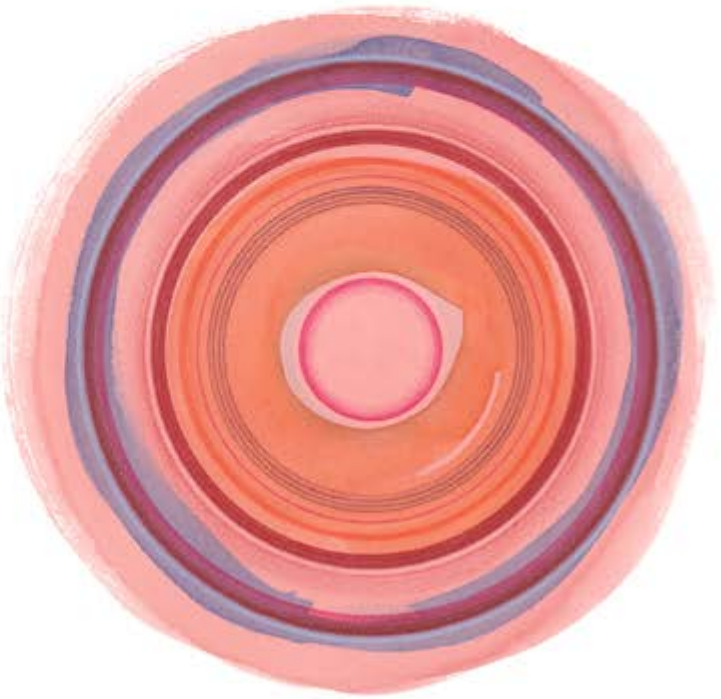
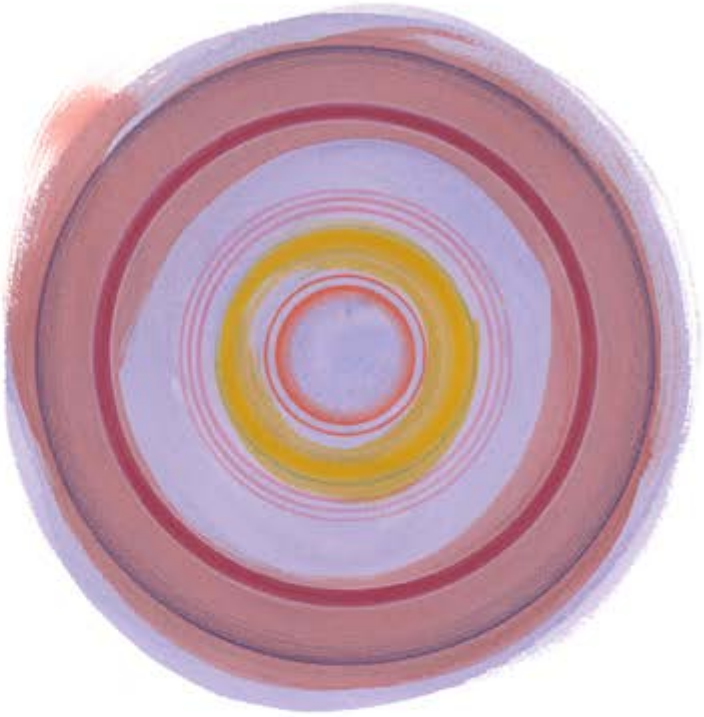
The Australian Wine
Research Institute





ANNUAL REPORT

The company

The Australian Wine Research Institute Ltd was incorporated on 27 April 1955. It is a company limited by guarantee that does not have a share capital.

The Constitution of The Australian Wine Research Institute Ltd (AWRI) sets out in broad terms the aims of the AWRI. The AWRI's activities are guided by its business and research, development and extension plans, and its stated mission, values and behaviours:

Mission

Supporting the Australian grape and wine industry through world-class research, practical solutions and knowledge transfer.

Values

Values provide guidance in how the AWRI will deliver on its mission. These values are:

- Excellence
- Integrity
- Passion

Behaviours

Behaviours in support of those values are:

Excellence

- Outcomes focused, delivering results
- Personal mastery – being the best one can be
- Asking and answering the right questions
- Relevant to industry
- Collaborating to achieve faster, better or cheaper outcomes

Integrity

- Accountability to stakeholders
- Dealing honestly, impartially and consistently
- Scientific and professional rigour

Passion

- Enthusiasm for our people, our industry and our products
- Spirit of creativity
- Enjoying work and celebrating achievements
- Desire to do better
- Pursuing knowledge and understanding

The AWRI's laboratories and offices are housed in the Wine Innovation Central Building within an internationally renowned research cluster on the Waite Research Precinct at Urrbrae in the Adelaide foothills. Grape and wine scientists from other organisations are co-located with the AWRI in the Wine Innovation Central Building.

The Waite Research Precinct is also home to other research and teaching organisations including: Australian Centre for Plant Functional Genomics (ACPFG), Australian Genome Research Facility (AGRF), Australian Grain Technologies (AGT), Australian Plant Phenomics Facility, CSIRO, South Australian Research and Development Institute (SARDI), the University of Adelaide's *School of Agriculture, Food and Wine* and the Waite Research Institute.

Registered office

Cnr Hartley Grove and Paratoo Road, Urrbrae, SA 5064
Postal address: PO Box 197, Glen Osmond, SA 5064
Telephone: (08) 8313 6600
Fax: (08) 8313 6601
Internet: www.awri.com.au
Facebook: www.facebook.com/The.AWRI
Twitter: www.twitter.com/The_AWRI
YouTube: www.youtube.com/c/TheAWRI
ABN: 83 007 558 296

Cover artwork

This year's cover features three works by artist Elizabeth Willing, who spent time at the AWRI in 2019 as artist in residence, supported by the Australian Network for Art and Technology. These works form part of a series of six, each representing the sensory characteristics of a Shiraz wine from a different Australian region.

ELIZABETH WILLING
Six Australian Shirazes (no.3) 2019 watercolour and pencil on cotton paper 40 x 30 cm (front cover, upper)

ELIZABETH WILLING
Six Australian Shirazes (no.4) 2019 watercolour and pencil on cotton paper 40 x 30 cm (front cover, lower)

ELIZABETH WILLING
Six Australian Shirazes (no.2) 2019 watercolour and pencil on cotton paper 40 x 30 cm (back cover)

Contents

66th Annual Report – 30 June 2020
Presented to the Australian grape and wine community

Chair and Managing Director's report

The 2019/2020 financial year will be remembered as a challenging one in the Australian wine industry, in Australia more broadly, and worldwide. Drought and bushfires at a scale not seen before in Australia 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, to allow us to continue to support Australia's grape-growers and winemakers in dealing with these challenges.

There were, of course, many positive developments during the year too. The 17th Australian Wine Industry Technical Conference (AWITC), held in Adelaide in July 2019, was a very productive gathering of the grape and wine community, with strong engagement across the value chain. Sustainable Winegrowing Australia saw very pleasing growth in member numbers and engagement. Many of the AWRI's current projects reached the end of their third year, bedding down some excellent results, which are summarised later in this report. Greater understanding of a range of viticultural and winemaking practices, commercialisation of new yeast strains and continued innovation in extension activities were all steps forward that will have positive industry impact. And while the bushfires and smoke exposure were absolutely devastating for so many regions, a very small silver lining could be found in the opportunities they afforded to learn more about smoke taint – in particular, the effects of early-season smoke exposure.

Leadership transition

The year also 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. We congratulate Dan on his new appointment and wish him well as he joins the university sector. A report from Dan immediately follows this report.

Drought, bushfires and smoke

The 2019/2020 bushfire season was triggered by hot temperatures in spring and summer following a prolonged drought across the eastern Australian states. Fire events occurred across all states and territories, starting as early as September 2019 and continuing through to March 2020. In mid-January 2020, a wave of heavy rain brought some relief, but it was not until mid-February, with the help of more heavy rain, that most of the fires began to be contained. Fires were concentrated within South Australia, New South Wales and Victoria and burned an estimated 11.9 million hectares, dwarfing the 1.3 million hectares burnt in the 2006/2007 Victorian bushfires, or the 187,000 hectares burnt in Tasmania in 2019. 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 between December 2019 and June 2020, compared to around 600 samples analysed in a typical year. Interpretations were provided for more than 4,300 samples by a team of staff recruited from across the organisation. The AWRI helpdesk responded to more than 1,600 smoke-related queries and the extension team staged twenty-five smoke and fire-related events across an eight-week period, with more than 1,300 people attending. Seven new fact sheets related to bushfires and smoke were produced. Close cooperation with national, state and regional organisations allowed for coordinated sample delivery to laboratories for analysis and tailored technical support.

Low vintage 2020 tonnage

The impacts of drought, smoke and bushfires resulted in a lower tonnage crop for vintage 2020 compared with recent years, estimated to be 1.52 MT. This level of crop triggers funding reduction provisions within the AWRI's Investment Agreement with Wine Australia. Productive discussions with Wine Australia have, however, resulted in an agreement to share the funding reduction across our two organisations and implement the reduction in 2021/2022. This cooperation is greatly appreciated.

Responding to COVID-19

Responding to the COVID-19 pandemic in a way that supports the health and well-being of AWRI staff, while maintaining services to industry and continuing to meet R&D targets has been a major priority for the AWRI's Board and Management team since January 2020. The AWRI's COVID-19 response has included:

- Restricting access to the AWRI for returning overseas travellers from January, adapting building access requirements in response to changing conditions and cancelling planned international and interstate travel
- Achieving approval from the South Australian Government to continue to trade as an essential service provider for the Australian grape and wine industry
- Establishment of a COVID-19 response team, which has met at least weekly since March 2020
- Transitioning the majority of planned face-to-face extension activities to virtual platforms
- Providing communications to industry via the AWRI website and *eBulletins* regarding COVID-19 impacts, including information on winery sanitation and training resources for an inexperienced pruning workforce
- Transitioning approximately 80% of AWRI staff to remote working arrangements for the period from 23 March to 22 June 2020, while maintaining essential staffing levels within laboratories and the winery
- Making significant changes to the work environment and practices to encourage good hygiene and appropriate social distancing
- Providing regular communications to staff including advice and support for maintaining mental health.

The AWRI community has responded incredibly well to these major and unanticipated changes to their work and life situation. Questions about

the AWRI's COVID-19 response were added to the HR survey carried out in June to canvass staff opinions on this subject. More than 75% of staff rated the response as 'highly effective' across three metrics relating to ensuring staff well-being, maintenance of services to industry and providing timely and effective communications.

Annual HR survey

Additional results from the AWRI's annual HR survey continued positive trends from recent years, with 93% of staff indicating that they consider the AWRI an Employer of Choice and 95% agreeing that the AWRI is a great place to work. Such results are an endorsement of steps taken to continuously improve conditions for staff, including a strong focus on professional development. Qualitative feedback indicated that flexible working conditions, well-being initiatives and the overall AWRI work environment were strongly valued, along with the people, culture and purpose of the AWRI's work.

AWITC

The 17th AWITC was held in Adelaide in July 2019, with more than 3,000 people attending the combined conference and trade exhibition. This event is underpinned by collaboration – with key partners including the Australian Society of Viticulture and Oenology (ASVO), Australian Grape & Wine, Wine Industry Suppliers Australia, Expertise Events and McWilliam's. The program included 11 formal sessions over three days, with 9 international speakers and 41 Australian speakers. The AWRI events team coordinated an ambitious program of 33 workshops held in a single day, and AWRI staff contributed strongly across both planning and delivery. Feedback from conference attendees was overwhelmingly positive, with more than 85% of respondents satisfied or very satisfied with the relevance of the information received. The importance of the WineTech trade exhibition as an integral part of the event was also stressed, with more than 90% of respondents indicating that it was valuable or very valuable.

Collaboration

The AWRI is grateful to its many collaborators in industry and in scientific institutions within Australia and across the world. So many of our activities depend on industry partners who provide samples, advice or access to facilities to ensure the relevance and impact of our research. AWRI scientists also benefit greatly from knowledge shared by visiting scientists and students, as well as participation in formal and informal networks within the global grape and wine science community. Every year, the AWRI works closely with hundreds of grapegrowers and winemakers, provides services to a wide range of investment partners and clients, and operates more than a hundred active research collaborations. Thanks are expressed to each of these important partners.

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.

Exploring the intersection between art and science

For the first time, the AWRI hosted an artist in residence, as part of the Australian Network for Art and Technology (ANAT) program. Visual artist, Elizabeth Willing, was embedded within the AWRI's sensory team, where she explored cross-sensory perceptions of colours and shapes related to wine sensory properties. Elizabeth, based in Brisbane, has a background in using food and beverages in her art practice. This collaboration not only resulted in the creation of a series of artworks, including those featured on the cover of this report, it also uncovered new insights into associations of wine flavours with visual cues. The ANAT program is intended to act as a mutually beneficial collaboration to bring art and science together, and that was very much the outcome experienced through Elizabeth's time at the AWRI. We look forward to being able to display some of the artworks created by Elizabeth through this collaboration at the AWRI in the coming year.

AWRI Commercial Services

AWRI Commercial Services delivered another strong year, with high sample numbers dominated by smoke analysis. The dedication shown by the Commercial Services team to manage this year's unprecedented smoke taint sample numbers was outstanding. It was also very pleasing to see increased demand for new services such as beer analysis and virus testing, justifying the investments made in developing these new capabilities.

Continued progress on sustainability

The Australian grape and wine industry's sustainability program, Sustainable Winegrowing Australia, was officially launched at the 17th AWITC, after several years of significant collaborative efforts, in particular with the McLaren Vale Grape Wine and Tourism Association. The program takes a holistic approach to managing, supporting and promoting sustainability and covers the environmental, social and economic aspects of grape and wine businesses. During 2019/2020, the AWRI and Australian Grape & Wine co-invested in the development and protection of a trust mark for use by certified members of the program, as a public endorsement of their commitment to sustainable practices. The trust mark became available for use on wine labels and marketing materials in June 2020. Wine Australia is also strengthening its commitment to the program, with increased marketing efforts planned for 2020/2021.

Unravelling the mystery of the Gingin Chardonnay clone

In a very exciting application of recent work on clonal genetic markers in Chardonnay grapevine, the mystery of the origin of the popular Gingin Chardonnay clone was solved by AWRI researchers. Introduced into Western Australia in 1957, 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 represents a significant leap forward for grapevine genomics and demonstrates that a great deal more is possible beyond simply confirming grape variety. The panel of markers identified for Chardonnay will be useful for verification of planting material by nurseries and vineyard owners, and for targeted importation of clones not currently available in Australia. The work also forms a foundation for identifying clonal markers in other grape varieties and potentially other crops. A new collaborative project with Adelaide Hills Vine Improvement Inc. (funded through the SA Wine Industry Development Scheme, with additional support from the project partners and Wine Australia) will apply similar techniques in sequencing genomes of clones of Pinot Noir planted in the Adelaide Hills, as part of bushfire recovery efforts and development of new source blocks for the region.

First Advanced Viticulture Course

A highly successful pilot Advanced Viticulture Course was presented in October 2019. Twenty participants travelled across four SA grapegrowing regions for a hands-on learning experience exploring the latest developments and innovations in viticulture. Following the success of this course, further courses are planned for 2020/2021 and beyond.

Extension review recommendations implemented

One of the recommendations of the 2019 independent performance review of Wine Australia was that the organisation 'review the way it manages extension and adoption of R&D outcomes and to consider whether a more structured approach is required'. A strategic review of

extension and adoption in the wine sector was conducted in 2019 and the final report was delivered to Wine Australia in March 2020. Since the finalisation of that review, the AWRI has worked closely with Wine Australia on the development of the extension and adoption annual operating plans (AOPs) for 2020/2021, to ensure they reflect the review's recommendations. The core AWRI extension project 'Improving viticulture and oenology practice through extension' was substantially modified in line with Wine Australia's expectations about how this project should be planned and executed. The project team consulted thoroughly on stakeholder needs with Wine Australia and Australian Grape & Wine via the Research Advisory Committee, as well as with regional and industry partners on extension design elements, with the objective of developing a 'review and plan in advance' mechanism to provide more detail regarding stakeholder needs in the AOP.

Wine Australia Performance Review

Wine Australia commenced a review of its strategic partnership agreements with the AWRI and other research providers in June 2020. The first stage of the review will focus on the agreement itself, while the second stage will cover the achievement of Year 3 deliverables, scientific and technical excellence, and industry impact. The AWRI will cooperate fully with the reviewers appointed by Wine Australia and looks forward to the opportunity to demonstrate the significant benefits that have been achieved for industry through the longer-term partnership structure.

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. Over the coming year we will work closely with Wine Australia and Australian Grape & Wine to adapt our project portfolio to better reflect the current needs of the Australian wine sector, as outlined in the two new strategic plans. It is envisaged that any substantial revisions to the AWRI's project portfolio would become effective from 2021/2022.

Technical trends from the AWRI helpdesk

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 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.

As described earlier in this report, the largest number of queries received this season were about bushfires and smoke taint. The AWRI helpdesk and extension teams were focused on smoke and fires for much of the first half of calendar year 2020. In addition, in March, technical enquiries began regarding COVID-19. These mainly focused on how to operate within recommended restrictions, what to do if a staff member tested positive for the virus, including cleaning requirements for grape and wine production facilities, and the risk of the SARS CoV-2 virus surviving in wine. A review of cleaning and sanitation agents suitable for winery environments was conducted and an *eBulletin* and webpage were produced to address these questions.

Responding to concerns that travel restrictions would have an impact on the availability of experienced pruners, a series of instructional videos on pruning was produced and a webinar delivered to provide training in the basics of spur and cane pruning. More than 200 people attended the webinar live and more than 500 people watched the videos within their first week of release.

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 (on topics of glutathione, rotundone and authenticity) as well as the launch of several important new projects (continuing efforts in smoke taint, new work on low- or no-alcohol products and a project responding to the ACCC market review of wine-grape pricing). The year will also feature:

- the completion of a performance review of the AWRI's strategic partnership agreement with Wine Australia
- a review of the AWRI's project portfolio to ensure ongoing alignment with the industry's new Vision 2050 and Wine Australia's strategic plan for 2020-2025
- preparation of a new AWRI Directions plan – the business and operational initiatives that support the AWRI's research, development and extension plan
- commencement of three new Directors in January 2021.

Thanks

An enormous vote of thanks is extended to outgoing Managing Director, Dr Dan Johnson, who finished his time at the AWRI at the end of January 2020. Dan has served the AWRI and the grape and wine community with dedication and commitment since 2007. His leadership has ensured that the AWRI has strengthened its position as a pre-eminent grape and wine research organisation on the global stage. Dan will be greatly missed, but we look forward to opportunities to collaborate with him in his new role as Pro Vice Chancellor Research Innovation at Macquarie University. Dan is also thanked for his efforts in ensuring a smooth transition and handover.

We would also like to thank Australian Grape & Wine and Wine Australia, who provide essential strategic and financial support to both the AWRI and the broader Australian wine community. The AWRI Board is warmly thanked for its contributions during the year. Dr John Harvey left the Board in December 2019 and is gratefully acknowledged for his input during his time on the Board. Finally, we would like to thank every member of the AWRI team, who have all showcased their determination and ongoing commitment to supporting industry in this challenging year.

Louisa E. Rose
Chair

Mark P. Krstic
Managing Director (from 1 February 2020)

Outgoing Managing Director's report

Leading the AWRI and working directly for Australian grapegrowers and winemakers has been a truly rewarding part of my life. I'm grateful for the opportunity to reflect briefly on my time at the AWRI and some highlights of what has been delivered for the Australian grape and wine industry. I'd like to thank the AWRI team, both staff and Directors, for their support during my time at the AWRI, in particular past and present AWRI Chairs Peter Dawson and Louisa Rose.

I would also like to extend my very best wishes to Dr Mark Krstic, who I know will do an exceptional job as the incoming Managing Director. His deep viticultural knowledge and experience, combined with a strong commercial mindset, will stand the AWRI in excellent stead into the future. I look forward to ongoing collaborations with the AWRI and seeing the organisation thrive under his leadership.

It is always hard to select highlights, particularly from an extended period of time. Much could be said about the positive organisational reforms achieved, which see the AWRI now regulated by the Australian Charities and Not-for-profits Commission, exempt from payroll tax, operating a world-class workplace health and safety program and benefitting from best practice governance. Even more can be said about the positive research outcomes and their impact for industry, some of which are highlighted below.

Partnerships and collaboration

Collaboration is essential for good science and a key part of the AWRI culture. Development and growth of partnerships that magnify the impact of the AWRI's activities, with direct benefits to the Australian grape and wine community, has been a priority. One example is the important partnerships that now support the AWITC, extending its reach and making it a must-attend event for people from all roles within our industry. International partnerships, such as the BAG alliance and Oenoviti, also have a big impact, bringing new ideas and people to the AWRI and allowing Australian researchers and industry to learn from the best minds in the world.

Long-term strategic investment partnerships with Wine Australia and its predecessor, the GWRDC, as well as strategic partners in government and industry have been so important to the AWRI's work throughout my tenure. They are a key factor behind the current strong international standing of the AWRI, and provided a platform for the organisation to successfully diversify its income base, allowing for talent retention during an era where the industry saw a significant decline in national research capability.

Viticulture and sustainability

Two key areas that have grown in importance at the AWRI in the past decade are viticulture and sustainability. It has never made sense to me to try to study wine science in isolation, without taking a full 'grape to glass' perspective. As such, I have been proud to support the growth of the AWRI's viticulture capability and see more holistic trials conducted that translate through to practical outcomes for growers and winemakers. In parallel, the AWRI's involvement in sustainability has also grown significantly. Since the AWRI commenced its custodianship of Entwine Australia in 2015, major steps forward have been taken in creating one unified national sustainability program for growers and winemakers and in developing the Sustainable Winegrowing Australia trust mark for certified members. I will look forward to seeing that mark on bottles of wine and vineyard fences as the program's reach and recognition continue to grow.

