2020 Report

The Australian Wine Research Institute

Mark Krstic, Managing Director

The past year will be remembered as a challenging one in the Australian wine industry, for Australia more broadly and worldwide. Drought and bushfires dominated the growing and vintage seasons, and the COVID-19 global pandemic followed soon after, creating unprecedented changes in the way people live and work. This has been a year where resilience and adaptability have been essential. Despite these challenges, there were many positive developments too. The 17th AWITC, held in July 2019, was a very productive gathering of the grape and wine community, with strong participation across the value chain. Sustainable Winegrowing Australia saw very pleasing growth in member numbers and engagement. Many current research projects reached the end of their third year, bedding down some excellent results with strong industry impact.

Leadership transition

The year saw a leadership transition for the AWRI, with Managing Director Dr Dan Johnson moving on to the role of Pro Vice Chancellor Research Innovation at Macquarie University in February 2020 and Dr Mark Krstic appointed as the AWRI's new Managing Director.

Drought, bushfires and smoke

The 2019/2020 bushfire season was triggered by hot temperatures in spring and summer following a prolonged drought across eastern Australia. Fires occurred in all states and territories of Australia, starting as early as September 2019 and continuing to March 2020. In some regions, the first fires occurred well before veraison, and continuous smoke drift was experienced over the following months. Factoring in the impact of smoke taint, Wine Australia has estimated that fire and smoke damage will equate to a loss of 60,000 tonnes or 4% of the national grape crop for 2020.

Smoke response

In response to the bushfire crisis, the AWRI mobilised a major response that covered analysis, interpretation, extension and communication efforts across the Australian wine sector. AWRI Commercial Services and the AWRI helpdesk worked seven days per week for an extended period to provide analysis and interpretation of results for Australian grape and wine producers. More than 4,600 grape and wine samples were analysed for smoke, compared to around 600 samples analysed in a typical year. The AWRI helpdesk responded to more than 1,600 smoke-related queries and 25 smoke and fire-related extension events were staged across an 8 week period, with more than 1,300 people attending.

Ensuring alignment with industry strategic plans

Australian Grape & Wine's Vision 2050 was released in June 2020. This strategy sets out a plan for a profitable and sustainable future for Australian grape and wine production over the next three decades. It, along with Wine Australia's new strategic plan for 2020-2025, will set the direction for future industry targets and priorities. Now that these two documents have been finalised, the AWRI will review its own RD&E plan (2017-2025) to ensure ongoing alignment with both of these plans.

Technical trends

As with previous years, the industry's technical support needs over the past 12 months were reflected in the volume, timing and topics of the enquiries answered by the AWRI helpdesk team, and the associated extension activities of the AWRI as a whole. The enquiries received were strongly influenced by the extreme and sometimes diverse climatic conditions experienced during the growing season and vintage, in particular drought and bushfires. In some vineyards, decisions had to be made on how best to allocate the available water and some businesses needed to enter the water market to survive. Where soils were very dry and insufficient water was able to be applied through the growing season, the amount of harvested fruit was significantly reduced.

Technical queries were also received about COVID-19, focusing on winery sanitation and workforce management. A review of cleaning and sanitation agents suitable for winery environments was conducted and an *eBulletin* and webpage produced addressing these questions. Responding to concerns that travel restrictions would have an impact on the availability of experienced pruners, a series of instructional videos was produced and a webinar delivered, covering the basics of spur and cane pruning.

Looking towards vintage 2021

Following the challenges of vintage 2020, Australian wine producers are looking to 2021 with a positive and resilient mindset, determined to continue producing exceptional wines enjoyed by consumers around the world.

At the AWRI, 2020/2021 will see a number of research projects wrapping up as well as the launch of several important new projects. The year will also feature:

- the completion of a performance review of the AWRI's strategic partnership agreement with Wine Australia
- preparation of a new AWRI Directions plan – the business and operational initiatives that support the AWRI's RD&E plan
- further collaboration with Australian Grape & Wine and Wine Australia in support of Sustainable Winegrowing Australia.

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Highlights of the year

Customers, consumers and markets

Consumers respond negatively to smoke-affected wine
A consumer study found a strong negative correlation between the proportion of smoke-affected wine in blends tasted by consumers and their liking score, providing evidence that consumers do not accept smoke-affected wine.

