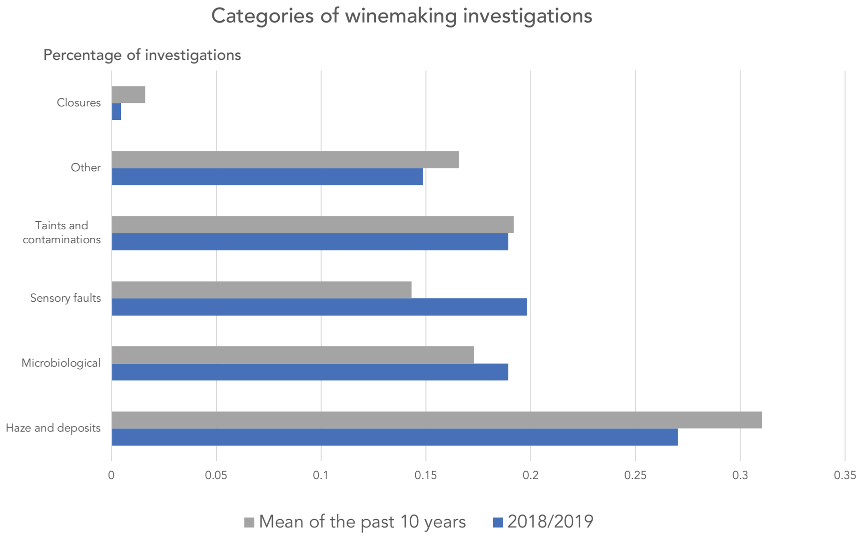

Figure 1. Categories of winemaking investigations conducted by the AWRI helpdesk in 2018/19, alongside the 10-year average for each category

The importance of monitoring wine taints and faults is underlined by the significant number of faulty wines identified at wine shows. Data gathered in conjunction with the International Wine Challenge (UK) over an 11-year period (2007–17) showed that approximately 3.5% of all entries across that period displayed a prominent taint or fault. The percentage of wines assigned to each fault category, according to closure type, is summarised below in Figure 2 (Wilkes, 2016).

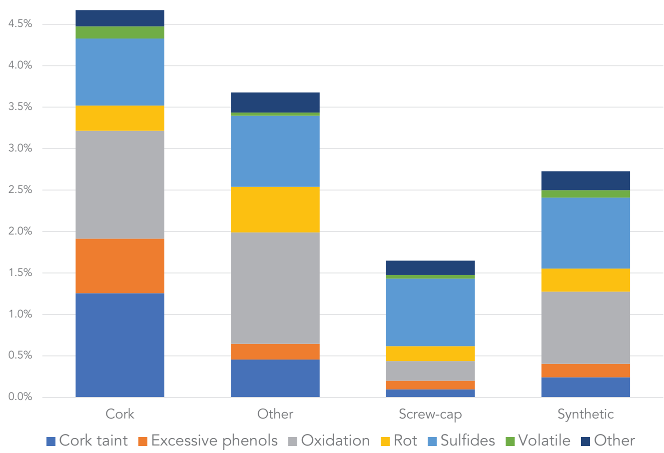

Figure 2. Percentage of wines identified as being faulty at the International Wine Challenge (UK) across 2007–17, broken down by closure type (n=106,351). Different colours within each bar denote the different types of taint or fault perceived.

Detection and identification of faults and taints

In order to better understand the ability of individuals within the wine community to correctly identify common winemaking taints and faults, two assessments were set up at the 17th Australian Wine Industry Technical Conference in July 2019:

1. A controlled sensory evaluation carried out during a workshop on winemaking taints and faults.
2. A less formal assessment offered to conference attendees at the AWRI's stand in the WineTech trade exhibition.

Workshop assessment

A group of 51 assessors was taken through a guided tasting using either commercially available white (Chardonnay) or red (Cabernet Sauvignon) wines spiked with the twelve taint and fault compounds at the concentration levels presented below (Table 2). To create the individual sensory standards, each of these compounds was spiked into 750 mL bottles of either white or red wine by adding the contents of food-grade capsules containing the compounds in question and inverting the bottles several times to mix the contents. The aroma perception threshold for each compound is provided for reference purposes.

Table 2. Winemaking taint and fault compounds included in the workshop assessment. Matrix indicates whether the compound of interest was added to dry white or red wine.