Genomics applications

Another area that is close to my heart is that of applying the science of genomics to real-world grape and wine industry problems. While the Australian wine industry has a clear policy position not to use genetically modified organisms in grape or wine production, there is still an enormous amount of benefit to be gained from using genomics techniques to study grapevines and wine microorganisms. The sequencing of the *Brettanomyces* genome and the first ever use of CRISPR to carry out gene editing on this species, new detailed understanding of the make-up of wild ferments, the Chardonnay reference genome, the latest discovery of the history of the Gingin Chardonnay clone and work on pest and disease resistance are just some examples of breakthroughs made possible by this technology. There is a very exciting future ahead as applications of genomics in grape and wine are expanded.

New service platforms and growth in commercial services

Recent years have seen a significant expansion of the services offered by AWRI Commercial Services. These have included a much greater emphasis on biological testing (including molecular techniques), analysis of beer and spirits to serve growing market segments, introduction of grapevine virus testing and elimination, and increased packaging and engineering services. Commercialisation in general has been a further area of focus. While a direct commercialisable outcome is not always the final goal for a research project, commercialisation is one important pathway to achieving adoption and ensuring that research remains grounded in commercial reality. Partnerships with yeast and bacteria companies, in particular, have resulted in the commercial release of new strains that bring direct benefits to beverage producers. The successful implementation of digital tools for industry in areas such as wine show software has also been a highlight.

The AWRI is a truly unique organisation. It has an incredible culture, unlike anywhere else I have worked. The common goal of working for the benefit of the Australian grape and wine industry unites staff and ensures a real sense of shared purpose. I will miss the AWRI and am grateful for the experiences and opportunities it has given me.

Dr Dan Johnson
Managing Director (to 31 January 2020)

Board members

Ms L.E. Rose
BAppSc (Oen), BSc, GAICD
Chair – Elected a member under Clause 25.2 (c) of the Constitution

Mr T.J. Bekkers
BAppSc (Ag) (Hons), Grad Cert (Mgt)
Elected a member under Clause 25.2 (c) of the Constitution

Ms W. Cameron
BAppSc (Biochem and Microbiol), MSc, BAppSc (Wine Sci), MW, GradDip (Ed), GradCert (Bus)
Elected a member under Clause 25.2 (c) of the Constitution

Dr J.S. Harvey
(until 31 December 2019)
BSc (Hons), PhD, MBA, GAICD
Elected a member under Clause 25.2 (c) of the Constitution

Dr D.L. Johnson
(until 31 January 2020)
BSc (Hons), PhD, MBA, GAICD
Ex officio under Clause 25.2 (a) of the Constitution as Managing Director of the AWRI

Mr I.M. Jones
BSc, MSc
Elected a member under Clause 25.2 (c) of the Constitution

Prof. K.D. Kirk
BSc (Hons), PhD, DPhil
Elected a member under Clause 25.2 (b) of the Constitution

Dr M.P. Krstic
(from 1 February 2020)
BAgSc (Hons), PhD, MBA
Ex officio under Clause 25.2 (a) of the Constitution as Managing Director of the AWRI

Ms E.A. Riley
BAppSc (Wine)
Elected a member under Clause 25.2 (b) of the Constitution

Mr M.R. Watson
BEc, MBA, CA, RITP, MAICD
Elected a member under Clause 25.2 (b) of the Constitution

Mr M.Y. Woods
BAppSc (Vitic), MBA
Elected a member under Clause 25.2 (c) of the Constitution

Board notes

Chair
Ms L.E. Rose

Audit committee
Mr M.R. Watson (Chair), Mr T.J. Bekkers, Dr J.S. Harvey (to 30 December 2019), Mr M.Y. Woods (from 25 February 2020)

Personnel committee
Ms L.E. Rose (Chair), Mr M.Y. Woods, Prof. K.D. Kirk

Meetings

Ordinary General Meeting
The 65th Ordinary (Annual) General Meeting was held on 26 November 2019.

Extraordinary General Meeting
An Extraordinary General Meeting was held on 25 February 2020.

Board
The Board of the AWRI met on the following dates: 16 and 17 September 2019, 26 November 2019, 25 February 2020, 2 and 16 June 2020.

Investment

The Board of the AWRI acknowledges the continuing financial support of Wine Australia; the Government of South Australia; the Australian Government Department of Agriculture, Water and the Environment; and Bioplatforms Australia, along with a large number of confidential commercial clients.

Appreciation

The AWRI benefits greatly from collaborations with individuals and organisations from the following countries: Australia, Bulgaria, Canada, China, France, Germany, Indonesia, Italy, South Africa, UK and USA. The assistance and cooperation provided by these partners across the globe are gratefully acknowledged.

Pictured left to right: Louisa Rose, Toby Bekkers, Mark Krstic, Mark Watson, Trish Giannini, Iain Jones, Marcus Woods
Absent: Liz Riley, Wendy Cameron, Kiaran Kirk

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. Project staff liaised with key stakeholders to prepare a response to the announcement seeking further information about the timeframe of the change and the proposed new residue definition. To inform the recommendations on the use of Group M3 fungicides, Agrochemical Reference Group members provided information on typical use patterns and 80 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 five *eBulletins,* which included the announcement of the registration of a new insecticide containing acetamiprid and pyriproxyfen and changes to the withholding period for difenoconazole.

Agrochemical digital tools

The AWRI led the development of an MRL app for the table grapes industry, which was released in app stores in November 2019. Other horticultural industries have signalled interest in having similar apps developed for their producers. New agrochemical and MRL portals for wine-grapes are in the final stages of user acceptance testing and are expected to be released in late 2020.

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 AWITC 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.

50th Advanced Wine Assessment Course

The AWRI presented its 50th Advanced Wine Assessment Course in November 2019 and celebrated this milestone with a function for previous guest judges and presenters.

Smoke support delivered

The AWRI helpdesk responded to more than 1,600 queries relating to smoke taint, interpreted more than 4,300 smoke analytical results and operated seven days per week during February and March 2020 to provide technical support to smoke-affected growers and winemakers. Twenty-five smoke and fire-related extension events were staged across an eight-week period, with more than 1,300 people in attendance. Seven new fact sheets related to bushfires and smoke were produced. Close cooperation with national, state and regional organisations ensured coordinated sample delivery to laboratories for analysis as well as tailored technical support and streamlined communications.

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. Further courses are planned for 2020/2021 and beyond.

Sheridan Barter and Laura Bey

Seminars and workshops

During the year, nine roadshow seminars and forty-one workshops were held in winemaking regions across Australia (see Appendix 2 for details). 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 and warning tools, seasonal outlooks, and managing fire-damaged vineyards.

Videos

Eight new videos covering sulfur dioxide (SO_2) analysis, advice on isolating deposits from wine and vineyard pruning were produced during the year as part of a successful pilot project.

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 (including the works featured on the cover of this report), but also new insights into associations of wine flavours with visual cues. The results of a series of sensory tests showed that individuals could readily relate wine flavour, when wines were tasted in black glasses, to specific shades of colour and to shapes. A slightly more acid, lean red wine was identified as 'bright red' in colour and 'spiky' in shape; a richer, fuller wine with 'ripe fruit' flavour was associated with 'deep purple' and a 'smooth' shape; and wines with 'stalky', 'vegetal' or 'mint' flavours were indicated as 'green' in colour. 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-volatile compounds 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', with sparkling wines classified as affected by this character significantly higher in indole concentration than those where the off-flavour was not evident. 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.

Whole bunch fermentation research wins poster award

A poster describing the effect of differing proportions of crushed whole bunches in Shiraz and Pinot Noir fermentations won both the best poster and people's choice awards at the 17th AWITC. The study showed how whole bunches can give clear 'stalky' flavour and elevated methoxypyrazine concentration in wine, as well as affecting colour, astringency and other sensory properties.

Rapid sensory methods can be substituted for time-consuming methods

Several rapid, relatively simple sensory methods were compared to the accurate and detailed but lengthy quantitative descriptive analysis method, which is the 'gold standard' method. The 'rate all that apply' method, when completed in a single session with 35 semi-trained assessors, gave similar results to the standard method. The new 'polarised sensory positioning' method, which also requires little time to collect data, showed promise as a sensitive means of determining whether several wines differ in sensory properties, using a relatively small panel.

Flavour precursor research wins student presentation prize

Research on the breakdown of flavour precursors in-mouth and the causes of individual differences in flavour perception was presented at the 'In the Wine Light' student forum at the 17th AWITC. This presentation was awarded the judges' prize for best student presentation.

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 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 (KHT) 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.

New methods to explore wine phenomena

Application of Fluorescence Correlation Spectroscopy for the first time in wine research presented promising opportunities to study many of the complex phenomena that occur in wines; for example, the mechanisms of astringency and haze formation. In addition, an improved method was developed to quantify protein in red wines, showing that a wide range of residual protein concentrations occurs across varieties, in some instances at concentrations that could cause heat-induced hazes.

Further understanding of role of aeration in red and white winemaking

Analysis of Shiraz and Chardonnay wines made using increasing intensity of aeration treatments revealed inherent differences in sensitivity to aeration of red and white wine fermentations. An examination of fermentation aeration dynamics suggests that the process of getting oxygen into ferments is similar regardless of whether those ferments are using red or white grapes.

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* when dealing with 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.

Investigating Shiraz terroir

In a project researching Shiraz terroir across sub-regions of the Barossa, for the two vintages completed to date, only wines made from Eden Valley fruit could be clearly discriminated from wines from the other Barossa sub-regions. In particular, Eden Valley wines had higher 'vegetative' aroma and flavour than wines from other sub-regions, as well as higher concentration of the C6 aldehyde, E-2-hexenal. In order to understand whether management practices can modify grape and wine attributes to a greater extent than site expression, a mulching trial was conducted. Changes in wine chemical composition introduced by mulching were significant, but not substantial enough to distinguish the mulched treatment from other vineyard sites.

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 yeast 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 hydrogen sulfide (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 (associated with '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 H_2S produced by the yeast during fermentation, suggesting that H_2S might be one of the precursors of benzyl mercaptan. In addition, yeast strains with an active Ehrlich pathway were found to produce lower levels of the volatile sulfur compounds methanethiol, methylthioacetate and methional. These strains could be chosen by winemakers to decrease the formation of off-flavours in wine.

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. Aluminium and H_2S concentrations can be minimised by increasing pH and oxygen concentration and by decreasing SO_2 concentration. The onset of H_2S formation can also be delayed if the copper concentration is decreased. A small-scale canning experiment demonstrated that the migration of aluminium into 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 a 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, 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. Consequently, a fine balance is needed to add carbon at a rate that will decrease smoke taint attributes while still retaining some positive flavour and aroma attributes. Carbon-treated wines may also require additional blending with a non-affected wine to blend away residual 'smoke' characters while increasing varietal aromas and flavours.

Dilution effective in treating smoke-affected wines

A smoke-affected 2019 Pinot Noir rosé 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 new two-year project with the University of Adelaide, PIRSA, Grain Producers SA, the SA Grain Industry Trust and La Trobe University commenced in 2019 to assess the potential impact of smoke from stubble burns on grapes and wine, with funding from the South Australian Wine Industry Development Scheme.

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 AWITC. 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

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. The trust mark is a public endorsement of certified members' commitment to sustainable practices.

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 represents a significant step forward for grapevine genomics, demonstrating that a great deal more is possible beyond simply confirming grape variety.

Impacts of SO_2 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.

Potential new species identified

Genome sequencing of several wine isolates of the genus *Aureobasidium* uncovered three potentially new species within this genus of yeast-like fungi that forms a part of the natural flora of grapevines and which may play an important role in the early stages of fermentation.

New wine aroma compound identified

The oxidation of the grape sesquiterpene α-ylangene, a compound commonly found in grapes from 'peppery' vineyards, was demonstrated to result in the formation of a new potent aroma compound, which is present in wine and contributes 'celery-like'/'spicy' characters.

Investigating agrochemical resistance in downy mildew

Next-generation sequencing is being used to track the prevalence of resistance alleles in both powdery and downy mildew, in a collaboration with the South Australian Research and Development Institute (SARDI). During the year, key resistance loci were genotyped across a number of powdery and downy mildew samples. Techniques were also developed to extract DNA from spore traps, which can be used to monitor the presence of fungi in the vineyard (including pathogens) and to determine the species composition of the spore-trap samples via next-generation sequencing of 'DNA barcodes'.

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. The increase in smoke-related analyses was somewhat offset by a reduction in the volume of routine testing for standard wine analytes during the 2020 vintage.

Smoke analysis efforts

The bushfires across Australia in the 2019/2020 summer saw AWRI Commercial Services called on to analyse more than 4,600 samples for smoke before the end of June 2020, with a peak of more than 1,500 samples in a two-week period in mid-February 2020. This compares to an average of around 600 samples submitted for smoke analysis in a typical year. Delivering this number of analyses required doubling the theoretical peak daily sample load to an average of 90 samples per day, an effort only achieved through the close cooperation of the whole AWRI and the Australian wine industry.

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.

Strategic IT achievements

Significant elements of the AWRI's IT Strategic Plan 2019-2021 were delivered, with key achievements including upgraded core network infrastructure and the implementation of multi-factor authentication.

Flexible work arrangements for staff during COVID-19

A raft of arrangements were put in place to allow remote working for a large number of staff during the initial phase of the COVID-19 pandemic. The AWRI's IT infrastructure stood up extremely well to the challenge of greatly increased numbers of staff using remote access. The use of cloud-based collaboration tools such as Microsoft Teams and SharePoint Online increased substantially.

Changes to the AWRI Constitution

The AWRI Constitution was amended to enable it to become more self-sufficient in the conduct of the Board election process, following a practice change within the Australian Government Department of Agriculture, Water and the Environment, which previously assisted with this process.

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 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.

Acknowledgements

Edited by Ella Robinson, Kate Beames and Mark Krstic

Compilation assistance from Natalie Burgan, Alfons Cuijvers, Chris Day, Shiralee Dodd and Dan Johnson

Design by Geoffrey Reed Communications

Photography by Jacqui Way Photography, Andy Steven Photography and Eric Wilkes

Staff

The number of AWRI staff employed in a full-time, part-time and casual capacity as at 30 June 2020 was 130 (103.92 full-time equivalents). When the number of AWRI-based students (both from Australia and overseas) and visiting researchers is added, the total increases to 137. Of these, approximately 61% were funded by Wine Australia in 2019/2020.

Office of the Managing Director

Mark Krstic, BAgSc (Hons), PhD *UniTas*, MBA *MelbBusSchool*, Managing Director

Dan Johnson, BSc (Hons), PhD *Flinders*, MBA *UniAdel*, GAICD, Managing Director (concluded 31 January 2020)

Ella Robinson, BA, BSc (Hons) *UniAdel*, Communication Manager

Shiralee Dodd, BA, LLB (Hons), GradDip (Legal Prac) *UniAdel*, Company Secretary

Natalie Burgan, Cert IV (Bus Admin) *National Group Training*, Dip (Proj Mgt) *SG Learning and Development*, Executive Officer

Corporate Services

Chris Day, BAgSc (Oen), MBA *UniAdel*, GradCert Chartered Accounting Foundations *Deakin*, CA, GAICD, Group Manager – Corporate Services

Mark Braybrook, Cert IV (Eng/Mech Trade) *TAFE*, Operations Manager

Kate Beames, AWITC Conference Manager

Sarah Ballantine, BSc (Hons) (Chem) *UniAdel*, Conference Secretariat (concluded 30 September 2019)

Adam Holland, Cert IV (IT) *NTUni*, IT Manager

Alfons Cuijvers, MLaw *UniAntwerp*, Human Resources Coordinator

Catherine Borneman, BBus (Acc) *RMIT*, CA, Accountant

Fang Tang, Undergrad (Foreign Econ) *RenminUniChina*, GradDip (Fin-Mgt), MCom *UniNewEng*, Finance Officer

Pauline Jorgensen, Cert III (Bus Admin) *TAFE SA*, Finance Officer

Kylee Watson, Cert III (Fin Services) *TAFE SA*, Finance Officer

Josephine Giorgio-Ion, Receptionist

Jennifer O'Mahony, Receptionist

Deborah Thornton-Wakeford, Receptionist (concluded 10 October 2019)

Research

Markus Herderich, staatlich geprüfter Lebensmittelchemiker (CertFoodChem), PhD *UniWürzburg*, GAICD, Group Manager – Research

Keren Bindon, BSc (Hons) (Biol) *UniNatal*, MSc (Plant Biotechnol) *Stellenbosch*, PhD (Vitic) *UniAdel*, Research Manager

Anthony Borneman, BSc (Hons), PhD *UniMelb*, Research Manager – Molecular Biology

Leigh Francis, BSc (Hons) *Monash*, PhD *UniAdel*, Research Manager – Sensory and Flavour

Simon Schmidt, BSc (Hons), PhD *Flinders*, Research Manager – Biosciences

Cristian Varela, BSc (Biochem), MSc (Biochem), PhD (Chem Eng and Bioprocesses) *CatholicUniChile*, Principal Research Scientist

Paul Henschke, BSc (Hons), PhD *UniAdel*, Emeritus Fellow

Marlize Bekker, BSc (Ind Chem), BSc (Hons), MSc (Chem), PhD (Chem) *Stellenbosch*, Senior Research Scientist

Jenny Bellon, BSc (Biochem and Genetics), PhD *UniAdel*, Research Scientist

Agnieszka Mierczynska-Vasilev, MSc, PhD *UniLodz*, Senior Research Scientist

Toni Garcia Cordente, BSc (Chem), BSc (Biochem), PhD (Biochem and Mol Biol) *UniBarcelona*, Research Scientist

Peter Costello, BSc (Hons), MSc *UniNSW*, PhD *UniAdel*, Research Scientist

Julie Culbert, BSc (Hons), PhD *UniAdel*, Research Scientist

Martin Day, BSc (Hons) *UniSussex*, PhD *UniNantes*, MOen *UniAdel*, Research Scientist (concluded 31 October 2019)

Richard Gawel, BSc, GradDip (Ed) *UniAdel,* GradDip (Oen) *Roseworthy,* PhD *Deakin,* Cert IV (Workplace training/assessment) *TAFE SA,* Research Scientist

Josh Hixson, BTech, BSc (Hons) *Flinders*, PhD *UniAdel*, Research Scientist

Darek Kutyna, MSc *AgUniPoland*, PhD *Victoria*, Research Scientist

Cristobal Onetto, MSc, PhD *UniAdel*, Post Doctoral Research Scientist

Mango Parker, BSc (Chem) *Flinders*, PhD *UniSA*, Research Scientist

Michael Roach, BBiotech (Hons), PhD *Flinders*, Research Scientist

Tracey Siebert, ScTechCert (Chem) *SAIT*, BSc *UniAdel*, PhD *UniSA*, Research Scientist

Alicia Jouin, BSc, MSc, PhD *ISVV*, Post Doctoral Research Scientist (started 2 March 2020)

Stella Kassara, BSc (Hons) *UniAdel*, Senior Scientist

Wes Pearson, BSc (Wine Biochem) *UniBritishColumbia*, GradCert (Appl Sensory Sci and Consumer Testing) *UC Davis*, Senior Scientist

Mark Solomon, BSc (Hons) (Med Chem) *Flinders*, Senior Scientist

Caroline Bartel, BSc (Hons) (Biotech) *UniAdel*, Scientist

Sheridan Barter, BTech (Foren and Analyt Chem), BSc (Hons) *Flinders*, Scientist

Eleanor Bilogrevic, BSc (Nutr and Food Sci) *UniSA*, Scientist

Damian Espinase Nandorfy, BSc (Hons) (Oen and Vitic) *BrockUni*, GradCert (Appl Sensory and Consumer Sci) *UC Davis*, Scientist

Yevgeniya Grebneva, DipFoodChem *TechUniDresden,* Scientist

Charlotte Jordans, BSc (Biochem), MSc (Agron) *UniCopenhagen*, Scientist

Allie Kulcsar, BSc (Foren and Analyt Sci) (Hons) *Flinders*, Scientist

Alex Schulkin, BSc *Bar-Ilan*, GradDip (Oen) *UniAdel*, Scientist

Flynn Watson, BSc (Hons) (Double Chem) *UniAdel*, Scientist

Angus Forgan, BSc (Hons) *Flinders*, Research Laboratory Manager

Melissa Aitchison, BAgSc (Oen) *UniAdel*, Technical Officer

Kate Cuijvers, BSc (Hons) (Genetics) *UniAdel*, Technical Officer

Simon Dillon, BSc (Hons) *Flinders*, Technical Officer

WenWen Jiang, BBioeng *DalianPolytech*, MOenVitic *UniAdel*, Technical Officer

Radka Kolouchova, AssocDip *TechCollFoodTech*, Technical Officer

Desirée Likos, BSc (Biochem and Microbiol) *UniAdel*, Technical Officer

Jane McCarthy, Cert (Anim Hand), Cert (Vet Nurs) *TAFE SA*, AdvCert (Med Lab Sc) *UniSA*, Technical Officer

Lisa Pisaniello, BSc (Foren and Analyt Sci) *Flinders*, Technical Officer

Song Qi, BSc (Molec and Drug Design) *UniAdel*, Technical Officer

Tim Reilly, BSc (Hons) (Nanotechnol) *Flinders*, Technical Officer

Steven van den Heuvel, BSc (Hons) (Molec Biol) *Flinders*, Technical Officer

Jelena Jovanovic, Purchasing Officer

June Robinson, Laboratory Assistant

Metabolomics South Australia

Natoiya Lloyd, BSc (Hons) *Flinders*, PhD *UniAdel*, Research Scientist

Luca Nicolotti, Master (Chem and Pharmaceut Technol), PhD *UniTurin*, Research Scientist

Vilma Hysenaj, BSc, Master (Pharm Chem), PhD (Food Chem) *UniGenova,* Post Doctoral Research Scientist

Maryam Taraji, BSc (Appl Chem) *UniGuilan,* MSc (Analyt Chem) *Al-Zahra*, PhD *UniTas*, Post Doctoral Research Scientist

Amanda Ylia, BSc (Hons) (Foren and Analyt Chem) *Flinders*, Technical Officer (concluded 24 March 2020)

Casual sensory panel

Amy Cantor, Sara Davis, Penelope Elliot, Josephine Giorgio-Ion, Cameron Grant, Philippa Hall, Sonya Henderson, Mary-Jane Hendry, Carrie Hill, Gurinder Khera, Mary Likos, Susan Lincoln, Paul Lindner, Junko Nagashima, Neil Owen, Cat Parkinson, Sue Robinson, Heather Smith, Jacqueline Stone