Responding to regulatory changes in export markets
Recommendations on the use of Group M3 fungicides were updated in response to an announcement from the European Union forecasting a change to the tolerance for mancozeb residues. To inform the recommendations on the use of Group M3 fungicides, Agrochemical Reference Group members provided information on typical use patterns and eighty wine samples were submitted for residue analysis. This information will help to understand the residue issues associated with this class of agrochemicals.

Agrochemical support provided
New formulations of two existing active constituents (glyphosate and potassium bicarbonate) were registered for wine-grape production in 2019/2020. Because the 'parent' compounds were already registered, sensory analysis and residue data were not required to assess the suitability of these constituents for use in wine production. Information on agrochemicals or pest and disease issues was provided via four *eBulletins*, which included the announcement of the registration of a new insecticide containing acetamiprid and pyriproxyfen and changes to the withholding period for difenoconazole.

Continued success for international ring test
The international ring test program managed by the AWRI continued its efforts to improve the consistency of international regulatory laboratories that measure wine parameters, helping to reduce the risk of wine being rejected in market. Now moving into its sixth year, the program has clearly demonstrated gains in laboratory accuracy and is being extended to a wider range of countries.

Extension, adoption and education

Contributions to 17th AWITC
In conjunction with ASVO and Australian Grape & Wine, the AWRI delivered a highly successful 17th Australian Wine Industry Technical Conference in Adelaide in July 2019. The program included 11 formal sessions over three days, featuring 9 international speakers and 41 Australian speakers. The AWRI events team coordinated a program of 33 workshops held in a single day, with a total of 957 participants. Overall, the event attracted more than 3,000 attendees across the AWITC and the WineTech trade exhibition.

Helpdesk support
The AWRI helpdesk responded to 3,400 enquiries in 2019/2020, approximately 1,500 more than in recent years, with the large increase in numbers driven by the severe bushfires and smoke experienced in the lead-up to the 2020 vintage. For the first time, more than 500 sustainability-related enquiries were received. The helpdesk team conducted 166 problem-solving investigations on 904 samples.

Advanced Viticulture Course launched
The first AWRI Advanced Viticulture Course was held in October 2019. This course proved to be a successful pilot for what will become an annual three-day course, with a group of 20 participants visiting a range of vineyards and sites across several regions to discover the latest practical developments and innovations in viticulture.

Seminars and workshops
During the year, nine roadshow seminars and forty-one workshops were held in winemaking regions across Australia. A total of 1,768 participants attended seminar and workshop events in 2019/2020. Seminar topics were chosen by regions from an extensive list of options to suit their technical priorities. Workshop topics included spray application, vine pruning methodology, Cabernet Sauvignon and Chardonnay winemaking treatment tastings and smoke taint.

Webinars
Eighteen webinars were presented to a total of 1,316 attendees in 2019/2020 – more than double the attendance from the previous year. Views of webinar recordings via YouTube approximately doubled compared with the previous year, with more than 18,000 views. Webinars covered a wide spectrum of topics, including heat-proofing vineyards, soil health, weed management, frost prediction, seasonal outlooks and managing fire-damaged vineyards.

Website
More than 172,950 visitors accessed the AWRI website during the year (a 14.5% increase from 2018/2019), with more than 606,261 page-views. New sections on COVID-19 and wine packaging were launched and major updates were made to information on smoke taint.

Library services
In 2019/2020 the library responded to 1,085 reference enquiries and delivered 2,513 articles – a 30% increase on the previous year. Library staff conducted 64 specialist literature searches and the library's eBook collection was expanded to almost 200 titles. Integrating library services with webinar events proved successful, resulting in nearly 200 event-related library requests.

Performance, products and processes

Combining art and science to assess multisensory perception
For the first time the AWRI hosted an artist in residence, as part of the Australian Network for Art and Technology program. Interactions between AWRI sensory scientists and the visual artist Elizabeth Willing resulted not only in artworks being produced but also new insights into associations of wine flavours with visual cues. These results suggest the benefit of aligning shapes and colours to wine style in packaging and marketing materials, or through decorative elements at the point of consumption, to enhance the tasting experience.

