Technical notes

New tools to manage common taint problems

Wine producers can proactively manage potential taint issues through a new set of tools available from the AWRI Analytical Service. In recent years, several taint problems have occurred in Australia resulting in serious financial consequences for the wine producers involved. The AWRI provides assistance in resolving these issues and we continue to develop services that enable winemakers and suppliers to proactively reduce the risk of wine contamination. The implementation of preventative measures and controls can minimise the development of taints. A broad suite of analytical services tailored for QC testing for the presence of taints in winemaking additives, closures and oak products as well as taint assessment of juices and wines is available through the Analytical Service. Recently, we have also developed a new sensory training tool to help winemakers recognise the most common taints.

Minimising risk

Early identification of the potential sources of contamination is critical. Testing of additives and juices/wines at critical control points proactively detects and eliminates any taints before they develop into a problem. Just like taking out insurance it comes with a small price tag compared to the risk of losing large volumes of wines due to serious taint problems. Also, in today's highly competitive market, the purchase of just one slightly tainted bottle of wine can be enough to influence a consumer to seek an alternative brand or label. So, it is crucial to have the ability to monitor and prevent taint and, if necessary, treat wines to prevent further tainting.

Analytical services to prevent and control taint problems

This article provides detailed information on three examples of commercial taint services developed by the AWRI Analytical Service in collaboration with staff at the AWRI and our stakeholders. The services we offer to prevent and control taint problems include:

1. halogenated phenols analysis;
2. low molecular weight sulfur compound analysis; and
3. wine taint and fault sensory training vials.

1. Halogenated phenols analysis (chlorophenols and bromophenols)

Mono-, di- and tri-chlorophenols are almost ubiquitous environmental contaminants and have been widely used as biocides. They are generated during paper manufacture or following the reaction between chlorine from chlorine-based sterilants and disinfectants with phenol

present in materials such as plastic, fiberglass, hoses, tank linings, phenolic-based resins, paints, fittings, cardboard and wood. Due to their widespread occurrence, chlorophenols can be introduced into wines via contaminated raw materials and processing aids, e.g. tartaric acid, yeast hulls, and diatomaceous earth, or during transport and storage in contaminated vessels.

Chlorophenols are generally described as imparting 'plastic', 'paint', 'medicinal' or 'phenolic' tastes to wines at very low concentrations, but sensitivity to these taints have been shown to vary among tasters (taste threshold levels reported of 16 ng/L [6-chloro-*o*-cresol] and aroma detection thresholds of 32 ng/L [2,6-dichlorophenol and 6-chloro-*o*-cresol]).

In 2006 and 2007, the AWRI responded to several serious incidents of contaminations involving halogenated phenols. As part of an emergency assistance to industry, the AWRI developed suites of analyses that can be used to analyse either wines or grape juices, or raw materials and processing aids.

The first suite of analyses is a 'halophenol' analysis, which includes a screen for the compounds 2-chlorophenol, 2-bromphenol, 6-chloro-*o*-cresol, 2,4-dichlorophenol, 2,6-dibromophenol, 2,6-dichlorophenol, 3&4-bromophenol, and 2,4-dibromophenol. The second suite of analyses is for 'chlorophenols', which includes screening for 2,3,4,6-tetrachlorophenol, 2,4,6-trichlorophenol, 2,4-dichlorophenol, 2,6-dichlorophenol, 2-chlorophenol, 4-chlorophenol, and pentachlorophenol.

Both suites are analysed on the Analytical Service's state-of-the-art Agilent GC-MS instrument, which allows rapid detection of each analyte at the extremely low detection limits.

The Analytical Service also offers analysis of 6-chloro-*o*-cresol, individually, at a very high sensitivity (LOD 0.5 ng/L), on wines, grape juices, and active dehydrated wine yeasts.

Table 1. Samples analysed for 'Halophenols' by AWRI Analytical Service in 2006 and 2007

Year	Additives samples e.g. tartaric acid	Wine and juice samples
2006	25	266
2007	31	208

2. Reduced sulfur compounds analysis

Today, the debate on the occurrence of reduced characters like 'rubber' and 'struck flint' in Australian wines and what causes them remains very relevant. Studies of wine chemistry

and closure choice have shown that wines bottled with closures with a low OTR (oxygen transmission rate) are more likely to develop reductive characters in the bottle if the wine in question has a propensity to become 'reductive' due to winemaking techniques.