Industry Development and Support

Con Simos, BAppSc (Oen) *UniAdel*, MBA *UniSA*, Group Manager – Industry Development and Support

Peter Dry, BAgSc, MAgSc, PhD *UniAdel*, Emeritus Fellow

Linda Bevin, BBus (Info Mgt), GradDip (Lib and Info Stud) *QUT*, Information and Knowledge Manager

Yoji Hayasaka, DipEng (Ind Chem) *Tokyo IT*, MPharm *Victorian College of Pharmacy Monash*, PhD *Yamanashi*, Senior Research Scientist – Mass Spectrometry

Adrian Coulter, BSc *Flinders*, GradDip (Oen) *UniAdel*, Senior Oenologist

Geoff Cowey, Dip *WSET*, BAppSc (Wine Sci) *CSU*, BSc (Hons) *UniAdel*, Senior Oenologist

Matt Holdstock, BSc *Flinders*, GradDip (Oen) *UniAdel*, Senior Oenologist

John Gledhill, BAppSc (Wine Sci and Vitic) *CSU*, Winemaker

Marcel Essling, BBus *Victoria*, BAgSc *UniAdel*, Senior Viticulturist

Tony Hoare, AssocDipAppSc (Hons) *UniMelb*, BAgSc (ViticSci), BSc (Hons) *UniAdel*, Senior Viticulturist

Mardi Longbottom, BAgSc (ViticSci), MVit, PhD *UniAdel*, Senior Viticulturist

Lieke van der Hulst, BSc *Leiden,* MSc *TechUniDelft*, PhD *UniAdel*, Assistant Winemaker (started 23 January 2020)

Gayle Baldock, BSc (Hons) *UniGuelph*, Scientist (concluded 29 April 2020)

Francesca Blefari, BBus *UniEdithCowan,* Events and Projects Manager

Anne Lord, GradDip (Info Stud) *UniSA*, Librarian

Michael Downie, BA (Hons) *UniAdel*, GradDip (Lib and Info Mgt) *UniSA*, Library and Information Services Coordinator

Elli-Marie Panagis, BBus (Tourism and Event Mgt) *UniSA*, Events and Projects Coordinator

Virginia Phillips, Events and Projects Coordinator

Jessica Scudds, BCA (Fashion Design and Tech) *Flinders*, Events and Projects Coordinator

Industry Engagement and Application

Peter Godden, BAppSc (Wine Sci) *UniAdel*, Manager – Industry Engagement and Application

Commercial Services

Eric Wilkes, BSc (Hons) (Chem), PhD *UniNewcastle*, Group Manager – Commercial Services

Neil Scrimgeour, BSc (Hons) (App Chem) *Wolverhampton*, Senior Project Scientist

Leanne Hoxey, BSc *UniAdel*, Quality Systems and Laboratory Manager

Randell Taylor, BSc (Hons) *UniAdel*, Manager Trace Laboratory

Amy Rinaldo, BBiotech (Hons) *Flinders*, PhD *UniAdel*, Manager Applied Biosciences

Nuredin Habili, BAgSc (Hons), PhD *UniAdel*, Senior Research Scientist

Simon Nordestgaard, BEc, BE (Hons) (Chem), PhD *UniAdel*, Senior Engineer

Bryan Newell, BAppSc (Chem and Physics) *UniSA*, Team Leader – Analytical Laboratory

Pamela Solomon, BTech (Foren and Analyt Chem), BInnovation-Enterprise (Sci and Tech) *Flinders*, Team Leader – Trace Laboratory

Kieran Hirlam, BE (Hons) (Chem), BFin *UniAdel*, Project Engineer

Heather Tosen, BSc *UniAdel*, Scientist

Thomas Almond, BSc (Hons) (Chem) *UniAdel,* Project Technician

Laura Bey, BSc (Foren and Analyt Chem), GradCert (Bus Admin) *Flinders,* Project Technician

Marco Schoeman, BSc (Biotechnol) *UniAdel*, Project Technician

Ida Batiancila, Laboratory Technician

Zung Do, BFoodSc, MFoodSc *HanoiUniSciTechnol*, PhD *UniAdel*, Laboratory Technician

Jesse Hall, BSc (Foren and Analyt Sci) *Flinders,* Laboratory Technician

Thomas Hensel, MSc (Chem) *Flinders*, Laboratory Technician

Kinga Kiziuk, BChem *UniGdansk*, Laboratory Technician (started 25 May 2020)

Jacinta McAskill, Cert III (Lab Operations) *Sunraysia TAFE*, Laboratory Technician

Kara Paxton, BPharmSc, BBiomedRes (Hons) *UniSA*, Laboratory Technician

Shaley Paxton, BSc (Nutr and Food Sci) *UniSA*, Laboratory Technician (started 21 April 2020)

Mark Rullo, BNutrFoodSci *UniSA*, Technical Officer (concluded 31 January 2020)

Dean Smiley, Laboratory Technician (started 10 March 2020)

Matthew Wheal, BSc (Hons) (Biol), PhD *UniAdel*, Laboratory Technician

Qi Wu, BPlantProtection *SouthChinaAgric*, MPlantHealthBiosecurity *UniAdel*, Laboratory Technician

Brigitte Lynch, Dip (Bus Admin) *Careers Australia*, MBA *AustInstBus*, Customer Relations Supervisor

Robyn Gleeson, Customer Service Officer

Jillian Lee, Customer Service Officer

Gina Sellars, Laboratory Assistant

Paul Witt, Courier (started 25 May 2020)

Students

Lisa Hartmann, *UniAdel*, PhD student

Jana Hildebrandt, *UniSA*, PhD student

Elise Laporte, *AgroSup Dijon, France,* visiting student (10/3/2020-14/8/2020)

Kristina Nobis, *Technical University of Dresden, Germany*, visiting student (1/10/2018-31/8/2019)

Elia Romanini, *Università Cattolica del Sacro Cuore, Italy,* visiting student (15/7/2019-9/9/2019)

Robin Stegmann, *Technical University of Dresden*, *Germany*, visiting student (16/3/2020-2/8/2020)

Yuki Takahashi, *Nagano Prefectural General Industrial Technology Center, Japan*, visiting student (6/1/2020-25/3/2020)

Anton Vashchenko, *University of Bonn, Germany,* visiting student (1/11/2019-30/4/2020)

Visiting researchers

Jang Eun Lee, *Korea Food Research Institute, South Korea* (5/2/2020-5/2/2021)

Staff activities

Kate Beames is a member of the Australian Wine Industry Technical Conference Planning Committee.

Anthony Borneman is an Affiliate Lecturer at the University of Adelaide.

Natalie Burgan is Executive Officer for the Wine Innovation Cluster Leadership and Research Committees and a member of the planning committee for Crush – the grape and wine science symposium.

Chris Day is a Chartered Accountant and a Director, Treasurer and Public Officer of the Australian Wine Industry Technical Conference.

Martin Day is a Chartered Chemist and member of the Royal Society of Chemistry (UK). He is also a member of the editorial board of the Atomic Spectrometry Updates, published in the *Journal of Analytical Atomic Spectrometry*.

Peter Dry is an Adjunct Associate Professor at the University of Adelaide and Associate Editor of the *Wine & Viticulture Journal*.

Angus Forgan is a member of the South Australian Institutional Biosafety Committee Network Forum.

Leigh Francis is an Associate Editor of the *Australian Journal of Grape and Wine Research*; a member of the Editorial Board of the *Journal of the Science of Food and Agriculture*; an Affiliate Associate Professor at the University of Adelaide; and an Adjunct Associate Professor at the University of South Australia.

Peter Godden is an *ex officio* Councillor of the Royal Agricultural and Horticultural Society of South Australia and was a judge at the 2019 Royal Melbourne Wine Awards.

Paul Henschke is an Associate Editor of the *Australian Journal of Grape and Wine Research*; an Affiliate Professor at the University of Adelaide; and Fellow of the Australian Society of Viticulture and Oenology.

Markus Herderich is an Affiliate Professor at the University of Adelaide; Director of the Australian Wine Industry Technical Conference; and member of the Metabolomics Australia Executive Management Group. He is also President of the Subcommission for Analytical Methods and expert in Commission-II (Oenology) at the Organisation Internationale de la Vigne et du Vin (OIV); a member of the Wine Industry Technical Advisory Committee; a member of the Wine Innovation Cluster Research Group; a member of the Advisory Board of the *Journal of Agricultural and Food Chemistry* and the Journal Advisory Committee of the *Australian Journal of Grape and Wine Research*.

Matt Holdstock is a Director of the Australian Society of Viticulture and Oenology.

Dan Johnson (to 31 January 2020) was Chair of the Australian Wine Industry Technical Conference; Honorary Adjunct Professor at Macquarie University Graduate School of Management; and a Director of the National Wine Foundation. He was a member of the International Scientific Board of L'Institut des Sciences de la Vigne et du Vin, Bordeaux, France; the *World of Fine Wine* Editorial Board; the Wine Innovation Cluster Leadership Group and the Waite Strategic Leadership Group. Dan is a graduate of the Harvard Business School Authentic Leadership Development program; the Australian Wine Industry Future Leaders Program; the INSEAD Blue Ocean Strategy program; the IESE Creative Negotiation program; and the Oxford Advanced Management and Leadership Program.

Mark Krstic is an Adjunct Professor at Macquarie University; Chair of the Australian Wine Industry Technical Conference; member of the Advisory Board for the South Australian Genomics Centre; Director of the National Wine Foundation; member of the Victorian Government's Wine Ministerial Advisory Committee (until October 2019); member of Hort Innovation's Table Grape Strategic Investment Advisory Panel; member of the National Wine Research and Extension Network; member of Australian Grape & Wine's Sustainability Advisory Committee; Associate Editor of *Wine & Viticulture Journal;* Honorary Senior Fellow at the University of Melbourne; and a graduate of the Australian Wine Industry Future Leaders Program.

Natoiya Lloyd is a member of the Metabolomics Australia Executive Management Group and a committee member of the analytical and environmental chemistry division for the Royal Australian Chemical Institute.

Mardi Longbottom is a Director of the Australian Society of Viticulture and Oenology; a Director of Australian Grape & Wine; a member of the Limestone Coast Grape and Wine Council Technical Subcommittee; a member of the Environmental Technical Committee of Freshcare Australia; Fellow of the Governor's Leadership Foundation Program; and a member of the Australian Wine Industry Technical Conference Planning Committee.

Brigitte Lynch is Secretariat for the Interwinery Analysis Group committee.

Bryan Newell is Samples Coordinator for the Interwinery Analysis Group.

Simon Nordestgaard is Vice President of the Winery Engineering Association.

Wes Pearson is a committee member of the McLaren Vale Districts Group and a graduate of the Australian Wine Industry Future Leaders Program and the Len Evans Tutorial.

Michael Roach is a committee member (webmaster and promotions) of the Adelaide Protein Group – a special interest group of the Australian Society for Biochemistry and Molecular Biology; and a member of the Australian Bioinformatics and Computational Biology Society.

Ella Robinson is a member of the Australian Wine Industry Technical Conference Planning Committee.

Neil Scrimgeour is a member of Australian Grape & Wine's Packaging Committee.

Con Simos is a member of the Australian Wine Industry Technical Conference Planning Committee; a member of the WA Wine Industry Association R&D Committee; and a graduate of the Australian Wine Industry Future Leaders Program.

Cristian Varela is a member of the Editorial Board of the journals *Applied and Environmental Microbiology, International Journal of Food Microbiology, Food Microbiology* and *FEMS Yeast Research*. He is also Affiliate Senior Lecturer at the University of Adelaide and member of the Australian Society of Viticulture and Oenology.

Matthew Wheal is the Secretary and South Australian representative of the Australasian Plant and Soil Analysis Council.

Eric Wilkes is the immediate past chair of the Interwinery Analysis Group committee; Treasurer of the SA branch of the Royal Australian Chemical Institute; and a member of the FIVS (International Federation of Wines and Spirits) Scientific and Technical Committee. He is also a member of the International Wine Technical Summit working groups on Authenticity and Counterfeit, Analytical Method Quality, Laboratory Quality and Expression of Limits.

Eric Wilkes

Project reports

Customers, consumers and markets

The Australian wine industry depends on producing wines that consumers value, trust and are able to access in both domestic and international markets. Projects under this theme aim to take a scientific approach to understanding consumer preferences; to provide technical guidance on agrochemical use to meet export market requirements; to provide support for market promotion activities; to preserve the integrity and quality of Australian wine; and to contribute technical expertise to national and international forums on wine regulation.

Staff

Francesca Blefari, Geoff Cowey, Marcel Essling, Peter Godden, Prof. Markus Herderich, Matt Holdstock, Anne Lord, Elli-Marie Panagis, Wes Pearson, Virginia Phillips, Jessica Scudds, Con Simos, Dr Eric Wilkes.

Collaborators

Accolade Wines (Jonathan Breach); Agrochemicals Reference Group; agrochemical manufacturers, suppliers and consultants; AgVet Chemical Forum (Janine Clark); Australian Grape & Wine (Tony Battaglene, Damien Griffante); Australian Pesticides and Veterinary Medicines Authority (APVMA) (Jason Lutze, Ken Robinson); CropLife Australia (Katie Asplin); Department of Agriculture, Water and the Environment (Nigel Pinto); E. & J. Gallo Winery, USA (Steve Tallman); ETS Laboratories, USA (Gordon Burns); FIVS (Dr Greg Hodson, Bennett Caplan); Food Standards Australia New Zealand (FSANZ) (Dr Mark FitzRoy); GrapeLink (Graeme Forsythe); Grapeweb (Mark Riddell, Mark Roberts); Homologa (Janika Schuster); Institute of Masters of Wine, UK (Olivier Chapman, Sarah Harrison); Organisation International de la Vigne et du Vin (OIV), France (Pau Roca, Dr Jean-Claude Ruf, Guido Baldeschi); SARDI (Barbara Hall); Treasury Wine Estates (Mandy Gerhardy); Wine Australia (Steve Guy, Laura Jewell, Ali Lockwood, Rachel Triggs); Wine Institute, USA (Katherine Bedard).

Supporting market access, safety and regulation

Background

Maintaining market access or opening markets for Australian wine, nationally and internationally, is facilitated by managing and reducing current and potential barriers to trade. The Australian wine industry needs to anticipate, facilitate and influence regulation of wine composition, production, labelling and marketing. This project provides regulatory-related scientific and technical advice and assistance for the activities of key industry stakeholders. In addition, representation at national and international industry forums raises awareness of matters of concern to the Australian wine industry.

Supporting export of Australian wines

Technical support for market access for Australian wine continued, despite travel restrictions in the second half of the year and the cancellation of a number of meetings and conferences. The project team actively participated in international forums including the International Wine Technical Summit, FIVS, World Wine Trade Group, the OIV and the APEC Wine Regulatory Forum. Support was also provided to the Wine Industry Technical Advisory Committee, with information provided on changes to the international regulatory environment and opportunities to improve market access.

Papers and presentations prepared during the year included:

- recommendations on the international harmonisation of sugar measurement in wines, presented at the International Wine Technical Summit
- a presentation to the New Zealand wine industry on the strengths and weakness of various wine fingerprinting technologies to authenticate wine
- recommendations to the OIV on the appropriate use of total dry extract
- information on improving wine laboratory performance, presented to an international workshop of laboratory leaders
- a paper on the challenges of using oxygen isotope methods to determine illicit water additions, prepared for the World Wine Trade Group.

The international ring test program managed by the AWRI in conjunction with the Interwinery Analysis Group continued its success in working to align the analytical capabilities of a range of APEC nations that import and export wine. The program aims to reduce incidents of wine being rejected in market due to failure to meet analytical requirements. The 2019 results from the program demonstrated the continuing improvement of participating laboratories when analysing core analytes used in the regulation of wines (Figure 1). The 2020 program now includes more than twenty countries, including emerging wine-importing countries in Africa, India and South America, with program funding secured from the Australian Government by Australian Grape & Wine. It is hoped that this will continue to reduce the occurrence of mismatched analytical results between importing and exporting countries.

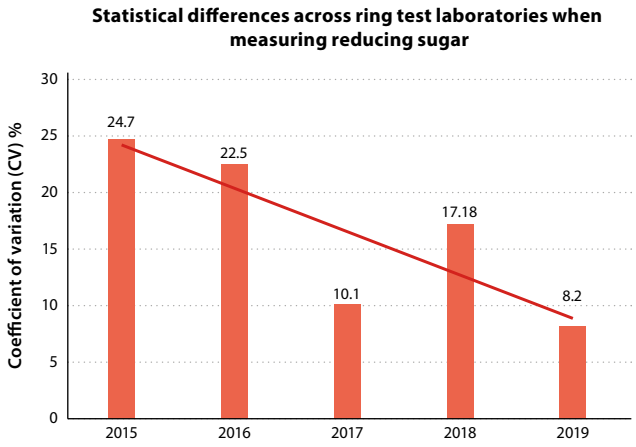


Figure 1. Statistical measure of the differences across laboratories participating in the international ring test when analysing the same wine for reducing sugar. The drop in coefficient of variation (CV) values from 2015 to 2019 represents continued improvement in consistency of the laboratories' analytical performance.

The project team also had significant involvement in helping to address issues arising from changing regulatory requirements in some destination markets, including new analytical requirements from the Thai and Brazilian Governments and approaches for quantifying water additions to must and wine.

Enhancing the reputation of Australian wine through market promotion activities

Background

This project supports Wine Australia's market development strategy by providing targeted technical content designed to inform and educate the wine trade, media and consumers. An engaging message creates opportunities to promote the innovation dimension of Australian wine. Under this project, the AWRI hosts and delivers presentations to international visitors and presents themed tastings, masterclasses and educational activities at Wine Australia events.

Market promotion activities

A one-day wine judging course for 16 Institute of Masters of Wine students was presented in Adelaide in November 2019. Presentations scheduled to be delivered in Austria, Germany and the United Kingdom in early 2020 were cancelled due to the bushfires in Australia. A number of international groups were hosted at the AWRI during 2019/2020, with visits including presentations on wine flavour and tours through the AWRI's facilities.

Collecting and disseminating information on agrochemicals

Background

Governments around the world monitor residues of agrochemicals and set limits for the amounts that are legally allowed in foods, including grapes and wine. Up-to-date information on agrochemical management is needed to ensure that finished wines meet these limits and do not encounter trade barriers. This project aims to assist grape and wine producers to manage agrochemical residue levels in their products. This is achieved by collating and providing accurate and timely information on regulatory and technical aspects of chemicals registered for use in Australian viticulture and the maximum residue limit (MRL) requirements of those chemicals in domestic and key export markets.

Monitoring a dynamic regulatory environment

The project team reviewed 187 Sanitary and Phytosanitary notifications from the World Trade Organization and 31 gazettes issued by the APVMA. These reviews highlighted changes to MRLs for ten key markets including Canada, China, the European Union and Japan. During the year there were 56 notifications relevant to wine-grape production, the majority of which were inconsequential because the new MRL did not require a change to the practices already recommended by the AWRI.

In April 2020 an announcement from the European Union forecasting a change to the tolerance for mancozeb residues did require a change in recommendations on the use of Group M3 fungicides, with a limit of three sprays per season imposed on this group for the 2020/2021 season. Project staff liaised with Australian Grape & Wine and the Australian Government Department of Foreign Affairs and Trade to prepare a response to the announcement, seeking further information about the timeframe for the potential change to the MRL for mancozeb and when details about the residue definition for enforcement would be available. To inform the recommendations on the use of Group M3 fungicides, Agrochemical Reference Group members provided information on typical use patterns for these fungicides and 80 wine samples were submitted for dithiocarbamate residue analysis. This information will help to understand residue issues associated with the use of this class of agrochemicals.

The APVMA gazettes revealed label changes to two active constituents: the insecticide chlorpyrifos and snail control methiocarb. An ant bait with active constituent broflanilide was registered (but not for 'in-field' use) and a review of neonicotinoid insecticides was announced.

Each year, post-harvest, the project team reviews the latest information on agrochemicals by liaising with regulators, chemical manufacturers, suppliers and end-users. Best practice recommendations are then incorporated into a new version of the publication *Agrochemicals registered for use in Australian viticulture* (commonly known as the 'Dog book'). More than 8,500 copies of the 2020/2021 'Dog book' were produced in June for distribution in July. Updates were made to the online search portal and the smart phone agrochemical app, and an electronic version of the 'Dog book' was made available through the AWRI website.

New formulations of two existing active constituents (glyphosate and potassium bicarbonate) were registered for wine-grape production. 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. Five agrochemical or pest and disease-related *eBulletins* were issued during the year and included announcement of the registration of a new insecticide containing acetamiprid and pyriproxyfen, and changes to the withholding period for difenoconazole.


Allie Kulcsar

Extension, adoption and education

The full value of research and development is only realised in industry when outcomes are effectively and efficiently implemented by practitioners. For this to occur, both extension and support for adoption are required. Projects under this theme apply a range of proven mechanisms to communicate research outcomes, solve industry problems, provide access to relevant technical resources, educate and train students, foster industry adoption and bridge gaps between research and practice.

Staff

Gayle Baldock (to 29 April 2020), Linda Bevin, Francesca Blefari, Adrian Coulter, Geoff Cowey, Michael Downie, Marcel Essling, Peter Godden, Dr Yoji Hayasaka, Prof. Markus Herderich, Tony Hoare, Matt Holdstock, Dr Mark Krstic, Dr Mardi Longbottom, Anne Lord, Dr Simon Nordestgaard, Elli-Marie Panagis, Virginia Phillips, Ella Robinson, Jessica Scudds, Con Simos, Randell Taylor, Dr Eric Wilkes.