Volatile compounds in Shiraz contribute to body and viscosity
Investigations into the effect of volatile flavour compounds in combination with non-volatiles showed that flavour is a multisensory system, with the volatile compounds having a much greater influence on properties such as body or viscosity than non-volatile compounds such as tannin. The addition of amino acids, previously largely unrecognised as being important to wine flavour, led to greater sweetness and a suppression of bitter taste. Amino acids can be considered as contributors to the desirable 'fruit sweetness' character of dry red wines.

New knowledge of off-flavours and their causative compounds
The compounds responsible for the unpleasant 'popcorn'/'mousy' off-flavour and the 'plastic'/'mothball'/'jonquil' off-flavour were investigated, through analysis of wines with these characters and evaluation of historical data. Analysis of data from 108 sparkling ferments showed a clear link between indole concentration in the wines and the sensory panel response for 'mothball'. For 'mousy' off-flavour, the previously suggested role of oxidation was strengthened, with the compound acetyl tetrahydropyridine (ACTPY) most strongly implicated.

Increasing 'apricot' flavour in white wines
Studies on Viognier vineyards from a warm inland region and a cooler climate region showed that choice of Viognier clone was important for the 'apricot' varietal character in the wines, with harvest date of lesser importance.

Greater understanding of white wine bitterness
Key points in the winemaking process for the formation of the 'bitter'/'hard' tasting compound tryptophol sulfonate were identified. Winemaking trials indicated that the compound mostly forms after fermentation and suggested that the sulfur dioxide (SO_2) regime at bottling and pH are crucial factors in its final concentration.

Zeolite could address heat and cold stability in a single treatment
Following work showing zeolite's potential as a bentonite alternative in heat stabilisation of wines, further trials showed that zeolite treatment brought three cold-unstable white wines to, or very close to, cold stability. With the precipitation of potassium hydrogen tartrate crystals occurring at 15˚C, zeolite use could potentially remove the need to chill wine as part of the cold stabilisation process, saving significant amounts of energy.

Exploring impact of glutathione additions
Additions of pure glutathione to Chardonnay juice prior to fermentation at levels recommended by the OIV were found to have little measurable impact on finished wine after six months in bottle, for both sparkling base and table wine styles. However, the addition of yeast products that contain glutathione may have additional effects beyond those of pure glutathione.

Suitability of 'rose' yeasts for sparkling wine production confirmed
Two high 'rose' aroma yeasts were assessed for their suitability for the production of sparkling wine. The strains were assessed for their ability to complete primary fermentation, secondary fermentation or both. The greatest impact on phenylethanol concentration (responsible for 'rose' aroma) in the final wines was achieved when the strains were used to perform primary fermentation.

Genetic response of *Oenococcus oeni* to SO_2
To gain insight into the survival strategies employed by *Oenococcus oeni* in the harsh wine environment, an experiment was undertaken to quantify gene expression levels in response to an SO_2 challenge. Results suggested that unlike many other wine-related microorganisms, *O. oeni* has few tools in its genetic toolbox to allow it to effectively deal with even low concentrations of SO_2. This perhaps explains the extreme sensitivity of the organism to SO_2 and reiterates that management of the environment into which *O. oeni* is inoculated is one of the key factors in ensuring a successful malolactic fermentation.

Understanding interactions between *Saccharomyces cerevisiae* and non-*Saccharomyces* yeasts
Situations where *Saccharomyces cerevisiae* and non-*Saccharomyces* yeast strains interact can arise in the early stages of a 'wild' ferment or if a winemaker chooses to inoculate a ferment with a non-*Saccharomyces* yeast. Assessment of the interactions of a range of *S. cerevisiae* strains with non-*Saccharomyces* yeasts revealed that some strains of *S. cerevisiae* perform better than others when in close contact with their non-*Saccharomyces* neighbours, providing further information to help inform yeast choices, depending on the desired outcome.