Fault/taint compound	Matrix	Concentration presented	Aroma detection threshold
2,4,6-Trichloroanisole (TCA)	White	300 ng/L	1-3 ng/L
Acetaldehyde	White	7 mg/L	100-125 mg/L
Geosmin	White	47 ng/L	25 ng/L
Hydrogen sulfide	White	96 µg/L	1.1-1.6 µg/L
Indole	White	235 µg/L	25 µg/L
Isovaleric acid	White	4,000 µg/L	30-35 µg/L
Methanethiol	White	13 µg/L	1.8-3.1 µg/L
2,6-Dichlorophenol	White	1,300 ng/L	32 ng/L
4-ethyl phenol	Red	2,700 µg/L	100-500 µg/L
Dimethyl sulfide	Red	340 µg/L	30-60 µg/L
Guaiacol	Red	120 µg/L	20 µg/L
2-Acetyltetrahydropyridine (ACTPY)	Red	240 µg/L	1.6 µg/L

The concentration of active compounds present in each capsule was based on the commercial products available at the time – in some cases, these concentrations are significantly higher than the aroma perception threshold.

Following the guided tasting, the workshop participants were then presented with a blind selection of wine samples that had been spiked with one of the taint or fault compounds. Control (unspiked) white and red wine samples were provided for reference purposes. Samples were presented as a set of six blind samples on a tasting mat as depicted in Figure 3. Participants were asked to identify the individual compounds from a pre-determined list, by aroma only, using an online sensory proficiency tool. Samples were presented in 30 mL aliquots in covered, standard wine glasses at 22–24°C.

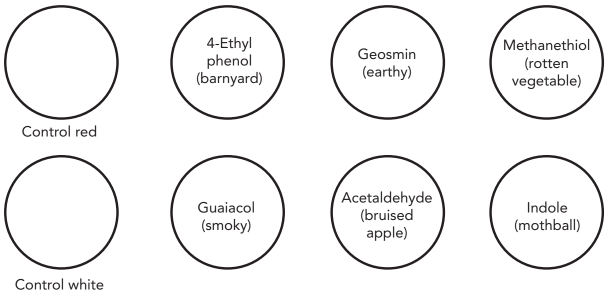

Figure 3. Tasting mat design used in the workshop assessment, indicating the compounds included for assessment. Note that the identity of the samples presented to participants was withheld during the assessment.

Eleven of the participants (22%) correctly identified all six compounds, while four of the participants (8%) only identified one of the compounds correctly. 4-Ethylphenol ('barnyard') appeared to be the most easily recognisable taint or fault, with 43 participants (84%) correctly identifying the compound. Indole ('mothball') was also correctly identified by a significant number of participants (82%). The least recognisable was methanethiol ('rotten vegetable'), with only 19 participants (37%) correctly identifying the compound (Figure 4).

The compounds methanethiol ('rotten vegetable') and hydrogen sulfide ('rotten egg') appeared to be highly confusable, with 41% of participants perceiving the sample spiked with methanethiol as exhibiting a 'rotten egg' aroma. Eight of the participants (16%) failed to identify any taint or fault in the sample spiked with acetaldehyde ('bruised apple'), suggesting that the spiked concentration level was too low for this to be easily perceptible or that their perception threshold was higher than the other participants. Five of the participants (10%) failed to identify any taint or fault in the sample spiked with guaiacol ('smoky'), suggesting that they may be anosmic or less sensitive to this particular compound.

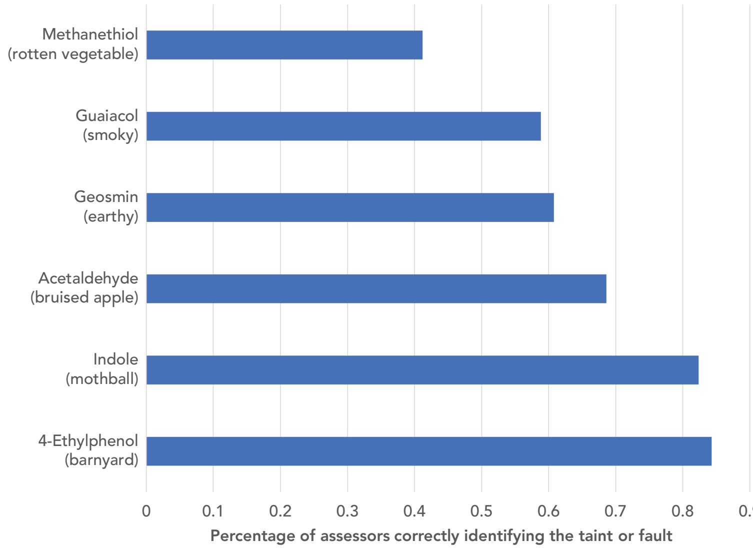

Figure 4. Percentage of correct identifications by workshop participants for each taint or fault compound presented