Collaborators

Agriculture Victoria (Dr Sze Flett, Dr Tim Plozza); Australian Table Grapes Association Inc. (ATGA) (Jeff Scott); Barossa Grape & Wine Association (Nicki Robbins); Brown Family Wine Group (Brett McClen); Department of Primary Industries NSW (Adrian Englefield, Darren Fahey); Hoddles Creek Estate (Franco D'Anna); Langhorne Creek Wine Region (Lian Jaensch); Limestone Coast Grape and Wine Council (Dr Kerry DeGaris, Ulrich Grey-Smith); Mornington Peninsula Vignerons Association (Olivia Barrie, Cheryl Lee, Tyson Lewis); Mount Langi Ghiran (Damien Sheehan); Murray Valley Winegrowers (Paul Derrico, Mike Stone); NSW Wine Industry Association (Angus Barnes, Liz Riley); OICCE Times-Rivista di Enologia, Italy (Dr Giusi Mainardi); Practical Winery and Vineyard Journal, USA (Don Neel); Queensland Wine Industry Association (Mike Hayes); Riverland Wine (Chris Bennett, Chris Byrne); state and regional wine industry associations; University of Melbourne (Prof. Snow Barlow, Dr Pangzhen Zhang); WBM (Anthony Madigan); Western Australian Department of Primary Industries and Regional Development (Richard Fennessy); Wine Australia (Hannah Bentley, Belinda Bramley, Jo Hargreaves, Dr Sharon Harvey, Ali Lockwood, Anita Poddar, Dr Paul Smith, Jacquie van Santen, Dr Liz Waters); Wine Communicators of Australia (WCA) (Lynda Schenk); Wine Grapes Marketing Board (Brian Simpson); Wine Network Consulting (Mark O'Callaghan, Rachel Sutcliffe); Wines of Western Australia (Larry Jorgensen); Wine Tasmania (Paul Smart); Wine Victoria (Angie Bradbury, Damien Sheehan, Rachael Sweeney); Winetitles (Sonya Logan, Hans Mick, Samuel Squire); Yarra Valley Wine Growers Association (Caroline Evans, Susanne Pyle); Yering Station (Willy Lunn, Darren Rathbone).

The staging and conduct of extension programs

Background

The AWRI's extension program uses a range of platforms with the aim of facilitating early awareness of research findings, adoption of new technologies and practice change, all of which contribute to improvements in competitiveness. Activities include the long-standing AWRI roadshow seminar program; workshops featuring practical components including tastings; webinars; the Research to Practice program; the Advanced Wine Assessment Course; and other tasting events. Education activities in areas not covered by levy-payer-funded extension are delivered under a user-pays model. Having a number of different platforms for the extension of technical information is important in the pathway to adoption, as it helps cater for diverse audiences and provides different ways for messages to be delivered. Events delivered by the AWRI in 2019/2020 are summarised in Appendix 2.

Roadshow seminars and workshops

During the year, nine roadshow seminars and forty-one workshops were held in winemaking regions across Australia (see Appendix 2 for details). Workshop topics included spray application, vine pruning methodology, Cabernet Sauvignon and Chardonnay winemaking treatment tastings, and smoke taint. A total of 1,559 participants attended workshop events in 2019/2020.

Webinars

Eighteen webinars were presented to a total of 1,316 attendees in 2019/2020 – more than double the attendance from the previous year (610). 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 and warning tools, seasonal climate outlook, and managing fire-damaged vineyards. The portfolio of presenters remained diverse, with only one-third of sessions presented by AWRI staff. The most popular webinar (with 190 attendees) presented during the year was titled 'A beginner's guide to grapevine pruning' and included three short demonstration videos. This webinar and associated videos were created to respond to COVID-19 restrictions having an impact on the mobility of the pruning workforce.

Educational courses and events

The AWRI presented its 50th Advanced Wine Assessment Course in November 2019 and held a celebratory event with past course judges and presenters. The ShowRunner software platform was again used by participants to provide their wine scores and comments. The events team coordinated a program of 33 workshops with a total of 957 participants at the 17th AWITC, for the first time all presented in one day. A range of additional educational events were also presented (see Appendix 2), with a highlight being the first AWRI Advanced Viticulture Course. 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.

Support for Wine Communicators of Australia

The AWRI provided technical support and hosting of the WCA webinar program and continued to enhance and support the WCA website.

Communication with stakeholders

Background

Communication with the Australian grape and wine community is an essential aspect of the AWRI's activities, helping to maximise benefits from investments in research, development and extension by promoting awareness and adoption. This project develops new content and manages the delivery of information and knowledge to Australian grape and wine producers in formats designed for easy understanding and practical adoption. Communication outlets include the AWRI website, industry journals, the AWRI Annual Report, *Technical Review*, electronic newsletters and social media. Details of all presentations delivered and articles published by AWRI staff in 2019/2020 are listed in the Appendices.

AWRI website

The AWRI website is a major platform for communicating with grape and wine producers, students, potential employees and the general public. 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. Of the total page-views, 33% were viewed using a mobile device or tablet. Updates to content included extensive information on bushfires and smoke taint, information on COVID-19, a new section on wine packaging, new and updated fact sheets and research updates on projects conducted under the AWRI's 2017-2025 RD&E plan. The website was also used to communicate with levy payers about the AWRI Board election and to promote events including seminars, workshops, tastings and webinars.

eBulletins and *eNews*

Twenty-three *eBulletins* were delivered to approximately 3,300 subscribers during the year (Table 1).

Table 1. *eBulletins* issued during 2019/2020

Date	Topic
1/07/2019	Agrochemical update - new insecticide registered
4/07/2019	Nominations open for AWRI Board positions
21/08/2019	Technical Review August 2019 issue available online
23/08/2019	Agrochemical update August 2019
2/09/2019	Four new AWRI webinars – registration is open now!
20/09/2019	AWRI Managing Director moving on
18/10/2019	AWRI Board election – voting now open
21/10/2019	The AWRI has released seven new webinars! Registration is now open.
24/10/2019	Technical Review October 2019 issue available online
14/11/2019	AWRI Board election result
10/12/2019	Technical Review December 2019 issue available online
19/12/2019	Christmas closure and support available during the break
19/02/2020	Technical Review February 2020 issue available online
27/03/2020	Winery sanitation and COVID-19
7/04/2020	AWRI services during COVID-19 pandemic
9/04/2020	Technical Review April 2020 issue available online
20/04/2020	Five webinars to assist growers with vineyards recovering from fire damage
22/05/2020	COVID-19 health and safety guidelines for vineyard workers
22/05/2020	Agrochemical update May 2020
4/06/2020	Technical Review June 2020 issue available online
23/06/2020	Agrochemical update June 2020 – new 'Dog book' available
29/06/2020	Agrochemical update June 2020
29/06/2020	The AWRI has released six new webinars!

Four issues of the AWRI's electronic newsletter, *eNews*, were distributed to an audience of more than 3,640 subscribers. This publication provides information about upcoming events, new information resources, research updates and a general snapshot of the AWRI's activities.

Social media

The AWRI's Twitter following grew by more than 300 during 2019/2020 to reach 3,840. The AWRI's Facebook presence also grew by almost 250 likes during the year to reach 1,498. The AWRI's YouTube channel includes AWRI webinar recordings and other AWRI video content. Subscribers grew by 449 during 2019/2020 to a total of 1,042 and the channel attracted more than 19,400 views, more than double the previous year.

Video content

A pilot project was conducted during the year to assess the resources required to produce video content for AWRI extension platforms. Eight videos were produced in conjunction with an external videographer, as test cases to evaluate staff time requirements and costs for filming and post-production. The videos covered a laboratory method (SO_2 analysis), helpdesk advice on isolating and identifying deposits in wine, and a viticultural practice (pruning). To date the videos have been promoted via AWRI outlets including *eNews*, social media and webinars, and by peak bodies including Australian Grape & Wine and the Wine Grape Council of SA.

Annual report

For the past 65 years, the AWRI has produced a printed annual report as its formal report to Australian winemakers and grapegrowers. Since 1999, the annual reports have also been made available on the AWRI's website. The AWRI publishes a summary of the annual report in the *Australian & New Zealand Grapegrower & Winemaker* and offers to deliver an annual presentation to the board or executive of each major state-based winemaking body. This formal activity complements the wide range of other extension and communication activities undertaken by AWRI staff members throughout the year (see Appendices).

Technical Review

The AWRI's bi-monthly publication, *Technical Review,* publishes abstracts of recently published grape and wine science literature and technical articles authored by AWRI staff. *Technical Review* is available to grape and wine producers via the AWRI website or a small number of hard copies. A total of 942 articles featured in the *Technical Review* Current Literature section were requested by and provided to readers during the year.

Editorial support

The AWRI contributes regular articles to *Wine & Viticulture Journal* and *Australian & New Zealand Grapegrower & Winemaker,* while also contributing to other Australian and international industry journals. Details of the articles published are included in Appendix 7.

Media liaison

The AWRI is regularly approached by national and international media for comment on technical issues related to wine. Eight media releases were prepared and distributed and 39 requests from the media were handled during the year (Appendix 6).

Development of digital extension tools and software

Background

The AWRI currently provides a range of online databases and mobile apps to support Australian grape and wine producers. The uptake of these technologies is high and the demand for technology to improve productivity or promote efficient processes will continue to increase. This project ensures there is a planned and coordinated approach to the development, delivery and maintenance of innovative and collaborative digital tools.

Agrochemical and MRL database platforms

The Agrochemical and MRL databases form the core capability behind the 'Dog book', agrochemical and MRL online search functions and agrochemical mobile apps. Redevelopment of the agrochemical and MRL database platforms commenced in 2019 with a new cloud-based data administration portal and search portal now in the final stages of user acceptance testing. The agrochemical mobile app also underwent a major upgrade with a new MRL search function added. The app and portal will be released in 2020/2021.

Table grapes MRL app

The AWRI has a long-standing partnership with the Australian Table Grapes Association (ATGA), having developed the Table Grapes MRL Search Portal in 2012 and supported it since then. In October 2019, the AWRI launched a new Table Grapes MRL app, which was the first MRL mobile app to be released among horticultural industries across Australia. Feedback from both the ATGA and industry users has been very positive and other horticultural industry bodies have signalled their interest in similar MRL apps for their producers.

Query investigation system

A project exploring the development of an online helpdesk platform commenced in 2019/2020, with the goal of replacing the current MySQL database and providing more efficient and flexible functionality for users. The current system is accessed by more than 35 AWRI staff and used to capture queries received across the organisation.

Redevelopment of winemaking calculator app

The design phase has commenced for the redevelopment of the AWRI winemaking calculator app. Using a single set of source code to generate apps for iOS and Android, the new app will include the current suite of winemaking calculators as well as the total package oxygen calculator. The apps will be available for download from the Apple App Store and Google Play by December 2020.

ShowRunner

Background

ShowRunner is an all-in-one show management software system developed at the AWRI, which covers all aspects of a wine show from online entries to electronic scoring and production of results. The software began as a tailored solution for the Advanced Wine Assessment Course and has been adapted to the processes and practices of the Australian wine show system.

Adoption by Australian wine shows and others

During the 2019/2020 wine show season, 33 shows used the ShowRunner platform, including the National Wine Show of Australia for the second year running. Phase 1 of the Grading and Classification module was launched in 2019. This module allows wineries and winemakers to use a modified version of ShowRunner as an internal grading and classification tool for wines.

BEDA Portal

Development of the BEDA (Benchmark Evaluation Data Analysis) Portal commenced during 2019. The initial focus was to combine all show data into one consolidated data set. Further development activities will allow the BEDA Portal to perform advanced statistical calculations, develop metrics and benchmark the performance of shows, exhibitors and judges.

Regional engagement – the AWRI Victorian node

Background

The AWRI's Victorian node delivers high-quality extension and practice change services to Victorian wine-grape growers and wineries through a partnership between Wine Victoria, Wine Australia and the AWRI. Project activities are overseen by Wine Victoria, which agrees on an annual workplan of activities under funding from Wine Australia's Regional Program.

Node activities

Key extension activities in 2019/2020 included the ongoing evaluation of a rootstock demonstration trial in the Mornington Peninsula in collaboration with the University of Melbourne; soft pruning workshops with Simonet and Sirch; a Chardonnay Symposium; planned burn coordination meetings with the Department of Environment, Land, Water and Planning; tastings of wines from the AWRI's Chardonnay winemaking trial; and Q&A sessions on smoke taint. The AWRI continued to provide support for a business plan in collaboration with Wine Victoria, seeking funding between 2021 and 2025 for four key priorities: climate change; premiumisation and productivity; biosecurity; and smoke taint.

Smoke taint support

During the 2020 vintage bushfires, close coordination with Agriculture Victoria and Wine Victoria supported a shuttle service to deliver samples requiring smoke taint analysis to the relevant analytical laboratories. In addition, assistance was provided for the development of a state government support package for members of the Victorian wine industry affected by bushfires and smoke taint.

AWRI helpdesk

Background

The AWRI's technical helpdesk plays an important role supporting grapegrowers and winemakers across Australia. The helpdesk provides rapid, confidential, technical support on topics across winemaking, viticulture and sustainability, delivered by an experienced multi-disciplinary team.

Helpdesk enquiries

During 2019/2020, 3,400 enquiries were received (Table 2). This is approximately 1,500 more enquiries than recent years, predominantly driven by the unprecedented bushfire events experienced in the past season. This is also the first year that more than 500 sustainability enquiries were received (Figure 2). The majority of enquiries were from grape and wine companies and suppliers actively aligned with the wine industry, with a small number coming from government organisations, students, legal practitioners and journalists. Figure 3 shows that the sources of enquiries were broadly in line with the proportional volume of wine-grape plantings for each state/territory, with slightly more queries than normal for fire-affected states such as Victoria and NSW.

Table 2. Enquiries received by the AWRI helpdesk in 2019/2020

Topic	Number of enquiries
Winemaking	2,592
Viticulture and sustainability	808
Total	3,400

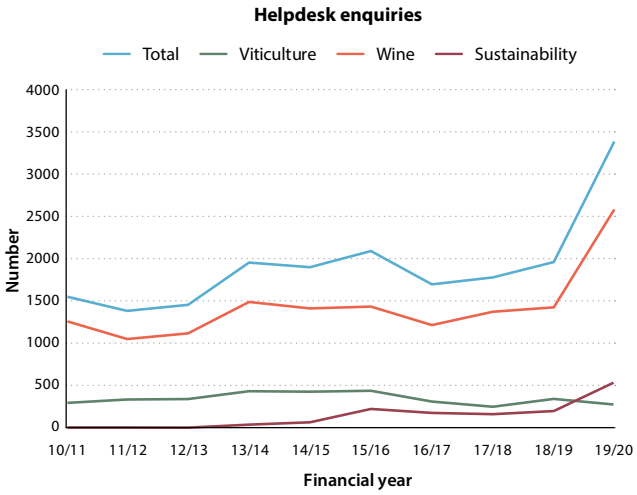


Figure 2. Number of sustainability, viticulture and winemaking enquiries received by the AWRI helpdesk over the past ten financial years

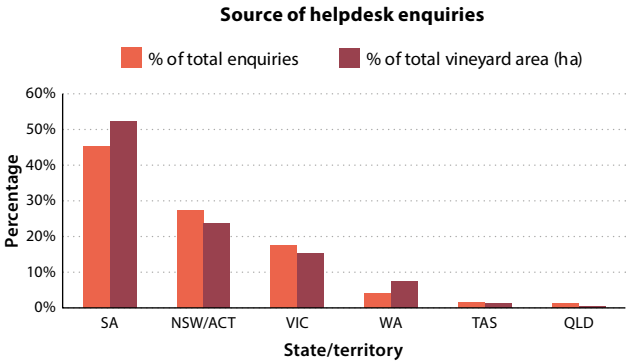


Figure 3. Enquiries received by the AWRI helpdesk in 2019/2020 by state/territory compared to wine-grape vineyard area in 2019 (Wine Australia National Vineyard Scan 2019)

Helpdesk enquiries are classified using more than 40 different keywords. The number of queries received under each keyword is compared to historical monthly data collected over more than 20 years, to help identify national, state and regional trends. This allows for prompt responses to emerging issues and timely provision of relevant information. Figure 4 shows the queries from 2019/2020 arranged from most to least used keyword, highlighting key events or issues that occurred.

Viticulture and sustainability enquiries

During the year, the viticulture team responded to 808 enquiries, with the largest proportion of these (537) on topics related to climate and sustainability. Drought was a key issue for growers, given that many Australian regions had been in drought for several years and received significantly below average rainfall during the growing season. 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. Other climate-related topics where queries were received included frosts, hail damage and strong winds or hot weather during flowering, which had a negative impact on fruit set in some regions.

Winemaking enquiries

The largest number of winemaking queries received this season (48%) were about bushfires and smoke taint. As part of the AWRI's smoke response, the helpdesk interpreted more than 4,300 smoke analytical results. More than 70 different grape varieties were submitted for smoke analysis from 47 different wine regions. Of the samples submitted, more than 75% were grape maturity samples analysed to give producers the information needed to make decisions on whether to harvest fruit, based on evidence of smoke exposure.

In March, technical enquiries began regarding COVID-19, mainly regarding how to operate within recommended restrictions and what to do if a staff member in a vineyard or winery tested positive for the virus, including any specific remediation or cleaning requirements for grape and wine production facilities. A review of cleaning and sanitation agents suitable for winery environments was conducted and an *eBulletin* and webpage produced addressing these questions. Queries were also received about the risk of the SARS-CoV-2 virus surviving in wine.

Winemaking problem-solving investigations

This year only 6% of winemaking enquiries resulted in investigations, where samples are requested and analysis performed to identify the problem and recommend a solution. This is lower than the usual 20% of enquiries resulting in an investigation, mainly due to the overriding number of smoke analysis interpretations. The helpdesk team conducted 166 problem-solving investigations on 904 samples (Table 3). This was approximately 40 fewer investigations than recent years;

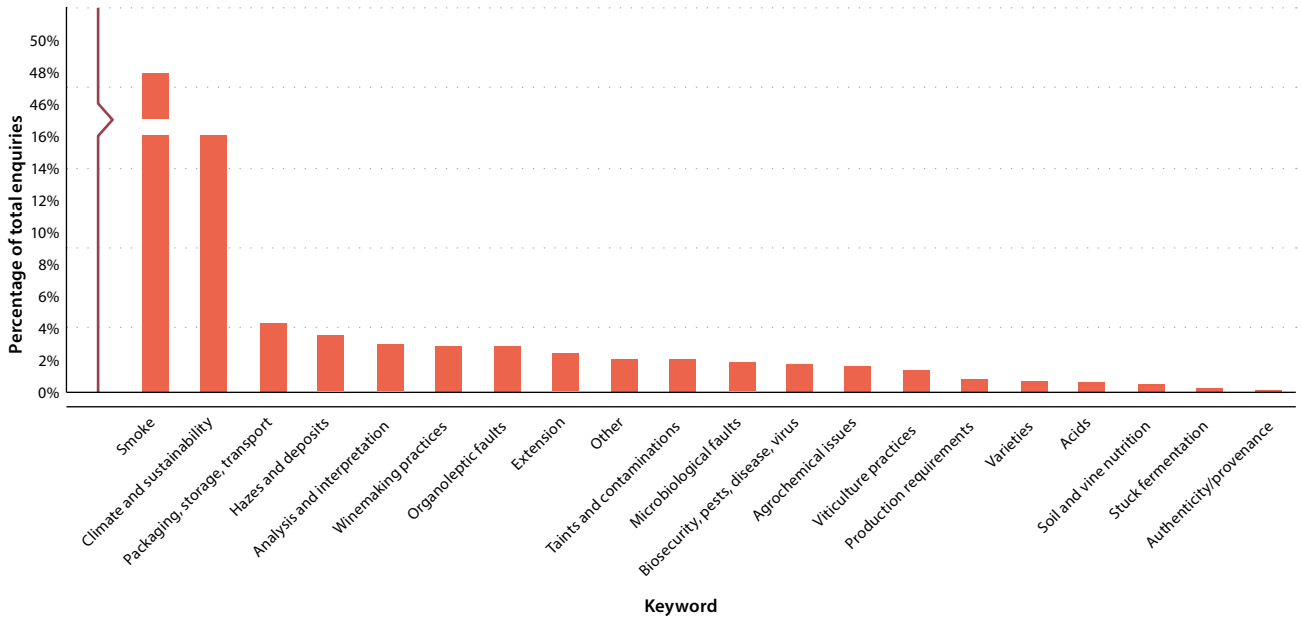


Figure 4. Enquiries received by the AWRI helpdesk in 2019/2020, organised by frequently used keywords. Enquiry numbers are represented as a percentage of total national enquiries, where the total number was 3,400.

however, the number of samples submitted is similar, showing that this year's investigations required larger numbers of samples than usual. As for enquiries, use of the problem-solving investigative service was mostly in line with the proportional volume of wine-grape plantings for each state/territory, with slightly more investigations conducted for Victorian producers than in previous years (Figure 5).

Table 3. Winemaking investigations conducted and samples analysed by the AWRI helpdesk in 2019/2020

Type of investigation	2019/2020
Hazes and deposits	58
Microbiological issues	18
Sensory investigations	35
Taints and contaminations	35
Other investigative analyses	15
Closure-related investigations	5
Total number of investigations	166
Total number of samples analysed	904

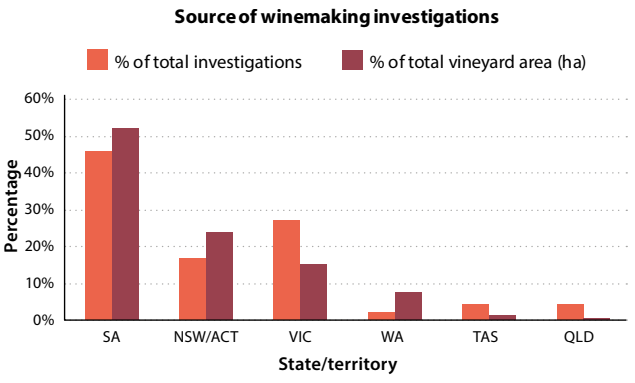


Figure 5. Winemaking investigations undertaken by the AWRI helpdesk in 2019/2020 by state/territory, compared to wine-grape area in 2019 (Wine Australia National Vineyard Scan 2019)

Winemaking investigations are assigned to five main categories: hazes and deposits; sensory investigations; microbiological issues; taints and contaminations; and other. The proportion of investigations in each category has remained relatively consistent over the last ten years, with approximately 20% in each category (Figure 6). Closures is an additional category where investigations were common in the past; however, investigations in this category are now relatively rare because of the widespread uptake in Australia of non-cork-based closures.