World-first genetic engineering of *Brettanomyces bruxellensis*
CRISPR technology was used to develop a method for manipulating the genome of spoilage yeast *Brettanomyces bruxellensis*. This allowed the creation of defined mutant strains through deletion of specific genes and allowed for the role of these genes in the growth of *B. bruxellensis* in wine to be investigated. Using this methodology, the SO_2-transporter gene *SSU1* was deleted from the genome of *B. bruxellensis*, confirming its role as a major facilitator of SO_2 tolerance in this spoilage species. This is the first time any laboratory in the world has been able to perform genetic engineering on this species. While genetically engineered yeasts are not used in the Australian wine industry, the ability to genetically manipulate microorganisms is essential for understanding their biology and metabolism, and can guide non-genetically modified strain development.

Further understanding of aeration to remove volatile sulfur compounds from wine
Aeration is one treatment commonly used by winemakers to try to remove volatile sulfur compounds from wine. A recent study in synthetic wine investigated the mechanism through which this works to remove H_2S and also identified novel oxidative reaction products bound to H_2S. Larger concentrations of polyphenolic-sulfhydryl adducts (which act as 'sulfur traps') were produced in wines treated with aerative sparging compared to wines treated with copper fining.

Impacts of yeast strain on volatile sulfur compound formation
Fermentation experiments using a synthetic must showed that the formation of benzyl mercaptan ('struck flint' character) was dependent on the metabolic activity of the wine yeast chosen. The amount of benzyl mercaptan produced depended on the strain used, and correlated with the amount of hydrogen sulfide (H_2S) produced by the yeast during fermentation, suggesting that H_2S might be one of the precursors of benzyl mercaptan.

Cross-linked polymers successful in preventing aluminium migration in canned wine
Most commercial canned wines exhibit a significant increase in aluminium concentration after packaging, leading to the formation of H_2S in a short timeframe. The onset of H_2S formation can be delayed if the copper concentration is decreased. A small-scale canning experiment demonstrated that the migration of aluminium into the wine, and the resulting H_2S formation, is faster when SO_2 levels are elevated and when cans are stored with a greater surface area of the lid contacting the wine. The use of a commercially available PVI/PVP polymer product to remove copper from wine prior to canning was effective in preventing the migration of aluminium into the wine.

Sensory impact of using activated carbon to remove smoke characters from juice
Activated carbon fining of juice prior to fermentation was trialled as a possible treatment to remediate smoke-affected fruit. At very high dose rates, activated carbon could remove up to 87% and 98% of smoke glycosides from Pinot Noir rosé and Chardonnay juices. However, following treatment at these high dose rates the wines become stripped of flavour and aroma and became very un-wine-like. At lower carbon dose rates 'smoke' attributes could be decreased while still maintaining some positive 'fruity' and 'confection' aromas.

Dilution effective in treating smoke-affected wines
A smoke-affected 2019 Pinot Noir wine was blended with an unaffected Pinot Noir wine of a similar style sourced from the same vintage to produce a dilution series of six samples, which were assessed by the AWRI technical quality sensory panel. Dilutions of the affected wine with 75% or more unaffected wine resulted in 'smoke' aroma and flavour scores not significantly different from the unaffected wine. This study confirmed that blending is an effective option for the remediation of smoke-tainted wine and can reduce 'smoke' aroma scores in a linear manner associated with the volume of tainted wine in the blend.

New smoke research initiated
Research assessing the impact of early-season smoke exposure on grape composition and wine sensory characteristics was initiated, with samples collected in the Hunter Valley and Adelaide Hills during the 2019/2020 bushfire season. In addition, a two-year project with the University of Adelaide, PIRSA, Grain Producers SA, SA Grain Industry Trust and La Trobe University commenced to assess the potential impact of smoke from stubble burns on grapes and wine, with funding from the South Australian Wine Industry Development Scheme.

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Commercialisation of new yeast strains

The AWRI worked closely with Wine Australia and Mauri Yeast Australia Pty Ltd to successfully commercialise two *Saccharomyces cerevisiae* yeast strains that produce high concentrations of 'rose' aroma compounds, 2-phenylethanol and 2-phenylethyl acetate. These strains were developed by the AWRI in 2016 as part of a Wine Australia-funded project. The process used for commercialising these yeast strains will serve as a template for future commercialisation activities.