Trade exhibition stand assessment

For the assessment set up at the AWRI's stand in the WineTech trade exhibition, a series of 30 mL white wine (Chardonnay) samples were presented blind in seven covered, standard wine glasses at 22–24°C. Each of the wine samples had been spiked with one of the taint or fault compounds using the food-grade capsules. A control (unspiked) white wine was provided for reference purposes and an unspiked wine was also included as one of the seven blind assessment samples. Participants were asked to identify the individual taint or fault compounds from a pre-determined list, by aroma only, using an online sensory proficiency tool.

A total of 129 attendees assessed the samples over a three-day period. Out of these, only three attendees (2%) correctly identified all seven taint or fault attributes. TCA ('musty') was the most recognisable taint or fault, with 81 attendees (63%) correctly identifying the attribute. Indole ('mothball') was the next most recognisable, with 71 correct responses (55%). The least recognisable was guaiacol ('smoky'), with only 26 attendees (20%) correctly identifying the attribute. Dichlorophenol ('plastic') and methanethiol ('rotten vegetable') appeared to be confusable with indole ('mothball'), with 22 attendees (17%) and 11 attendees (9%), respectively, incorrectly perceiving the samples to display a 'mothball' attribute. The proportions of correct responses for the samples in this assessment are shown in Figure 5.

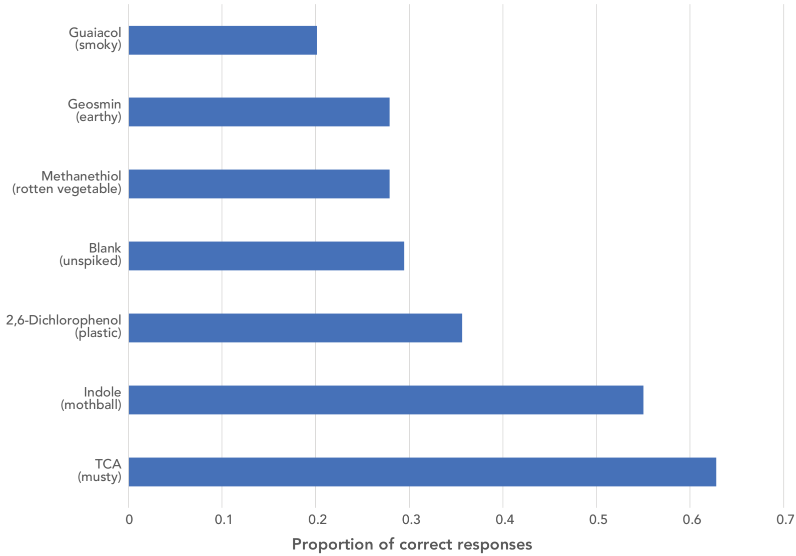

Figure 5. Proportion of correct responses given for the seven compounds presented to attendees at the AWRI trade exhibition stand

Summary

The results of these two sensory assessments indicate that the most common winemaking taint and fault compounds were difficult to identify consistently and objectively. The most easily recognisable attributes, from those presented across the two assessments, were TCA ('musty'), indole ('mothball') and 4-ethylphenol ('barnyard').

The compounds that appeared to be the most challenging to correctly identify were methanethiol ('rotten vegetable') and guaiacol ('smoky'). Methanethiol appears to be highly confusable with compounds such as hydrogen sulfide ('rotten egg') and indole ('mothball'), which tends to lead to a lower correct response rate in this type of assessment. The low percentage of assessors correctly identifying the 'smoky' attribute of guaiacol may be related to the sensitivity in the population with respect to perception of this taint, or to the presence of background guaiacol levels in the wines from oak treatment during production.

These results suggest that additional training on recognition of common faults and taints may be beneficial across the Australian grape and wine community. The commercially produced food-grade capsules used in these assessments can be used as part of a familiarisation or training program, panel selection or ongoing proficiency program within wine companies, to improve confidence in sensory assessments for quality control. The AWRI can assist with the implementation of such programs, which can be conducted with minimal resourcing or specialist knowledge.

Acknowledgement

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References

Wilkes, E. 2016. Is it the closure or the wine? *Wine Vitic. J.* 31(6): 22–25.

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