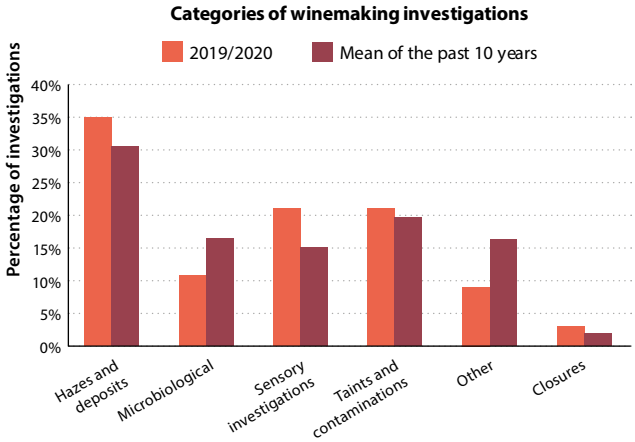


Figure 6. Distribution of winemaking investigations across five main categories (plus closures). For 2019/2020 the total number of investigations was 166.

Hazes and deposits

There were slightly more haze and deposit investigations this year than the ten-year average. One-third of the hazes and deposits identified were crystalline, with two-thirds of these identified as calcium tartrate, similar to last year. These crystals form over time post-bottling and are caused by elevated calcium levels rather than ineffective cold stabilisation for potassium hydrogen tartrate (KHT). Another third of the hazes and deposits were protein instabilities, and a further third classified as 'other deposits', a wide-ranging category including anything from pieces of packaging materials (from cork to fragments of bottle dividers) to, unusually, even a piece of meat!

Microbiological issues

There were fewer microbiological investigations than the ten-year average this year, which is a promising sign. Specific microbiological issues encountered included elevated acetic acid concentrations in wine caused by bacterial spoilage, 'mousy' off-flavour and *Brettanomyces* spoilage.

Sensory investigations

Sensory issues investigated by the helpdesk are often related to oxidation or sulfide development. This year sensory investigation numbers remained high (Figure 7), with additional investigations conducted related to indole formation in sparkling wine.

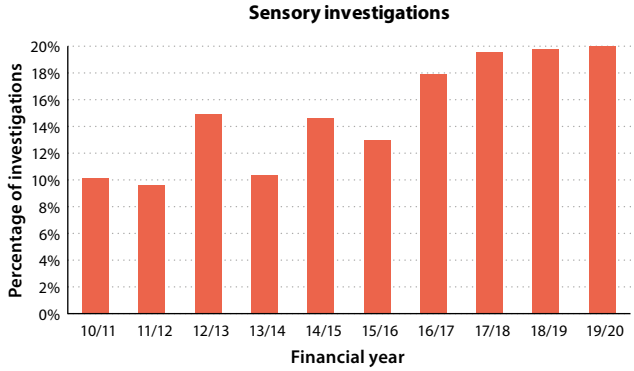


Figure 7. Sensory-related investigations conducted by the AWRI helpdesk from 2010/2011 to 2019/2020

Taints and contaminations

This category of queries was dominated by chlorophenol and 'musty' taints in wines. There were also investigations comparing smoke analytical results with the sensory perception of 'smoky' characters as assessed by the AWRI quality panel.

Library services

Background

The John Fornachon Memorial Library holds one of the largest collections of grape and wine resources in the world, with more than 100,000 print and digital resources on offer via a range of information discovery tools and services. The library supports the Australian grape and wine sector by providing access to technical information that supports learning, understanding and adoption of research outcomes.

eBook collection

The library's eBook collection is steadily growing with nearly 200 titles now available across two platforms. Users are displaying increasing familiarity with the medium, justifying the library's strategic decision to invest strongly in electronic resources including eBooks.

Staff publications database

The staff publications database, accessible via the AWRI website, received nearly 6,000 hits, resulting in 889 staff publications requested and delivered. This collection holds almost 2,200 AWRI-authored items. A number of these publications are offered via open access where licensing allows.

Online information packs

Online information packs are reference lists with a specific topic focus and provide growers and winemakers with seamless access to highly curated and relevant information. During the year, 15 new information packs were created on topics complementing those presented at AWRI webinars. The library received nearly 200 requests stemming from webinar-related information packs, and in total delivered 1,058 articles from information packs, nearly twice the number delivered in the previous year.

Library reference and information requests

The library responded to a total of 1,085 reference and information requests, resulting in supply of 2,513 articles (Table 4), a 30% increase compared to the previous year. More than 90% of requests were completed within a single business day and more than 90% were received via the AWRI website or other electronic means. Library staff also performed 41 specialised literature searches on a variety of topics across winemaking, vineyard management, winery operations and pest management.

Table 4. Articles supplied from library collections in 2019/2020

Article type	Number of items supplied
AWRI staff publications	889
Technical Review collection	942
Library reprint collection	682
Total	**2,513**

Regional Program

Background

Since 2017/2018, the AWRI has coordinated Wine Australia's Regional Program, which supports the regional extension and adoption of research and development findings in the Australian grape and wine sector. The program provides an important connection between relevant research and development and locally identified grapegrower and winemaker needs. Funding from Wine Australia is provided to 11 Regional Program partners, who develop, deliver and report on activities completed within the Regional Program. Management of the Regional Program will revert to Wine Australia for 2020/2021 onwards.

Regional activities

The AWRI assisted in coordinating the design and delivery of extension and adoption activities within the program's 11 regions via input into each region's annual operating plan. The annual regional partners meeting was held in Margaret River, WA in August 2019. This meeting provides an opportunity for the 11 regional partners to share results and experiences from the activities undertaken in the previous year. The Regional Program also supported the implementation of Wine Australia's Incubator Initiative, a program that provides early career researchers with opportunities to spend time in wine regions to conduct research and development activities.

Performance, products and processes

There are numerous processes involved in wine production, from grapegrowing through to delivery of finished product to consumers. Projects under this theme aim to optimise these processes and reduce costs, resulting in overall improvements to wine quality and business sustainability. Specific areas include target setting and objective measures for grape quality and wine style; optimisation of primary and secondary fermentation; assessing new winery processes and equipment; preventing and treating taints and faults; and achieving a greater understanding of wine flavour and texture.

Staff

Melissa Aitchison, Gayle Baldock (to 29 April 2020), Caroline Bartel, Sheridan Barter, Dr Marlize Bekker, Dr Jenny Bellon, Laura Bey, Eleanor Bilogrevic, Dr Keren Bindon, Dr Anthony Borneman, Dr Peter Costello, Adrian Coulter, Kate Cuijvers, Dr Julie Culbert, Dr Martin Day (to 31 October 2019), Simon Dillon, Damian Espinase Nandorfy, Angus Forgan, Dr Leigh Francis, Dr Toni Garcia Cordente, Dr Richard Gawel, Yevgeniya Grebneva, Dr Yoji Hayasaka, Prof. Markus Herderich, Kieran Hirlam, Dr Josh Hixson, WenWen Jiang, Charlotte Jordans, Dr Alicia Jouin (from 2 March 2020), Jelena Jovanovic, Stella Kassara, Radka Kolouchova, Dr Mark Krstic, Allie Kulcsar, Dr Darek Kutyna, Desireé Likos, Jane McCarthy, Dr Agnieszka Mierczynska-Vasilev, Dr Cristobal Onetto, Dr Mango Parker, Wes Pearson, Lisa Pisaniello, Song (Luke) Qi, Tim Reilly, June Robinson, Dr Simon Schmidt, Alex Schulkin, Neil Scrimgeour, Dr Tracey Siebert, Mark Solomon, Dr Cristian Varela, Flynn Watson, Dr Eric Wilkes.

Students

Jana Hildebrandt (University of South Australia), Eva (Yihe) Sui (University of Adelaide), Colleen Szeto (University of Adelaide).

Visiting students

Elise Laporte (AgroSup Dijon, France), Elia Romanini (Università Cattolica del Sacro Cuore, Piacenza, Italy), Robin Stegmann (Technical University of Dresden, Germany), Yuki Takahashi (Nagano Prefectural General Industrial Technology Center, Japan), Anton Vashchenko (University of Bonn, Germany).

Collaborators

Accolade Wines (Warren Birchmore, Lucy Clements); Agriculture Victoria (Joanne Bui, Dr Tim Plozza, Pei Zhang); Australian Network for Art and Technology (Vicki Sowry, Jenn Brazier, Elizabeth Willing); Ball Corporation, USA (Brent Trela); Best Bottlers (Mark Zeppel); Brown Family Wine Group (Geoff Alexander, Joel Tilbrook); Constellation Wines, USA (Martin Di Salvo, Chris Hartless, John Thorngate); Cornell University, USA (Prof. Gavin Sacks); CSIRO (Dr Paul Boss, Dr Rob Bramley, Peter Clingeleffer); E. & J. Gallo Winery, USA (Dr Gal Kreitman, Steve Tallman); Flinders University (Dr Martin Johnston); Grain Producers SA (Peter Cousins); Henschke Wines (Prue Henschke); Hochschule Geisenheim University, Germany (Prof. Doris Rauhut, Prof. Manfred Stoll); Indonesian Institute of Sciences, Indonesia (Dr Satriyo Wahono); Iowa State University, USA (Erin Norton); Dr John Danilewicz, UK; La Trobe University (Dr Ian Porter); Max Planck Institute for Polymer Research, Germany (Dr Kaloian Koynov, Prof. Hans-Jürgen Butt); Mount Langi Ghiran (Damien Sheehan); Mount Majura Vineyard (Dr Frank van de Loo); National Wine and Grape Industry Centre (NWGIC), Charles Sturt University (Dr Andrew Clark, Dr Sijing Li, Prof. Leigh Schmidtke); Northwest Agriculture and Forestry University, China (Dr Anque Guo); Orora Beverage (Kane Chandler); Pernod Ricard Winemakers (Kate Lattey, Dr Jean Macintyre, Tim Pelquest-Hunt); Revenir Winemaking (Peter Leske); SA Grain Industry Trust (Dr Allan Mayfield); SARDI (Dr Marcos Bonada, Roger Maywald, Dr Paul Petrie); Sofia University, Bulgaria (Dr Aleksey Vasilev); Stellenbosch University, South Africa (Prof. Wessel Du Toit); Treasury Wine Estates (Iain Jones, Josh Miles); University of Adelaide (Assoc. Prof. Sue Bastian, Dr Dimitra Capone, Prof. Timothy Cavagnaro, Assoc. Prof. Cassandra Collins, Dr Lukas Danner, Dr Robert Falconer, Assoc. Prof. David Jeffery, Ross Sanders, Assoc. Prof. Kerry Wilkinson); University of Bordeaux Institut des Sciences de la Vigne et du Vin, France (Prof. Philippe Darriet, Dr Alexandre Pons); University of South Australia (Dr Miguel de Barros Lopes, Prof. Peter Majewski, Prof. Krasimir Vasilev); University of Tasmania, Tasmanian Institute of Agriculture (Dr Fiona Kerslake); Vasse Felix (Michael Langridge); Vinpac International (Greg Edwards); Western Sydney University (Dr Gabriel Perrone); Wine Victoria (Rachael Sweeney); Wines by Geoff Hardy (Geoff Hardy, Shane Harris); Yalumba Family Winemakers (Heather Fraser, Brooke Howell, Glynn Muster, Louisa Rose).

Identification and control of compounds responsible for important sensory attributes

Background

The aroma and flavour properties of wine are largely directed by numerous volatile aroma compounds. While many wine sensory attributes can be explained by knowledge of compounds previously studied, there remain several significant wine flavour characteristics where the causative compounds are not known. The ability to identify and measure compounds that give desirable flavour in wines is important to provide targets for grape and wine producers for improvements in vineyard practices and winery processes. This project is also studying innovative and less time-consuming sensory methods for wine evaluation, to better link wine flavour chemistry and sensory outcomes.

Understanding the role of varietal thiols in red wine

Sulfur compounds such as 3-mercaptohexanol (3-MH) and 3-mercaptophexyl acetate (3-MHA) are important flavour compounds in white wines, most notably in Sauvignon Blanc, where they contribute 'tropical fruit', 'passionfruit', 'grapefruit' and 'box hedge' characters. Much less is known about the sensory significance of thiol compounds in red wines.

A sensory quantitative descriptive analysis study was conducted to assess the effects of varietal thiols in red wine flavour, with the compounds added singly or in combination to a Pinot Noir wine. Earlier analytical data had indicated that Pinot Noir wines can have quite high concentrations of 3MH compared to other red varieties. For the sensory addition study, however, little effect was observed, except when the compound 3MHA was added at a high level (double the highest concentration found in a recent red wine compositional survey), where it gave a 'box hedge'/'sweaty' flavour. This study provided evidence that these thiols are unlikely to contribute to fruit-related attributes in Pinot Noir flavour. In recent AWRI sensory-compositional correlative studies there has been some evidence that 3MH can contribute to 'green'/'vegetal' flavour in Shiraz, and this was also noted in wines from the vineyard foliar spray investigations discussed overleaf.

Foliar nutrient sprays and changes in varietal thiols

To improve understanding of the importance and control of the potent 'tropical fruit' thiol compounds through common viticultural practices, studies of foliar sprays were completed over several seasons. Such sprays, including basic nitrogen and sulfur formulations, applied in Chardonnay or Shiraz vineyards close to veraison were found to have a major influence on the concentrations of thiols in finished wines.

The 2019 vintage Shiraz wines made from fruit sourced from vines sprayed with a lower dose nitrogen and sulfur formulation had only minor sensory differences compared to the control wines, with a higher 'cooked vegetal' attribute, while a higher dose spray gave strong undesirable sulfidic-related attributes including 'rubber' and 'drain', as well as lower colour intensity. For the Chardonnay wines, both dose rates had a strong effect on 'tropical fruit' aroma and flavour in the wines, and also contributed a sulfur compound-related 'struck flint' character. Overall, the Chardonnay wines made from treated vines showed more desirable sensory properties than the Shiraz wines, confirming the results from a previous vintage. Wines from a final study assessing a single foliar spray to Chardonnay vines were made during the 2020 vintage. Such an approach, where only one spray application needs to be made per season, may be more practical for growers to adopt.

Riesling flavour: TDN and aged character

Riesling flavour characteristics, especially after some time in bottle, can be affected by the presence of TDN (1,1,6-trimethyl-1,2-dihydronaphthalene), sometimes described as 'kerosene-like'. If TDN is present early in a Riesling wine's life it can be considered detrimental. A collaboration with Hochschule Geisenheim University, Germany continued, with a series of investigations into viticultural and other influences on the propensity of Riesling vineyards to give wines with elevated TDN. A viticultural experiment involving shade cloth of different colours found that TDN concentration diminished with the influence of shade cloth; black and green shade cloth gave a greater reduction of TDN than red shade cloth, with few other sensory effects. The colour of the shade cloth significantly affected the composition of the grapes and wine, specifically around the wavelengths that induce changes for chlorophyll and/or carotenoids. This provides a practical means of limiting the contribution of TDN in wine made from grapes grown in warmer climates.

'Apricot' flavour in white wine

A sensory-compositional study of the relative effects of region of origin, harvest date and grapevine clone was used to probe 'apricot' flavour in Viognier and the monoterpenes related to this flavour found in many white wines. Region of origin was the most important factor, but clone and harvest date were also significant, with one clone giving a higher level of 'apricot' aroma and flavour. This result has potential to provide producers with knowledge to apply in decisions on future plantings or harvest timing.

'Raisin'/'jammy' flavour in ripe Shiraz

The volatile compounds that cause 'raisin' or 'cooked fruit' aroma, especially in late-picked Shiraz, are not well understood. Ripe and overripe grape samples and wines were assessed using a sensory panel, detailed quantitative volatile analysis and GC-olfactometry analysis (with individuals acting as 'detectors' to smell compounds as they are emitted from a gas chromatograph instrument). These investigations showed that several compounds are implicated in 'raisin'/'cooked fruit' characters. Further work will be conducted to confirm the role of these compounds.

The effect of volatile compounds in Shiraz flavour compared to taste, mouthfeel and texture compounds

Responses to wine flavour involve multisensory perception, with the experience of drinking a wine involving the senses of smell, taste and touch, and also usually the visual sense. To assess the role of volatile compounds in the overall flavour experience, the interactions between the volatile fraction of a Shiraz wine, a tannin/anthocyanin extract and taste-active amino acids were assessed by a trained sensory panel at concentrations matching those of a full-bodied Shiraz wine. Interestingly, volatiles made the greatest contribution to sensory properties such as body or viscosity, while the tannin fraction had little effect on these characteristics. The presence of amino acids, previously largely unrecognised as being important to wine flavour, led to greater sweetness and a suppression of bitter taste, with proline, the major amino acid found in wine, having the largest effect on sweetness. This result could have important implications for better control of so-called 'fruit sweetness' in dry red wines.

Assessment of rapid, alternative sensory methods

Quantitative sensory descriptive analysis is a powerful and precise sensory method that allows detailed characterisation of sensory properties across a set of wines, but has the major disadvantage of requiring many days to complete. The results obtained from alternative, much faster methods were compared with those obtained from sensory descriptive analysis. Six Shiraz wines of varying styles were characterised by four different methods:

- sensory descriptive analysis (DA) with a highly trained sensory panel
- the rapid 'check all that apply' method using a panel of 35 semi-trained assessors
- the 'rate all that apply' (RATA) method using a panel of 35 semi-trained assessors
- the rapid polarised sensory positioning method using the trained panel.

The rapid methods gave similar overall results to the time-consuming DA, with RATA showing the greatest promise as a rapid alternative, being more amenable to conventional, shorter statistical analysis and giving the most detailed results. Polarised sensory positioning, which involves assessors rating the degree of difference of each wine against three reference wines, showed promise as a sensitive means of assessing overall sensory differences using a relatively small panel in a single session, although with less informative outcomes regarding attributes that differed.

Artist in residence: Elizabeth Willing

In 2019/2020 the AWRI hosted an artist in residence as part of an Australian Network for Art and Technology program, which aims to bring art and science together in a mutually beneficial collaboration. The visiting artist, Elizabeth Willing, was interested in exploring cross-sensory perceptions of colours and shapes related to wine sensory properties. Elizabeth, based in Brisbane, has a background in using food and beverages in her art practice. A projective mapping procedure was completed with the six Shiraz wines used in the rapid sensory methodology evaluations discussed above, to assess associations of wine flavour with colours and shapes. While all wines in the study were Shiraz, the colours that tasters associated with the wines when tasted in black glasses were surprisingly well-defined. Figure 8 shows that the Canberra District wine, which was relatively acidic, was associated with red colours, while the 'vegetal'/'stalky' Yarra Valley wine was mapped in the green part of the spectrum. The high 'dark fruit' flavoured McLaren Vale wine was associated with deeper blue/purple colours, while the Shiraz-Grenache blend with 'floral' and 'confection' characters was related to yellow shades. The panel also separately marked each wine on a scale for associations with smooth, curving shapes versus angular, spiky shapes, and here the wines with higher astringency were rated as more spiky, while the softer, slightly sweeter wines were rated as more curved.

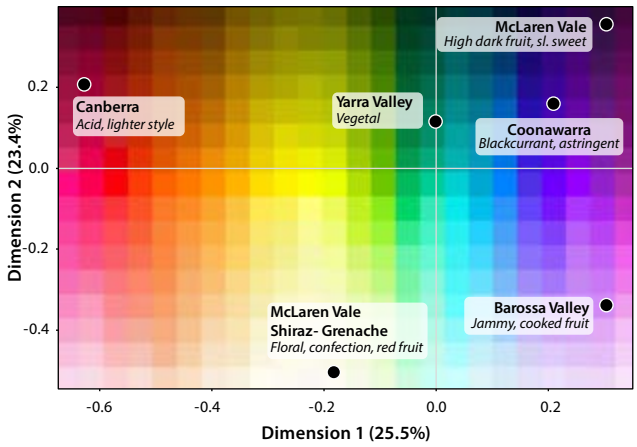


Figure 8. A representation of the colours associated with the flavour of six young commercially produced Shiraz wines (including one blend) by a panel of 62 assessors, tasting the wines in black glasses. Note that the wines were not selected as representative of their regions, with the selection criteria only involving the inclusion of wines with diverse sensory characteristics. The descriptors associated with each wine are taken from a separate quantitative sensory descriptive analysis study.

The outcomes from this type of assessment could be used by producers to align packaging and marketing cues to match wine sensory perception, with a view to enhancing the tasting experience. A small preference study (n=38 assessors) was also conducted with three of the wines tasted under three conditions: white sensory booth, booth decorated with a graphic matching one of the wines, and booth with a graphic matching another of the wines. The results suggest that the graphics affected preference, providing insight into options for differentially increasing enjoyment for in-store tastings or cellar door settings.

Elizabeth developed artworks relating to the wines studied, some of which feature on the cover of this report. She also worked with a Brisbane hospitality venue to showcase her wine-related art and intends to develop a larger exhibition stemming from her experiences at the AWRI.

Investigating compounds responsible for 'plastic' and 'mousy' off-flavours

Further understanding has been gained about the compounds responsible for two off-flavours in wine – described respectively as 'popcorn'/'mousy' and 'plastic'/'mothball'/'jonquil' – through evaluating historical data and by analysing wines with these characters. Analysis of data from 108 sparkling ferments revealed a clear link between indole concentration and the sensory panel response for the 'mothball' character, with sparkling wines classified as affected by this character having significantly higher concentrations of indole than those where the off-flavour was not evident.

The role of *o*-aminoacetophenone and other similar compounds in indole-related off-flavour was also assessed, with this compound quantified in 16 wines representing a range of intensities of indole-like off-flavour. No detectable levels were found in any of the wines, demonstrating that this volatile compound was not a contributor to the off-flavour. Indole itself, however, was clearly implicated in the off-flavour. From further GC-olfactometry of three affected wines, there was an indication of other compounds contributing indole-like aroma, with identification of these compounds underway. As part of this work, an improved and efficient analytical method for *o*-aminoacetophenone was developed and validated, with the analyte included in the method used for 'mousy' compounds.