Environment, sustainability and natural capital

Sustainable Winegrowing Australia launched

Sustainable Winegrowing Australia is Australia's national program for grapegrowers and winemakers to demonstrate and continuously improve their sustainability. The program was officially launched in July 2019 at the 17th Australian Wine Industry Technical Conference. It takes a holistic approach to managing, supporting and promoting sustainability and covers the environmental, social and economic aspects of grape and wine businesses. Sustainable Winegrowing Australia is endorsed and supported by Australian Grape & Wine and Wine Australia.

Importance of economic metrics to sustainability

In 2019, a collaborative project with the Food Agility CRC supported the incorporation of economic metrics into Sustainable Winegrowing Australia. Modelling of the data collected was used to investigate a sustainability index and artificial intelligence was applied to assess the value of models to predict 'sustainable' vineyards.

Trust mark developed for Sustainable Winegrowing Australia

The AWRI and Australian Grape & Wine co-invested in the development and protection of a trust mark for use by certified members of Sustainable Winegrowing Australia. The trust mark became available for use on wine labels and marketing materials in June 2020 and is a public endorsement of certified members' commitment to sustainable practices.

SUSTAINABLE WINEGROWING AUSTRALIA · CERTIFIED ·

Origin of Gingin Chardonnay clone confirmed through genomic analysis

Newly identified clonal markers were used to investigate the heritage of the popular Chardonnay clone known as Gingin. Introduced into Western Australia in 1957 via the University of California, Davis, Gingin was believed by some to be derived from the same source material as a clone known as Old Foundation Block (OF) Chardonnay, but was also commonly thought of as being the same as another clone with similar traits called Mendoza. The new genomics research revealed that all three clones have a shared heritage, but are, however, quite distinct from each other. This work demonstrates that a great deal more is possible from grapevine genomics beyond simply confirming grape variety.

SO_2 impacts on wild ferments

Winemaking trials were performed across three vintages assessing the ability of SO_2 additions to influence the microbial and chemical composition of wild Chardonnay fermentations. The addition of as little as 35 mg/L of SO_2 prior to the initiation of fermentation significantly and reproducibly altered the non-*Saccharomyces* yeast composition of the wine. This was accompanied by changes in the final chemical composition of the wines produced, with significantly higher levels of acetate esters being observed in the wines made from SO_2-treated juice.

Foundational data and support services

AWRI Commercial Services

In 2019/2020 the Commercial Services laboratories processed 26,561 samples, 13% higher than the historic three-year (2017-2019) average of 23,450. There were 349 new customers – an increase of 93% compared to the previous year. Both of these increases were predominantly due to the significant sample numbers associated with smoke taint testing.

Yeast and bacteria samples updated to high-throughput screening format

More than 4,000 strains in the AWRI Wine Microorganism Culture Collection (3,032 yeast and 1,096 bacteria) were transferred to a format suitable for high-throughput screening.

WIC Winemaking Services

WIC Winemaking Services processed 416 (6-150 kg and 1-2 tonne) batches of wine during the 2020 vintage, made up of 20% white wines and 80% red wines. Protocols were developed to allow services to continue to be delivered while operating under COVID-19-related restrictions.

New instruments for metabolomics

A state-of-the art liquid chromatography-high resolution mass spectrometry instrument (Orbitrap IDX), a liquid chromatography-triple quadrupole mass spectrometer and a 400MHz nuclear magnetic resonance (NMR) instrument were acquired, to expand metabolomics service provision. New laboratory space was secured to assist with this expansion.

Continued extension of practices survey data

Knowledge and data gained from the AWRI Vineyard and Winery Practices Survey continued to be drawn upon for extension and communication activities including industry articles, presentations, workshops, posters and AWRI helpdesk requests.

Readers are encouraged to read the annual report in detail rather than relying on the brief details provided here. The full report can be found on the AWRI website: **www.awri.com.au.**

Acknowledgements The Australian Wine Research Institute, a member of the Wine Innovation Cluster in Adelaide, is supported by Australian grapegrowers and winemakers through their investment body, Wine Australia, with matching funds from the Australian Government. The contribution of collaborators in Australia and overseas is gratefully acknowledged.

Photography Jacqui Way Photography, Andy Stevens Photography, Eric Wilkes, AWRI

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