Understanding the factors behind reductive characters and optimising winemaking techniques and closure choice to suit the desired wine style and intended shelf life are the keys to delivering the wine in optimal condition to the consumer. To meet this objective, winemakers require a tool to evaluate the composition and chemistry of their wine with special attention to the volatile low molecular weight sulfur compounds which contribute to the reductive characters.

Following method development work by the AWRI, Analytical Service is now able to identify and quantify the compounds responsible for reductive wine characters in its new 'low molecular weight sulfur compound analysis' suite, using gas chromatography with a sulfur chemiluminescence detector (Siebert and Pollnitz 2008). Winemakers can use this information to assist in treating existing wines and to prevent production of further wines with reductive characters.

The suite offered by AWRI Analytical Service analyses the following compounds:

Hydrogen sulfide

Hydrogen sulfide (H_2S), or 'rotten egg gas', is commonly produced during the fermentation of grape juice containing low levels of soluble nitrogen, when the 'starved' yeast become stressed and release hydrogen sulfide into the fermenting juice. The presence of elemental sulfur on grape skins (from sulfur sprays), addition of SO_2 to must and juice prior to ferment, B-complex vitamin (pantothenic acid or pyridoxine) deficiency, or unusually high levels of cysteine or metal ions in the juice can also lead to H_2S production, as can the selection of higher H_2S-producing yeast strains. The sensory detection threshold of H_2S in wine is about 1–2 µg/L.

Mercaptans – methanethiol and ethanethiol

Mercaptans are characterised by attributes like 'cabbage', 'garlic', 'onion', 'sewage' and 'rubber' (all contain an –SH moiety). They are formed during either 'normal' yeast metabolism, or more prevalently, following the direct chemical reaction between alcohols (e.g. ethanol and methanol) and H_2S in wine. Our method measures ethanethiol and methanethiol at levels far below the 1.5 µg/L sensory threshold for these compounds.

Disulfides – carbon disulfide, dimethyl disulfide and diethyl disulfide

Formed following the oxidation of mercaptans, disulfides are particularly difficult to remove from wine and impart highly unpleasant 'burnt rubber', 'onion', 'vegetal' and 'cooked cabbage' flavours and aromas. Analysis for the three most common disulfides – carbon disulfide, dimethyl disulfide and diethyl disulfide – are all offered in the suite.

Dimethyl sulfide (DMS)

Dimethyl sulfide (DMS) is an important compound formed during ageing of wine in the bottle. DMS is an interesting compound, given that at low concentrations (15 to 20 µg/L in whites and 20 to 30 µg/L in reds) it is thought to contribute to the body and mouth-feel of aged white wines and in reds it can lead to a 'blackcurrant' character. However, at > 30 µg/L for whites and > 50 µg/L for reds, DMS leads to 'asparagus', 'cooked corn', 'cooked tomato' or 'molasses' characters, which are considered faults in the wine.

Diethyl sulfide

Diethyl sulfide, with its aroma threshold of 1 µg/L, imparts 'garlic' and 'rubbery' characters in wine.

Ethyl thioacetate

Ethyl thioacetate naturally occurs in beer and wine, and possesses an unusual array of flavour and aroma attributes that span from 'onion' and 'garlic', to 'coffee', 'sweet and fruity'.

3. New sensory training tool – wine taint and fault vials

As mentioned earlier, the ability for winemakers to recognise and take early preventive action against the development of taints is extremely important.

Whilst the 'halogenated phenols' and 'volatile low molecular weight sulfur compound' analysis suites are able to assist in quantifying contaminant compounds, they do not assist winemakers in the sensory recognition of these compounds.

To address this need, the AWRI Analytical Service has developed a set of 12 different wine taint and fault vials (Table 2) that, when mixed into 750 mL of clean neutral wine, yield 'spoiled' wines which can then be used for sensory assessment training.

To ensure that each taint and fault can be recognised by a wide audience, but within a reasonable sensory range, all chemical strengths used in the vials were assessed and approved by our expert team of sensory panellists.