In related work, three white wines shown to have 'mousy' off-flavour based on sensory data were analysed for compounds associated with this off-flavour after a period of exposure to air, to investigate the possibility of an oxidative pathway for their formation. Acetyl tetrahydropyridine (ACTPY) was found to be increased in two of the three wines. A small survey of nine fortified wines (a style of wine sometimes affected by 'mousy' characters) was also completed, where not detected or negligible concentrations of ACPY (acetyl pyrroline) and AP (acetyl pyridine) were found. Evidence from the last 12 months indicates that ACTPY is the main compound responsible for 'mousy' off-flavour.

Using glycosides and other flavour precursors for improved wine flavour

Background

Odourless grape-derived glycoside compounds in wines can be broken down during tasting, releasing a surge of long-lasting flavour. This effect is caused by the action of enzymes from salivary bacteria. The glycosides can also release flavour compounds during winemaking and bottle ageing. Previous work showed that there is a wide range of sensory responses to glycosides among individuals, with some easily able to perceive strong flavour from all types of glycosides, some only able to perceive flavour from some precursor compounds, and others who report only a weak taste or do not respond at all. Glycosides have been shown to contribute 'fruity' flavour, and are also well known to be involved in smoke taint in wines made from fruit that has been exposed to smoke.

Understanding flavour precursors in winemaking

To better understand the types of flavour precursors present in grape skin, and their role in wine flavour, numerous marc samples from different varieties were extracted and analysed. Non-targeted liquid chromatography tandem mass spectrometry analysis provided by Metabolomics Australia gave several hundred structural molecular features of interest that can be used to define the glycoside extracts. Interestingly, there was little difference between the profiles of white and red varieties. A Muscat à Petit Grains Blanc extract was found to be unique due to the presence of specific glycosides of phenylethanol, a compound with a 'rose-like' aroma. Glycoside material isolated from the grape marc of a dozen varieties was added back to a base Chardonnay wine. After five months of storage, the extent of breakdown and subsequent release of aroma was assessed by a rapid sensory method, with results indicating that the source of the grape marc glycosides heavily determined the aroma outcome.

Moving outcomes towards impact

The increased flavour from marc-derived glycosides observed in this project formed the basis of a joint AWRI/Wine Australia team in the 2019 CSIRO ON Prime program. Team 'Wine-grape extracts' used the ten-week program to explore the potential for natural flavours extracted from wine-grapes to be used in wine products and other beverages and foods. The team members conducted more than 100 conversations across different industry segments, participated in coaching sessions and learned from a team of program mentors. The team was awarded the facilitator prize for its commitment to the ON Prime strategy of customer-led discovery, ensuring the right questions were being asked through market validations within different segments, and building business model capabilities.

Molecular drivers of wine texture and taste

Background

High-quality wines 'feel' right. An important element of wine quality from the viewpoint of consumers is the general perception of how the wine feels in the mouth when consumed. As such, wine texture is a major product differentiator for wine. Improving wine texture relevant to the desired style of wine depends on knowing the compounds that influence wine texture and understanding their winemaking origins. This knowledge will enable winemakers to optimise positive textural attributes while minimising negative ones.

Impact of dissolved CO_2 in still wines

Still wines are the only alcoholic beverages that contain significant but sub-saturated concentrations of carbon dioxide (CO_2) – concentrations that are routinely adjusted by winemakers using gas exchange prior to bottling. A previous investigation of the direct impact of dissolved carbon dioxide (DCO_2) and how it interacts with the wine matrix to influence the properties of still white wine was furthered by:

- conducting a study on the impact of DCO_2 on the sensory properties of red wines
- exploring a consumer perspective by quantifying the dynamics of CO_2 loss from the glass during serving and consumption.

As with the previous findings for white wines, higher DCO_2 concentrations in red wines decreased bitterness and astringency and increased sweetness while having no significant effect on viscosity, hotness or overall flavour. Importantly, DCO_2 did not show consistent interactions with key aspects of the wine matrix in either white (ethanol, acidity) or red wine (ethanol, tannin), implying that the intensity of the spritz sensation elicited by DCO_2 has a compelling effect on the tastes and textures of both wine styles.

A previously developed 'in wine glass' measuring system was used to assess wine DCO_2 as it would be experienced by wine consumers. A study quantified the losses of DCO_2 in white wines of varying composition from the time of opening, through pouring and when standing in the glass prior to being consumed. A single white wine was adjusted to two levels of tartaric acid (H_2T), ethanol and fructose, creating eight wines of differing composition. For each wine, 150 mL at 7°C was poured into restaurant-style glasses and allowed to stand at room temperature for 15 minutes while regularly undergoing DCO_2 analysis. Pouring a wine into the glass resulted in immediate significant reductions in DCO_2 compared with the concentration in the bottle, and the DCO_2 of the wine in the glass continued to decline in a linear fashion during standing. Increased ethanol in the wine resulted in a significantly higher rate of decrease in DCO_2 (Figure 9). However, it is unlikely that most consumers would notice a difference in 'spritz' sensation, as even under the highest rate of decrease, it was only after 15 minutes of standing that the decrease in DCO_2 was greater than the reported difference threshold of DCO_2 (i.e. the concentration difference in CO_2 in white wines that is perceptible as a difference in 'spritz' by a trained sensory panel).

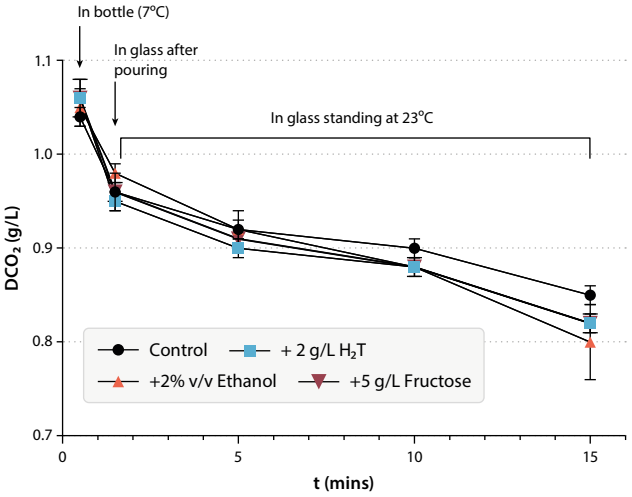


Figure 9. The effect of differences in the white wine matrix on the reduction of dissolved CO_2 in the wine glass over the time from pouring to consumption

Does using grape seed powder as a bentonite alternative affect wine sensory properties?

Powdered grape seed has been proposed as a natural, grape-derived alternative to bentonite for producing protein-stable wines, but it is not yet known whether its use affects wine sensory attributes. Since wines fined using grape seed powder (GSP) contain significantly higher concentrations of phenolics, it was considered that this might impart some undesirable sensory traits. To investigate the effect of GSP on wine sensory attributes, two doses, 7.5 g/L (low) and 15 g/L (high) of GSP were applied during the fermentation of Sauvignon Blanc and Semillon juices. Protein concentration in the finished wine was reduced by 4-6% by the low GSP dose and by 37-57% by the high GSP dose. Wines that received the highest dose still had a residual protein concentration greater than that generally associated with heat stability; however, surprisingly, heat stability was significantly improved. This suggests there may be some kind of protective factor in the grape seed preparation contributing to the improved heat stability. Along with higher phenolic concentrations, GSP-treated wines were more yellow in appearance. The Sauvignon Blanc wines treated with GSP were slightly more bitter than the untreated control, but interestingly, were rated higher in viscosity. The GSP-treated Semillon wines were similar to the untreated control in terms of astringency, but the wine that received the highest GSP dose had slightly higher bitterness. With the exception of yellow colour, the overall effects of GSP addition on sensory attributes were generally minor.

Understanding the drivers of negative wine characters

Small-scale white winemaking investigations of the formation of the 'bitter'/'hard' tasting compound tryptophol sulfonate indicated that the compound mostly forms after fermentation and that SO_2 concentration and pH influence its formation. Riesling, Gewürztraminer and Chardonnay juices were fermented in single-batch large-scale fermenters using the high tryptophol-producing 'rose' yeast. Just prior to bottling, the wines were split and SO_2 was added at either 50 or 150 mg/L, and then split again to receive either no addition or a 2 g/L addition of tartaric acid to adjust the pH. Tryptophol sulfonate concentration was found to increase significantly from its pre-bottling levels and was continuing to increase at the latest sampling point nine months post-bottling, with SO_2 concentration at bottling being a primary driver of the rate of increase (Figure 10).

As previous work in model white wine had shown that neither the proteinaceous fining agent casein, nor bentonite were effective in removing tryptophol sulfonate, other possible options for removing it from wine were investigated. A medium molecular weight polysaccharide fraction derived from a Chardonnay wine made up of grape-derived arabinogalactans and small mannoproteins (most likely arising from yeast lees contact) was found using nanoparticle tracking analysis to introduce changes in the particle size distribution of tryptophol sulfonate under various ethanol concentrations and pH levels typical of white wines. Based on this information, follow-up work using isothermal titration calorimetry will seek to determine whether this polysaccharide fraction can bind to tryptophol sulfonate, potentially reducing its negative sensory impact in wine. A winemaking trial to assess the factors affecting the development of tryptophol sulfonate in red winemaking and bottle storage, with an additional emphasis on the role of tannins, was also instigated during vintage 2020.

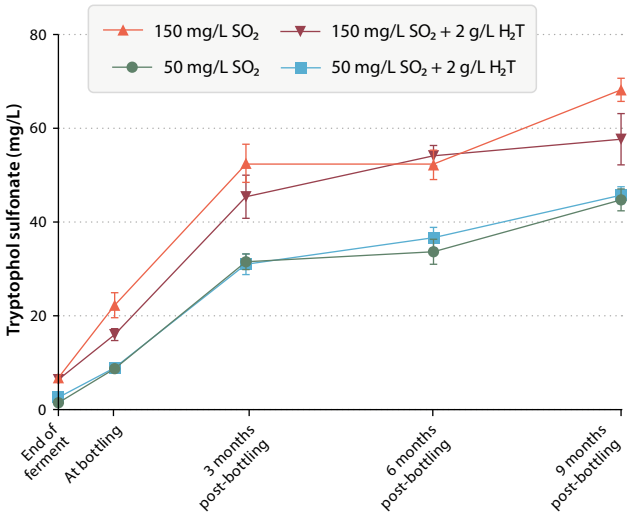


Figure 10. Formation of tryptophol sulfonate post-fermentation and post-bottling, showing the effects of SO_2 and tartaric acid additions prior to bottling

Towards an understanding of 'savoury' character in wine

The term 'savoury' is often used by wine tasters and consumers to describe complex, high-quality wines. However, to date the molecular drivers and possible origins of 'savoury' character in wine are unknown. An initial investigation into the source of the 'savoury' character in wine began by searching for the contributors to 'savoury' characters in other foods and beverages. The search led to the amino acid glutamic acid, succinic acid and salt as possible contributors to 'savoury' character in wine. One hundred Australian wines were surveyed and analysed to establish concentration ranges of glutamic and succinic acid (Figure 11). Salt concentrations were based on the recent Australian literature. Glutamic acid has recently been found to occur above threshold levels in Australian Shiraz wines described by the AWRI sensory panel as 'umami'-like (described as tasting like broth, meat stock or monosodium glutamate). Tastings of mixtures of these compounds by trained winemakers at wine-like concentrations found that succinic acid elicited a complex sensory profile including 'bitterness'/'hardness' and acidity, while all combinations that included glutamic acid were considered 'savoury'.

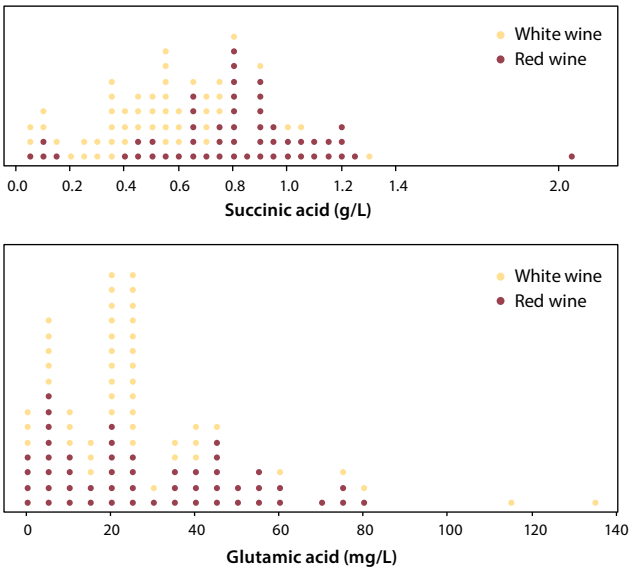


Figure 11. Distribution of glutamic acid and succinic acid concentrations in commercially available Australian red and white wines (n=100)

Managing wine extraction, retention, clarity and stability for defined styles and efficient production

Background

This project investigates wine macromolecules such as tannins, polysaccharides and proteins to understand their extraction and subsequent impact on various aspects of wine stability, clarity and filterability. The research seeks to find improved ways to measure wine macromolecules and their interactions, to better understand the impacts of winemaking techniques, additives or surfaces (e.g. filtration membranes, adsorbents) on the colour, cold and heat stability of wine. The results generated will provide winemakers with options to better predict and manage macromolecule extraction, stability and loss, ultimately with the aim of improving production efficiency.

Using Fluorescence Correlation Spectroscopy to understand how wine macromolecules interact

Despite the large body of literature focused on interactions between polysaccharides, proteins and phenolic compounds (tannins), a great deal of information is still lacking about the unique medium of wine, especially regarding the structure of complexes at the molecular and macromolecular level. In part, this can be attributed to limitations of current analytical techniques. Currently, it is difficult to identify experimental methods that are sufficiently sensitive to discriminate among the structures of wine macromolecules without disturbing the complex wine matrix. In a collaborative project with the Max Planck Institute for Polymer Research in Germany, this knowledge gap was addressed by employing Fluorescence Correlation Spectroscopy (FCS) for the first time in wine research (Figure 12). This technique offers an opportunity to study molecular and macromolecular aggregation by the addition of only tiny amounts of fluorescently labelled molecules of interest (such as proteins, polysaccharides or phenolic compounds) and therefore allows visualisation without disturbing the wine matrix.

Bovine serum albumin (BSA) was used as a model protein due to its structural similarity to grape and salivary proteins, both of which are relevant to wine colloidal systems. The structural changes and conformational dynamics of BSA induced by ethanol, polysaccharides and tannins were investigated. Experiments primarily focused on the impact of the following aspects on protein aggregation:

- ethanol concentration
- polysaccharides
- grape skin and seed tannin
- a mixed macromolecule matrix.

Conformational relaxation time components of native BSA drastically varied with the addition of wine macromolecules, signifying changes in conformation dynamics. The effect of tannin type (seed vs skin) on protein aggregation was very significant, pointing to a higher affinity of BSA towards seed tannin. The effect of wine polysaccharides was also very pronounced, with a rhamnogalacturonan II-enriched fraction inducing protein aggregation, and a mannoprotein-enriched fraction having the opposite effect. This work demonstrated that FCS holds promise for investigation of interactions between wine macromolecules in model and real wine systems.

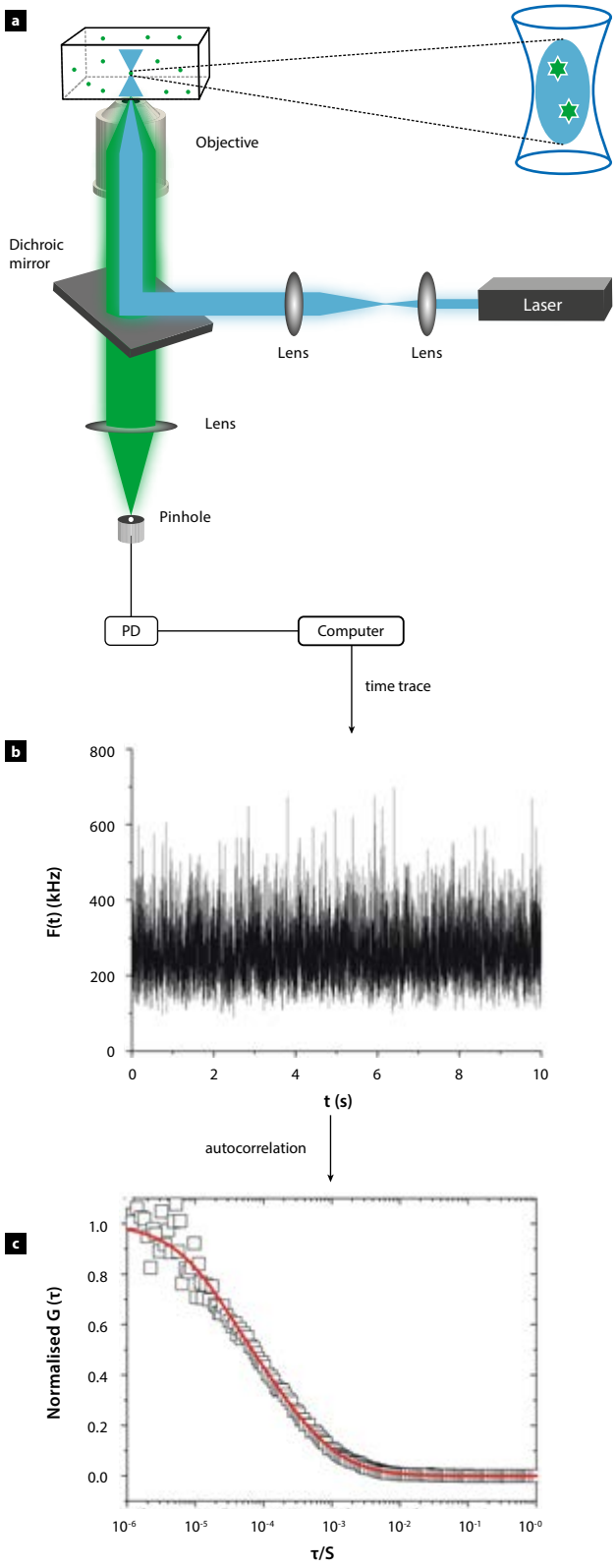


Figure 12. a) Schematic representation of the Fluorescence Correlation Spectroscopy set-up. The light from an argon-ion laser (488 nm) passes through a water immersion microscope objective to excite the fluorescent sample. The emitted fluorescence light is then collected by the detector. The fluorescence lifetime is obtained by fitting the slope of fluorescence decay curves of photons, and the residence time by fitting the autocorrelation function of fluorescence in the focal volume; b) fluorescence intensity time trace recorded for BSA and c) the corresponding experimental autocorrelation curve (symbols). The red line represents a fit.

New analytical methods to help manage heat and cold stability

Two new methods have been developed to assist with management of wine instabilities, one to determine the concentration of heat-unstable proteins in white wines using a fluorescent dye and a second to accurately quantify tartrate crystal formation after a three-day cold test. It is hoped that the new test for heat-unstable proteins will enable winemakers to easily and accurately determine if their wines are above or below a haze formation threshold for protein concentration, as it relates to the existing heat test. The new cold stability test subjects a wine to the same conditions as the standard three-day test, but instead of observing crystal formation with the naked eye, recovers and quantifies the crystals formed. To validate the method, ten unstable wines were analysed using the new approach. Results were compared to those from the standard three-day test and a mini-contact (conductivity) test and were well correlated for all wines. Future work will use the newly developed method to assess the role of wine macromolecules in the development of cold instability.

Investigating zeolite's effect on cold stability

In early trials of zeolite as an alternative to bentonite for heat stabilisation of wines, it was interesting to note that the concentration of potassium in wines decreased by more than 30% following zeolite treatment. This suggested that zeolite addition might also be a viable approach to improve cold stability in wine and this was investigated during the year. Encouraging preliminary results showed that zeolite treatment brought three cold-unstable white wines to, or very close to, cold stability as measured using the mini-contact test. This test measures the change in conductivity over time of a wine that has been chilled, mixed and heavily super-saturated with powdered KHT. A result of less than 5% change in conductivity indicates a cold-stable wine. The stabilising effect of zeolite was observed in a Muscat Gordo wine immediately following zeolite treatment, with a conductivity change below 2%, and for the Sauvignon Blanc and Chardonnay wines a progressive crystallisation of KHT was observed at 15°C over four months (Figure 13A), with conductivity changes of 5 and 5.5%, respectively. This suggests that zeolite may not adsorb potassium, but rather may help initiate crystallisation, inducing the loss of potassium from wine as KHT. Importantly, results indicated that zeolite could simultaneously heat and cold stabilise wines. Moreover, with precipitation of KHT 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. As depicted in Figure 13B, reductions in potassium content of 40%, 20% and 30% were observed for the zeolite-treated Muscat Gordo, Chardonnay and Sauvignon Blanc wines, respectively. A further positive outcome was that despite losses in tartaric acid due to crystallisation, changes in wine pH were negligible for the Sauvignon Blanc and Chardonnay wines and small for the Muscat Gordo wine (Figure 13C), and thus substantial doses of tartaric acid may not be required after treatment. Work to understand the sensory impacts of zeolite addition on white wines is being finalised.

Proteins in red wine – are they important?

Wine protein is most commonly considered in relation to white and rosé wines, since these are the wines most susceptible to the development of visible protein haze. In red wine, protein is often thought to be absent, being removed during the early stages of winemaking due to precipitation of tannin-protein complexes. Earlier research at the AWRI revealed that in red grapes, protein is present in sufficient quantities to precipitate a substantial amount of tannin that would otherwise be extracted into wine (Bindon et al. 2016). Furthermore, in cold-hardy hybrid (non-*vinifera*) grape varieties that contain higher levels of protein than *Vitis vinifera* grapes, high concentrations of residual protein remain in wine and can precipitate oenological tannins added during winemaking (Springer et al. 2016). Based on these observations, it was of interest to understand how important protein is in modifying macromolecule extraction and stability in red wines.

Initially, existing methods for protein analysis were used, but they were found to be unsuitable for red wine due to interference from wine tannins. A new method was developed and validated specifically

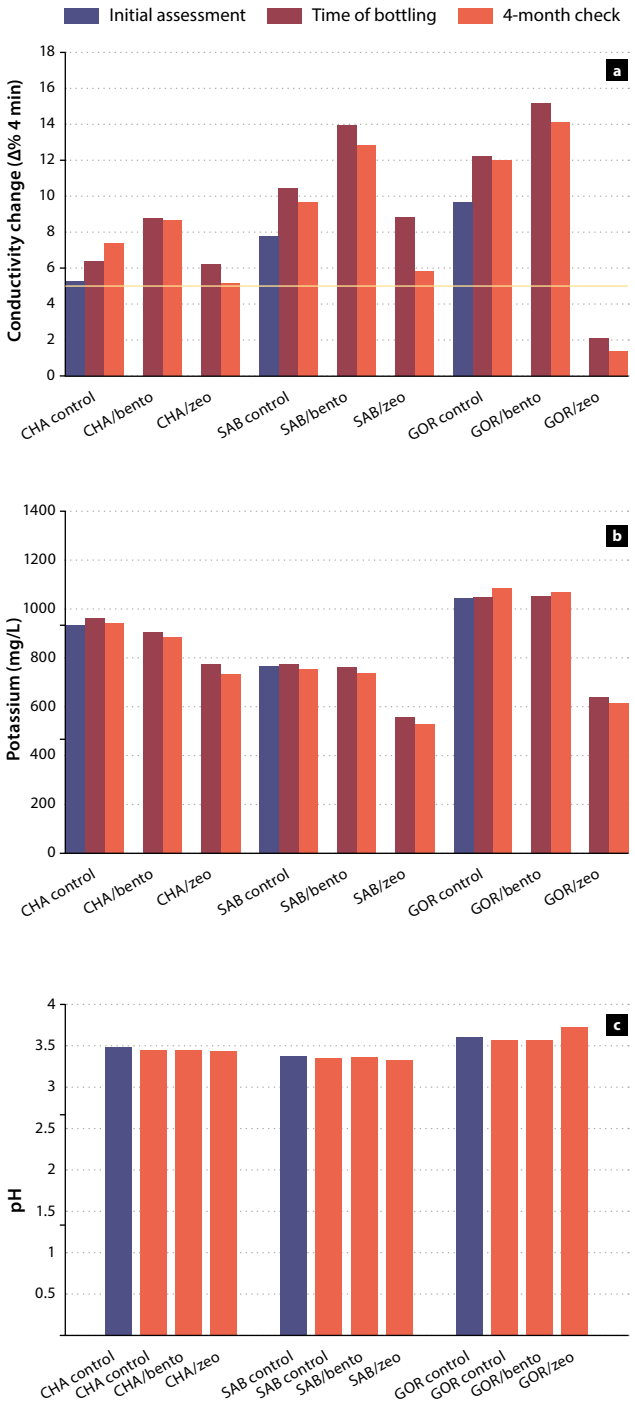


Figure 13. a) Conductivity change in the mini-contact test, b) potassium concentration and c) pH of Chardonnay (CHA), Sauvignon Blanc (SAB) and Muscat Gordo (GOR) wines before and after treatment with Pluxcompact bentonite (bento) and zeolite (zeo). The yellow line in (a) represents a change in conductivity of 5%. Wines with results at or below this level are considered cold stable.

for protein quantification in red wines, and more than 100 red wines, including wines made from non-*vinifera* varieties and their interspecific hybrids sourced from the USA, were analysed. Protein concentrations in Australian *Vitis vinifera* red wines ranged from 16 mg/L to 113 mg/L with a median of around 50 mg/L (Figure 14). Protein concentration was found not to vary according to grape variety in *Vitis vinifera* red wines. Wines made from non-*vinifera* varieties and their interspecific hybrids had a wide range of protein concentrations from as low as 13 mg/L up to 350 mg/L, with a median of 70 mg/L. It was noteworthy that the cold-hardy hybrid varieties had the highest protein concentrations, with a median of 124 mg/L.

Given the relevance of protein to the development of haze in white wine, it was considered that high-protein red wines might in fact be heat-unstable, and potentially present difficulties with filtration or develop deposits following addition of oenotannin or during ageing. This was particularly relevant, given that red wines could contain protein concentrations at levels that would result in haze in white wines. It was found that while most red wines (both *vinifera* and non-*vinifera* varieties) were not heat stable according to a red wine heat test, the extent of heat instability did not increase with increasing protein concentration. While it was also found that unfiltered wines did not necessarily have higher protein concentration than filtered wines, the role of red wine proteins in membrane fouling during filtration will continue to be studied. Although bentonite treatment of commercial USA hybrid wines known to be influenced by excess protein was not able to remove protein, experiments are underway to determine whether protein can be enzymatically broken down during fermentation. It is thought that by uncoupling protein-tannin interactions during fermentation, wine tannin concentration may be improved in low-tannin grape varieties, such as Pinot Noir.

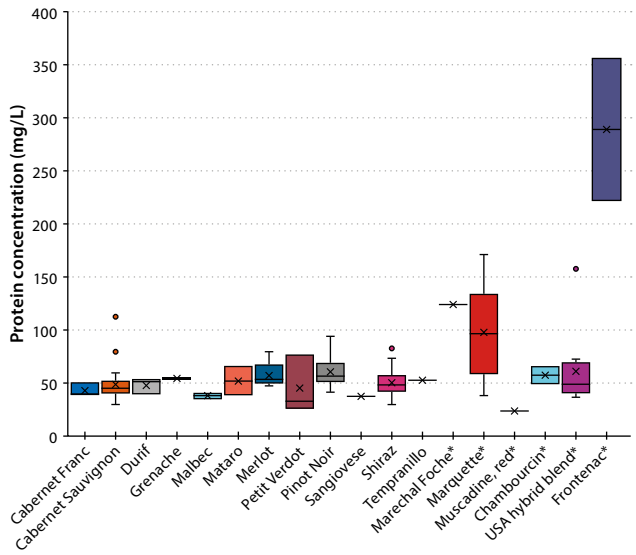


Figure 14. Box plot of wine protein concentration in red wines of different varieties, with USA varieties and their hybrids indicated by an asterisk

References

Bindon, K.A., Li, S., Kassara, S., Smith, P.A. 2016. Retention of proanthocyanidin in wine-like solution is conferred by a dynamic interaction between soluble and insoluble grape cell wall components. *J. Agric. Food Chem.* 64(44): 8406-8419.

Springer, L.F., Sherwood, R.W. Sacks, G.L. 2016. Pathogenesis-related proteins limit the retention of condensed tannin additions to red wines. *J. Agric. Food Chem.* 64(6): 1309-1317.

Influencing wine style and efficiency through management of oxygen during wine production

Background

This project is using both model systems and pilot-scale fermentations to investigate the impacts of oxygen exposure at crushing or during fermentation on fermentation efficiency and wine style. It is also monitoring wines with known oxygen exposure as they age, to assess oxygen-related chemical changes that occur after fermentation. Different approaches to oxygen delivery are being explored in collaboration with industry partners.

Finding the right aeration options

Previous work has shown that introduction of air or oxygen during the active phase of fermentation can be beneficial. In white grape ferments, aeration can be used to stimulate fermentation rate, especially in low-turbidity musts, without significant impact on the sensory qualities of the finished wine. In red grape ferments, aeration has a minimal impact on fermentation kinetics; however, stylistic changes associated with tannin structure and abatement of 'reductive' characters, particularly as wines age, have been observed. In 2019 the capacity of red and white fermentations to withstand increasingly extreme aeration treatments was tested and the limits of aeration, beyond which oxidative damage becomes apparent, were defined.

In general, either long-duration, low-intensity aerations or repeated short-duration, high-intensity aerations during fermentation have been required to produce beneficial changes in red and white wines without causing oxidative damage. Such regimes may suit winemaking approaches where limited resources are available or where aerations might be undertaken during scheduled pump-overs. However, a question remained as to whether a single well-timed, short-duration high-intensity aeration would be able to elicit the same result. This question was addressed in the 2020 vintage.

Short-duration, high-intensity aerations were compared to long-duration, low-intensity aerations in both Chardonnay and Shiraz fermentations at pilot scale. The amount of air delivered during each of the treatments was calibrated such that each of the ferments was exposed to equivalent amounts of oxygen regardless of the treatment format. Preliminary results suggest that a single well-timed, short-duration high-intensity aeration does not 'pack the same punch' as the other modes of delivery (repeated and long, low-intensity aerations). In low-YAN Chardonnay ferments the long-duration, low-intensity treatment reduced fermentation time by 15 days compared to the short-duration treatments and by almost 20 days compared to the no-treatment control. Consistent with earlier observations, there were no differences in ferment duration in the red fermentations. Whether or not these treatments had an impact on wine composition will be determined through post-bottling analysis in 2021. These experiments reinforce previous observations, highlight the practical differences between white and red winemaking when using aeration during fermentation, and provide practical detail about how aeration can be implemented in the winery for maximum benefit.

Aeration of wild ferments – finding the sweet spot

Aeration of non-inoculated fermentations introduces a different combination of possible interactions. Modulating the timing of aeration provides an opportunity to interact with different members of the microbial community that can be dominant during the early phases of a fermentation and potentially enhance the survival of selected members. Earlier work showed that long-duration, low-intensity aeration of non-inoculated ferments had the effect of reducing fermentation times, similar to that

observed in inoculated ferments. This was true irrespective of when during the first three days of fermentation the aeration was applied. Aside from suppression of medium-chain fatty acid production, few other variations to wine composition were observed.

This year, understanding of how wild fermentations respond to aeration was extended by maintaining a long-duration treatment format but increasing the intensity of the treatment. The effect of aeration on fermentation progress was similar to that observed in the previous year; however, marked changes in the volatile profile of the wines were observed, even for the lowest intensity treatment. An exploration of the effect on microbial community structure is currently being undertaken in collaboration with the AWRI's bioprospecting project. It is of great interest to understand whether the changes observed in volatile profiles are underpinned by alterations to microbial populations. The potential benefits of aeration in the management of non-inoculated fermentations will continue to be explored within this project.

Exploring the mechanics of aeration – moving beyond the why to the how

Over numerous vintages the impacts of aeration on red and white fermentations have been shown to be distinctly different. But what about the process of aeration itself? Is it necessary to calibrate air input rates depending on whether the ferment is Shiraz or Chardonnay? Is the same dissolved oxygen response achieved from the same input of air in the two systems? Given a target dissolved oxygen value, do the air input rates required to achieve the target scale in a predictable way with fermenter size? These are questions that are beginning to be addressed through analysis of laboratory-scale and pilot-scale dissolved oxygen data covering six years of vintage experiments. It is anticipated that this will provide important foundational data to inform winemakers how macro-aeration can best be managed in the winery.

Winemaking interventions to modulate glutathione status

Background

Glutathione (GSH) is a naturally occurring antioxidant present in grapes that plays an important role during winemaking. It can preserve wine colour and aroma by reacting sacrificially with quinones and acting as an antioxidant. It can also act as a precursor to a range of desirable and undesirable volatile sulfur compounds. The concentration of glutathione in wine can be enhanced by direct addition, or indirectly as a consequence of winemaking practices. The OIV has passed resolutions allowing the addition of GSH to juice and wine. However, pure GSH has not yet become a permitted additive in the food standards codes of either Australia or Australia's major wine export destinations, although some additives containing GSH (such as some inactive dried yeast products) are permitted. This project will be completed in 2020/2021.

What are the sources of glutathione?

Glutathione is present in many natural products. In freshly pressed grapes GSH concentrations have been reported to be as high as 50 mg/L, with some proportion of that concentration still present at the end of fermentation. The concentration of GSH in grape juice is dependent on the conditions under which grapes are processed. Other potential sources of glutathione include yeast-derived products, some of which are marketed as glutathione-enriched inactivated dry yeast preparations. Compared to grape processing interventions, these additives contribute relatively little to the overall concentration of glutathione in juice.

Can small concentrations of GSH at crush make a difference to finished wine?

OIV resolution OIV-OENO 445-2015 recommends the addition of no more than 20 mg/L of GSH to must or wine. The effect of such an addition to freshly pressed grape juice was evaluated in a pilot-scale trial producing Chardonnay sparkling base and Chardonnay table wine. Glutathione additions were made immediately after pressing and two yeast strains were used to make the wines. Analysis of wine composition after six months in bottle indicated very few differences between the wines. Standard wine chemical measures and low molecular weight volatile sulfur compounds did not vary with treatment. Polyfunctional thiol concentrations did, however, vary, both with winemaking style (sparkling base vs table wine) and wine yeast used.

The polyfunctional thiols 3-MH and 3-MHA are typically associated with 'passionfruit' aroma in Sauvignon Blanc wine but more recently have been shown to be important contributors to aromatic complexity in other varieties. When GSH was added to Chardonnay juice from grapes harvested to meet a sparkling base specification, the concentrations of 3-MH and 3-MHA were not different from the controls, regardless of the yeast strain used. However, when GSH was added to Chardonnay juice from grapes harvested for table wine, the 3-MH and 3-MHA concentrations in the finished wine were higher than in the controls and the degree to which their concentrations increased was dependent on yeast strain. Surprisingly, for one of the yeast strains, the concentration of 3-MH in particular was almost double that of the no treatment wines and substantially above its aroma threshold. Whether these results translate into perceptible sensory differences remains to be determined. While it initially seemed unlikely that such a small addition of GSH to a freshly pressed juice would result in measurable differences in finished wine, the 3-MH results of this trial suggest otherwise. It should also be noted that the addition of yeast products that contain glutathione may have additional effects beyond those of pure glutathione.

Putting microbial diversity to work in shaping wine style

Background

While there are a large number of wine yeasts currently available for winemaking, extensive genetic analysis has shown the genetic diversity among these yeasts to be extremely shallow. This limited depth means there is scope to expand the genetic diversity of wine yeasts through breeding and selection. This project builds on previous work in which *Saccharomyces cerevisiae* was mated with non-*cerevisiae* members of the *Saccharomyces* genus to produce genetically complex hybrids and work where non-GM methods of selection were employed to develop low H_2S and low acetate producing yeasts. Together these breeding and selection strategies will deliver non-genetically modified germplasm that can be used by industry and provide new microorganisms for winemakers seeking a point of differentiation in their wines.

Driving enhancement of aromatics in sparkling wine

The suitability for production of sparkling wine of two third-generation phenylethanol (PE) ('rose' aroma) over-producing yeasts, with moderated tryptophol and tyrosol production and improved resilience in difficult ferments, was assessed. The trial design, using the traditional method of sparkling wine production, was constructed so as to reveal whether these new yeast strains were suitable for both primary and secondary fermentation phases and in which phase the new yeasts would have the greatest impact. In treatments where the yeasts were used for only one phase, they were paired with the yeast PDM (commonly used in sparkling wine production) in the complementary phase. The strains were all shown to be capable of completing either primary

fermentation, secondary fermentation or both. The wines, made in the 2019 vintage, were disgorged in 2020 and an assessment of their chemical and sensory attributes was undertaken. This analysis revealed that it was during primary fermentation that these yeasts had the greatest impact in terms of driving concentrations of PE in the finished wines.

While the ageing time of these wines was relatively short (eight months) compared to the time traditional method sparkling wine might spend in bottle prior to commercial release, one obvious question is whether aroma compounds such as PE have sufficient longevity in bottle to contribute to sensory attributes after extended bottle ageing. The impact of bottle ageing on PE concentration was evaluated in an earlier trial of PE over-producing strains in still Chardonnay wine. These wines were analysed 3 and 15 months after bottling and showed that overall concentrations of PE remained stable over time (Figure 15). It is understood that bottle ageing of still and sparkling wines differs with regard to lees contact; however, this work shows that PE continues to influence sensory attributes well after wine is bottled.

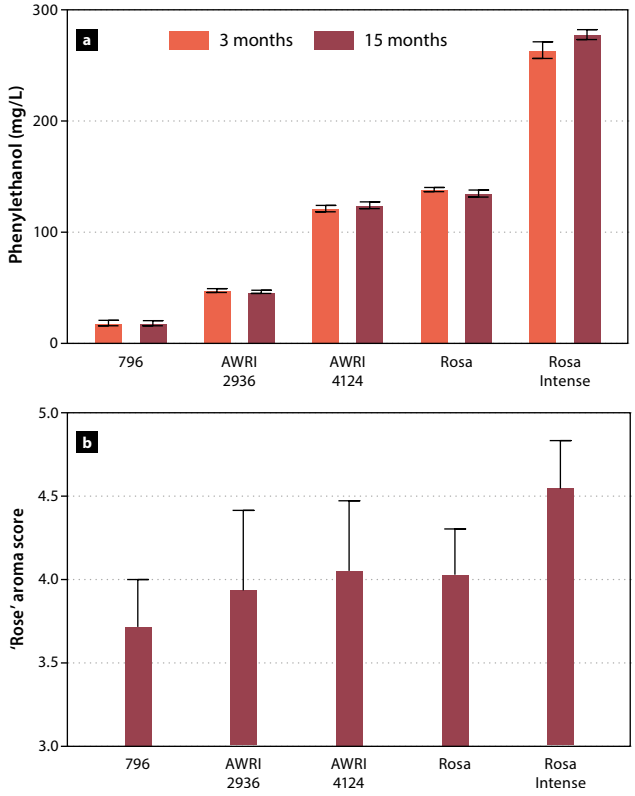


Figure 15. (a) Phenylethanol concentrations in Chardonnay wines made using the yeast strain AWRI 796 and four phenylethanol over-producing variants, after 3 months (red) and 15 months (maroon) of ageing in bottle; (b) sensory ratings for 'rose' aroma of the same wines after 15 months

The hybrid test – are two genomes better than one?

A previous project generated a *Saccharomyces cerevisiae* x *Saccharomyces uvarum* hybrid that exhibited low acetate production in high-sugar conditions. The concentration of acetate produced by this hybrid was not intermediate between the two parents, but significantly less than both, suggesting an unusual genetic interaction. To investigate this further, a large collection of progeny resulting from the sporulation of the hybrid was generated. This collection showed variance in the concentration of acetate produced, which could be used to map the determinants of the low-acetate trait. Quantitative trait loci analysis revealed chromosomal loss to be a driver of low acetate production in progeny from this hybrid, suggesting that genome instability can sometimes have advantages. While this spore population was produced with the aim of mapping genetic features that contribute to low acetate production, it will also be useful in identifying genetic determinants of other characteristics.

In previous work, a head-to-head comparison of seven hybrids of *S. cerevisiae* with all compatible non-*cerevisiae Saccharomyces* yeasts was undertaken in Riesling. The earlier trial revealed distinct features of individual hybrids from a flavour and aroma perspective as well as technical aspects relevant for production. But how do these hybrids perform in red winemaking? To answer that question, an equivalent trial in Shiraz fermentations was undertaken this year with the same hybrid set to assess their performance in red winemaking.

Contributions of yeast to non-volatile wine components

Previous work assessed the relative contribution of different hybrid yeasts to the extraction of phenolic compounds in Tempranillo. This work identified the major source of yeast-derived variation in wine phenolic concentrations to be the *Saccharomyces cerevisiae* parent of the hybrid. This observation is consistent with earlier work at the AWRI that highlighted differences between *S. cerevisiae* yeast strains in phenolic compound extraction. With these results in mind, an internal collaboration with AWRI researchers working on wine macromolecules was initiated, whereby 94 *S. cerevisiae* wine yeast strains were assessed for their capacity to influence phenolic extraction in red wines.

The relationship between grape juice composition and the progress of alcoholic and malolactic fermentation

Background

This project brings together two previously separate research areas, yeast and bacterial fermentation, to achieve an integrated approach to the study of fermentation performance. Poor fermentation progress can occur even in juices and wines that satisfy the usual criteria for appropriate fermentation progress (e.g. YAN, Baumé, SO_2). The starting point for any ferment, the juice, is a rich ecosystem and the uncontrolled growth of non-target microorganisms can be inhibitory to alcoholic or malolactic fermentation, either through competition for nutrients or through the production of secondary metabolites. In addition, simultaneous alcoholic and malolactic fermentation (MLF) is increasingly being used to manage winery scheduling more efficiently. The interactions of different microorganisms with the grape juice environment, both individually and as a community, and how those interactions shape fermentation performance, are key areas of focus for this work.

Quantifying the genetic response of *Oenococcus oeni* to SO_2

It has been known for some time that high total SO_2 concentrations are a primary factor in the failure of MLF. In response, considerable effort has been expended at the AWRI and elsewhere, exploring the physiological response of *Oenococcus oeni* to inoculation into fermentations or wine containing various concentrations of SO_2. Strain-specific responses, or lack thereof, have been characterised and timing of co-inoculation has been optimised for *O. oeni* during alcoholic fermentation. While there is now an increasingly detailed understanding of the various factors that interact with SO_2 to shape the likely success or failure of MLF, the genetic factors that might tip the balance in favour of the bacteria when it is challenged by SO_2 concentrations are not understood.

Tim Reilly and Jenny Bellon

To characterise the genetic response of *O. oeni* to SO_2, and therefore gain insight into the survival strategies employed by this species, an experiment was undertaken where gene expression levels were quantified in response to an SO_2 challenge. While still in its preliminary stages, the results of this work suggest that unlike many other wine-related microorganisms, *O. oeni* has few tools in its genetic toolbox that 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 MLF.

Investigating interspecies microbial interactions

Considering the many different types of microorganisms present in grape juice at the start of fermentation and the competition for resources that likely occurs immediately following grape crushing, the ability of *Saccharomyces cerevisiae* to eventually dominate the environment is a testament to its robust biology. However, recent metagenomic profiling of uninoculated ferments at the AWRI and elsewhere shows that domination by *S. cerevisiae* is not an assured outcome. In addition, with non-*Saccharomyces* yeast being used increasingly as direct inocula into grape juice, often at high cell densities and usually prior to inoculation with *S. cerevisiae,* an obvious question to ask is whether some strains are better competitors than others? Are there strain-specific responses of *S. cerevisiae* to the presence of other organisms in their environment?