Table 2. Sensory properties, sources, and concentrations of AWRI taint and fault vial chemicals

Chemical name	Major cause	Common descriptors	Sensory threshold	Conc. in 750 mL wine
2,6-Dichlorophenol	External wine taint formed during manufacture or storage	Chlorine, plastic, chemical	32 ng/L	400 ng/L
6-Chloro-*o*-cresol (6 CoC)	External wine taint formed during manufacture or storage	Chlorine, plastic, chemical	74 ng/L	400 ng/L
4-Ethyl catechol (4-EC)	*Brettanomyces* spoilage marker compound	Horsey, leather	774 µg/L	4000 µg/L
4-Ethyl phenol (4-EP)	*Brettanomyces* spoilage marker compound	Bandaid, medicinal	368 µg/L	1000 µg/L
4-Ethyl phenol, 4-Ethyl guaiacol 'Brett mix'	*Brettanomyces* spoilage marker compounds	Bandaid, medicinal, smoky, spicy	322 µg/L for 'mix'	750:75 µg/L
Guaiacol	Smoke taint, toasted oak	Smoky	20 µg/L	120 µg/L
2,4,6 trichloroanisole (TCA)	Cork-related taint	Musty, wet hessian	1–2 ng/L	7 ng/L
Acetaldehyde	Microbial spoilage and oxidation	Bruised apple, nutty, sherry	100 mg/L	120 mg/L
Acetic acid	Microbial spoilage and oxidation	Vinegar	0.6-0.9 g/L	1 g/L
Ethyl acetate	Microbial spoilage and oxidation	Nail polish remover	10 mg/L	150 mg/L
Dimethyl disulfide	Reductive winemaking fault, stressed fermentations	Cooked cabbage, onion, sewage	29 µg/L	540 µg/L
Methyl mercaptan	Reductive winemaking fault, stressed fermentations	Burnt rubber, rotten cabbage, garlic	0.02 µg/L	10 µg/L

Furthermore, all 12 chemicals (sold in single-use-vials) are available individually or in any combination and quantity required to assist with your training. For details, please see www.awri.com.au/analytical_service/analyses/sensory_evaluation/taint_and_fault_vials.asp.

For further information regarding any of the AWRI Analytical Service offerings, or for technical advice on identifying and handling wine faults and taints, please visit the AWRI website on www.awri.com.au under Analytical Service, email analyticalservice@awri.com.au or call us on (08) 8303 6600.

Future perspectives – services in the pipeline

Minimising the risk of taints and contaminations in winemaking requires a holistic approach to the entire value chain. This includes winemakers and suppliers of additives and other products that come into direct contact with the wine (such as packaging and storage materials, closures, and oak products). Analytical Service already offers a wide range of routine and non-routine chemical and sensory analysis services targeted to assist wine producers and suppliers of raw materials and processing aids. These services include chemical testing for a broad range of different taint compounds, 'sensory taint' assessment of wine by the AWRI's trained sensory panels, as well as tailored contract studies for evaluating wine contact materials, such as packaging materials.

Analytical Service plans to offer the wine sector additional taint prevention tools, as we are currently evaluating an option for air sample monitoring. It is well known that taints can be picked up during transport of bulk wine, and in the transport or storage of winemaking products (e.g. oak products and barrels, additives etc.). These contamination problems are often identified when it is too late and the wine is already affected. Analytical Service is in the process of investigating an air trap system tailored to detect a broad range of compounds associated with wine taints. This system will allow wine producers to implement monitoring to prevent taints resulting from transport containers or storage facilities.

Additional information

AWRI. Wine fault/taint vials. http://www.awri.com.au/analytical_service/analyses/sensory_evaluation/taint_and_fault_vials.asp.

AWRI. Sensory assessment. http://www.awri.com.au/industry_development/problem_solving/sensory_assessment/default.asp.

Siebert, T. and Pollnitz, A. (2008) Determination of low molecular sulfur compounds in wine. [Poster] Blair, R.J.; Williams, P.J.; Pretorius, I.S. (eds) Proceedings of the thirteenth Australian wine industry technical conference, 29 July–2 August 2007, Adelaide, SA: Australian Wine Industry Technical Conference Inc., Adelaide, SA: 282.

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