Following the establishment of a barcoded wine yeast collection at the AWRI, it was possible to experimentally approach the question of wine yeasts' competitive response to grape juices that had previously been inoculated with different non-*Saccharomyces* yeast strains commonly found in grape juice or available as commercial preparations. With 94 strains in the collection, the question of whether some strains were better able to cope with the increased competition from non-*Saccharomyces* yeast could be addressed. Several specific *S. cerevisiae*/non-*cerevisiae* strain pairs were observed that did not appreciate the close contact with one another. These observations are currently being verified using a range of more specific experiments.

Management and optimisation of the AWRI Wine Microorganism Culture Collection

Background

The AWRI Wine Microorganism Culture Collection (AWMCC) originates from early microbiological investigations in Australian wines conducted by John Fornachon in the 1940s and the earliest days of the AWRI. Since that time, ongoing additions to the AWMCC from wineries and researchers across Australia have developed a repository that houses the Australian wine industry's microbial germplasm heritage. An electronic database is used to record information about each strain and to manage their movement (deposition and supply) and intellectual property. The AWMCC holds reference strains, research strains and a large number of Australian indigenous yeast and bacterial isolates. Many of these have yet to be identified and characterised for what they can bring to winemaking.

Identification, storage and distribution of microbial strains

In 2019/2020, a total of 393 individual yeast and bacterial strains were submitted to the AWMCC by researchers and wineries. During the year, the AWMCC distributed 617 microbial strains from cryogenic stocks to AWRI researchers, wineries and external research partners. In addition, another 3,100 microorganisms were collected from wineries for the bioprospecting project and are housed in the collection, bringing the total number of available microorganisms to around 22,000.

Keren Bindon

Many of the strains are stored in specialised individual vials which have been designed to ensure the long-term viability of micro-organisms stored at ultra-low temperature. Storage in individual vials reduces the risk of cross-contamination that can occur when using multi-well storage systems and is therefore best practice for ensuring the long-term integrity and traceability of critical microbial germplasm. However, storage in individual tubes is labour-intensive and not amenable to high-throughput screening methods. For this reason, several screening populations representing commonly studied subsets of the collection have been prepared in 96-well format, which is accessible to robotic handling equipment. More than 3,000 yeast and more than 1,000 bacteria previously stored in individual tubes have been assembled into seven populations: *Saccharomyces*, *Brettanomyces* and non-*Saccharomyces* yeast (excluding *Brettanomyces*), *Oenococcus*, lactic acid bacteria and acetic acid bacteria. These populations are now available for high-throughput screening for characteristics of interest.

Objective measures of quality and provenance in Australian vineyards

Background

The project forms part of a multi-agency collaboration to research Shiraz terroir across a range of scales, primarily in the Barossa Valley. Twenty-four sites across six sub-regions were monitored, with fruit sampled for ripeness, yield assessment, chemical analysis and small-lot winemaking. The sub-regions were identified by the Barossa Grounds Project, and are classified as Northern Grounds, Central Grounds, Southern Grounds, Western Ridge, Eastern Ridge and the Eden Valley. Detailed chemical analysis was performed on the small-lot wines at the AWRI, and sensory analysis was conducted at the University of Adelaide as part of the collaboration.

Chemical and sensory factors that define Eden Valley wines

The second season of the project was completed. Chemical and sensory analysis were performed on wines from three locations within each of 23 and 24 vineyard sites in the first and second seasons, respectively. In both seasons of the study, the wines from the Eden Valley were the most clearly distinguished from the other Barossa sub-regions using chemical analysis alone. Partial least squares discriminant analysis was performed, and a number of compounds were consistently associated with the Eden Valley wines for both vintages. In both seasons, the primary grape anthocyanin, malvidin-3-glucoside, was lower in the Eden Valley wines, while other non-malvidin anthocyanins were elevated. Changes in the ratios of anthocyanins may be a response to the interactive effects of sunlight, temperature and, potentially, elevation. For wine volatile compounds, Z-3-hexanol, E-2-hexenal and an ester hexyl acetate (associated with 'green' characters) were elevated in Eden Valley wines in both vintages. The key wine odorant β-damascenone ('red fruit'/'floral') was also consistently lower in Eden Valley wines. Interestingly, 'vegetative' sensory attributes were elevated in Eden Valley wines in both seasons and since E-2-hexenal has a strong 'vegetative'/'green' aroma, this may point to its significance in defining wine style from this part of the Barossa. However, there are interactive effects between wine volatiles, and the lack of β-damascenone may also be relevant since it can potentially mask the expression of 'vegetative' attributes. In subsequent seasons the existing project work will continue, along with efforts to understand the effect of vineyard management interventions on specific sites.

The impact of mulching on wine chemical composition

An experiment was conducted on an Eastern Ridge site to assess whether a viticultural intervention (mulch) could substantially change the characteristics of wines from a single vineyard, relative to the differences observed between vineyards. Mulch was applied to three areas within the vineyard, while another three corresponding areas were untreated and used for comparison. Wines made from mulched sections had lower tannin concentration (including skin tannin, overall tannin molecular mass and degree of polymerisation). Wine colour density was not affected by the mulching treatment, but polymeric pigment and chemical age were lower in mulched areas, and there were higher concentrations of free monomeric anthocyanins in the wine. This indicated that a greater proportion of anthocyanin had reacted with tannin to form polymeric pigments in the areas that did not receive mulch. Other wine components that differed between the treatments were metals, with mulched areas being clearly defined by increased potassium, while concentrations of other metals including iron were lower. Although the effect of the mulch treatment was evident, the wines were nonetheless compositionally similar relative to wines from the other sites in the study. This suggests that strong site-specific 'terroir' effects may exist. Further viticultural interventions are planned for subsequent seasons to explore the influence of management practices as a component of 'terroir'.

Understanding *Brettanomyces* and its adaptation to control measures

Background

Brettanomyces yeast can cause wine spoilage by producing 4-ethylphenol and 4-ethylguaiacol, which are responsible for 'phenolic', 'leather', 'sweaty' and 'medicinal' aromas (collectively known as 'Brett' character). Although wine spoilage from this yeast was a major issue in Australian red wines produced in the late 1990s and early 2000s, the risk of 'Brett' spoilage is now commonly managed via a multi-faceted strategy disseminated by the AWRI, which enables winemakers to significantly decrease levels of 'Brett' spoilage compounds in finished wines. Yet, *Brettanomyces* has not been eliminated from Australian wineries, and loss of wine value still occurs. To ensure Australian winemakers' continued ability to manage *Brettanomyces* in a cost-effective manner, the control strategy must be future-proofed against potential market pressures to minimise levels of SO_2 in wine, and augmented with rapid detection methods.

Development of sulfur dioxide tolerance

A key question for the Australian wine industry is whether *Brettanomyces* may be developing tolerance to SO_2, as this would severely constrain current control strategies. Studies conducted using industry isolates sourced from 2004 to 2019 identified many highly tolerant isolates, especially from more recent years, suggesting that tolerance to SO_2 may be increasing over time. Whole-genome sequencing of these tolerant isolates was initiated to determine if the tolerant strains represented a novel genetic group or evolved members of an existing genotype. Genetic comparisons showed that the tolerant strains were all members of the existing AWRI 1499 clade, a group of strains already known to be tolerant to SO_2, albeit to levels lower than those observed in many of these newer isolates (Figure 16). Detailed genomic analysis is now being used in an effort to uncover the precise genomic changes that may be responsible for the increased levels of SO_2 tolerance observed in these strains compared to older members of the AWRI 1499 clade.

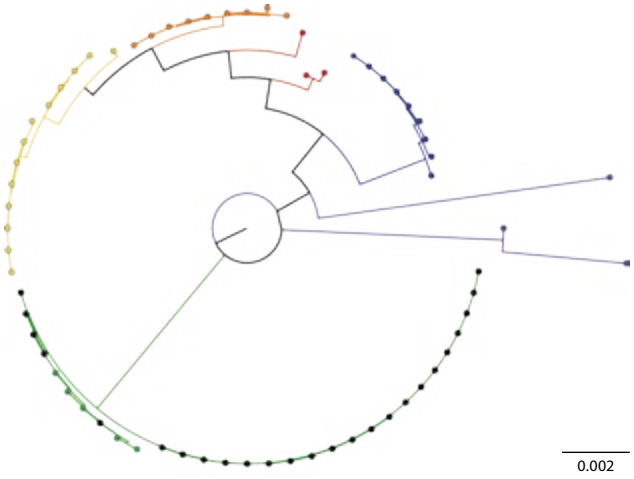


Figure 16. Genetic analysis of SO_2-tolerant *Brettanomyces* strains. A whole-genome phylogeny was assembled from a collection of reference strains (coloured circles) and SO_2-tolerant industry isolates (black circles). The phylogeny could be sub-divided into six clear genetic groups as indicated by the color-coding. All industry isolates were shown to cluster within the AWRI 1499-like clade (shown in green). Phylogeny is scaled by substitutions per site.

Molecular engineering of *Brettanomyces bruxellensis*

The ability to genetically manipulate microorganisms is essential for understanding their biology and metabolism. CRISPR technology was used to develop a way to manipulate the genome of *Brettanomyces bruxellensis* for the first time. This enabled 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 elucidated. 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.

Formation and fate of sulfur compounds associated with negative attributes in wine

Background

Volatile sulfur compounds (VSCs) can contribute both positive and negative attributes to wines, and it is therefore desirable to be able to control their concentrations in a winery environment. The occurrence of VSCs can be influenced by factors including yeast selection and fermentation conditions; the nature and quantity of precursor compounds; the availability or absence of oxygen at different points of the winemaking process; and the availability and speciation of transition metal ions such as copper. By exploring the chemistry of VSC formation and the important role played by metals, these common winemaking observations can be better understood, potentially leading to recommendations for ways to decrease the risk of undesirable 'reduced' aromas and maximise positive aromas.

Evaluating the formation of sulfur traps and latent sources of sulfur compounds

Hydrogen sulfide (H_2S) can have a highly detrimental effect on wine quality, imparting aromas of 'rotten egg' and 'sewage' when present at concentrations above its aroma threshold (1.1 to 1.6 µg/L). Aerative remediation strategies, such as macro-oxygenation and racking/splashing techniques are successfully used by winemakers to remove H_2S from wine. The mechanisms by which aerative treatments are

thought to remove H_2S include straightforward volatilisation of H_2S or the formation of less detrimental oxidation products. Sulfhydryl compounds may also add to quinones produced when polyphenols are oxidised, and these adducts are presumed to be stable and unable to release H_2S once bound ('sulfur traps'). Aerative remediation techniques may also produce latent sources of H_2S (compounds that can release H_2S at a later time, such as diorganopolysulfanes).

To investigate the chemical mechanism through which aerative remediation strategies remove H_2S, an experiment was designed to investigate the compounds formed when different remediation strategies were applied to a synthetic wine with 'reduced' character. Ferments were conducted in chemically defined grape juice media and treated with either aerative sparging (macro-oxygenation) or copper fining at the time when H_2S was generated by the yeast in the ferments. A trace amount of a glutathione-based polysulfane was produced in wines treated with copper fining, as well as in wines treated with macro-oxygenation, and this compound may act as a latent source of H_2S during storage. Larger concentrations of polyphenolic-sulfhydryl adducts ('sulfur traps') were produced in the wines treated with aerative sparging (Figure 17).

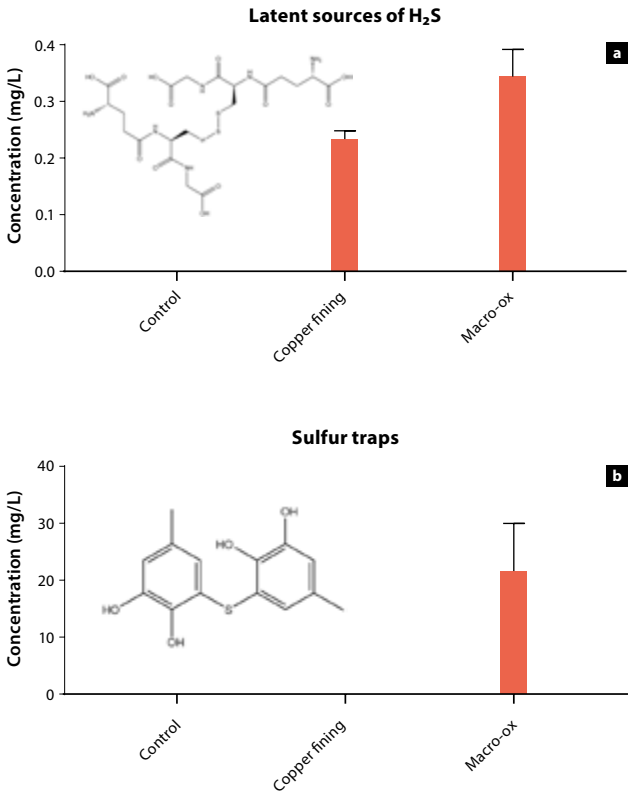


Figure 17. Production of (a) latent sources of H_2S (diglutathionyl polysulfanes) and (b) 'sulfur traps' (polyphenolic sulfhydryl adducts) after copper fining and macro-oxygenation treatments were applied to a synthetic wine to remediate H_2S

Influence of yeast strain on volatile sulfur compound formation

Commercial yeast manufacturers offer a wide range of yeast strains, but little information is known about their ability to modulate the formation of important VSCs such as benzyl mercaptan (associated with 'struck flint' character) in wine. During fermentation of a synthetic wine, it was shown that the formation of benzyl mercaptan was dependent on the metabolic activity of the wine yeast. The amount of benzyl mercaptan produced depended on the strain used, and correlated with the amount of H_2S produced by the yeast during fermentation (Figure 18). These results suggest that H_2S might be one of the precursors necessary for the formation of benzyl mercaptan.

The Ehrlich pathway is a major pathway describing amino acid catabolism and it explains the breakdown of methionine into methionol and methional. In a laboratory-scale experiment using synthetic wine, it was shown that yeast strains with an active Ehrlich pathway produced lower levels of the undesirable compounds methanethiol, methylthioacetate and methional. These strains could be chosen by winemakers to decrease the formation of off-flavours in wine.

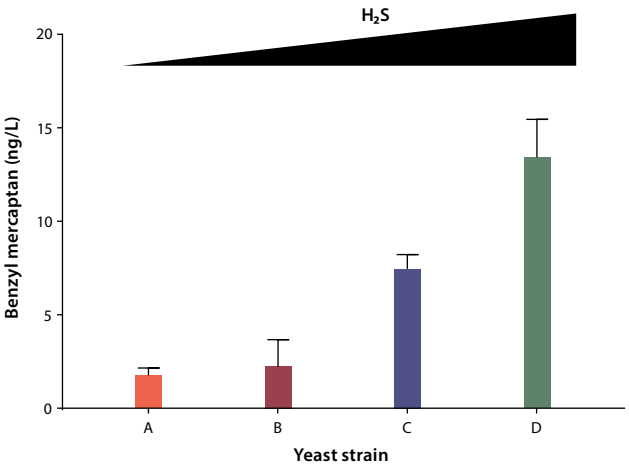


Figure 18. Production of benzyl mercaptan by four wine yeast strains after fermentation of a synthetic wine as a function of hydrogen sulfide (H_2S) concentration produced by the yeast strains

Understanding and mitigating the development of 'reductive' characters in canned wine

Background

Recent industry trends indicate that wines packaged in cans are particularly susceptible to the formation of 'reductive' characters post-packaging. This has the potential to significantly damage consumer expectations for this packaging format and the brand integrity of Australian wine packaged in this manner. A detailed understanding of the chemical pathways involved in the development of these 'reductive' compounds and the role of the packaging material in their formation is required. This knowledge will help identify potential strategies to mitigate the risk of formation of 'reductive' characters, either prior to, or following, packaging in cans.

Evaluating the impact of wine attributes on aluminium cans

Previous benchmarking studies showed that, unlike most other canned carbonated beverages, most commercially canned wines experience a significant increase in aluminium concentration after packaging. This can lead to the development of 'reductive' attributes in the wines, especially H_2S ('rotten egg'), in a relatively short timeframe (Figure 19).

The corrosion chemistry of aluminium dictates that elevated concentrations of SO_2, copper and chloride can lead to pitting in the can surface and migration of aluminium into the wine. There is potential for this to be more significant across the surface of the can lid, as the application process for the protective barrier film (epoxy-based polymer) is different from that applied to the inner surface of the can body.

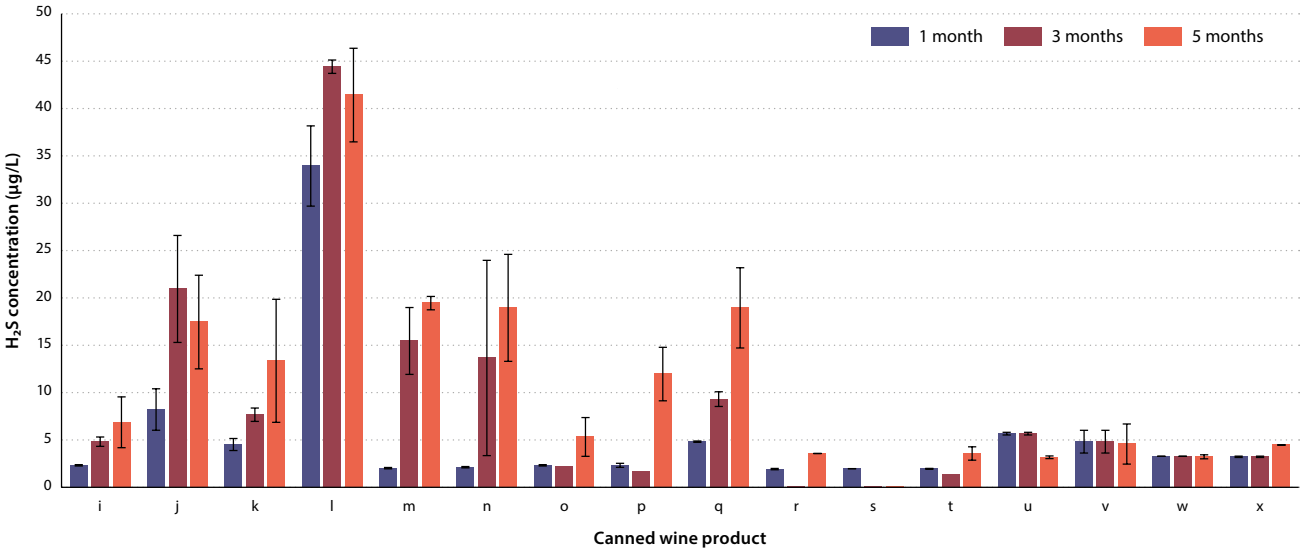


Figure 19. Hydrogen sulfide (H_2S) concentrations in sixteen commercially canned wine products one, three and five months post-packaging. Error bars indicate standard deviation across duplicate cans. Note that the aroma threshold of H_2S in wine is 1.1 to 1.6 µg/L.

Understanding the development of 'reductive' compounds

In order to better understand the role of individual wine attributes in the development of H_2S in canned wines, bench-scale experiments were set up using a commercially available wine with varying pH and varying concentrations of copper, aluminium, SO_2 and oxygen. These experiments showed that:

- transition metals, such as copper, can speed up the formation of H_2S in canned wines, especially in a low-oxygen concentration environment
- the presence of aluminium (metal) accelerates the formation of H_2S, both with and without copper present
- the onset of H_2S formation can be delayed if the copper concentration is significantly decreased, even when aluminium (metal) is present
- the impact of aluminium on H_2S formation appears to be lower when pH is higher, oxygen concentration (total package oxygen) is higher and SO_2 concentration is lower.

Assessing the effectiveness of strategies to decrease H_2S formation

Poly-vinyl imidazole/poly-vinylpyrrolidone (PVI/PVP) co-polymers have been shown to be effective in scavenging copper species from wines and therefore decreasing the transfer of aluminium into wine after canning and the subsequent H_2S generation. To date, this appears to be the most effective method for delaying the onset of H_2S production in canned wines. A small-scale canning experiment demonstrated that the migration of aluminium into 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 (inverted storage in Figure 20). The use of a commercial PVI/PVP product (Claril HM, Enartis Pacific) to remove copper from the wine prior to canning was effective in preventing the migration of aluminium into the wine. The data in Figure 20 were generated for a lightly carbonated (~2 g/L CO_2) Chardonnay wine after three months in can. Samples were subjected to elevated temperature (35°C) to accelerate the reactions occurring in the wine. Half of the wine was treated with the PVI/PVP scavenging agent to remove copper prior to canning and half of the canned samples were stored inverted.

Future work

A commercial canning production run will be carried out to directly compare the performance of PVI/PVP-treated wines to untreated (control) wines. If this proves successful, it will be an important step towards eliminating negative attributes associated with canned wines and will help contribute to the ongoing success of this product category for Australian wine producers.

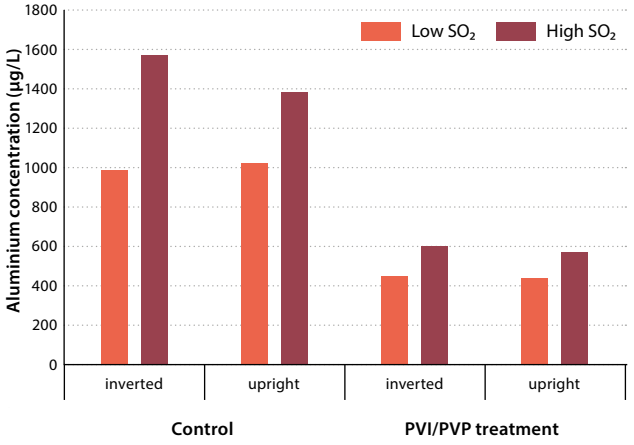


Figure 20. Aluminium concentration levels in canned wine samples after 12 weeks of storage at 35°C, showing effects of two SO_2 concentrations, inverted vs upright storage and PVI/PVP treatment

Smoke taint research

Background

The AWRI, Agriculture Victoria, La Trobe University and Wine Victoria collaborated on a project funded by Wine Australia, the AWRI and the Australian Government Department of Agriculture, Water and the Environment as part of its Rural R&D for Profit program. The AWRI's primary role in the project was to evaluate a range of possible remedial management options and processing tools for dealing with smoke-affected grapes and wine. This project was completed in January 2020 and the Final Report is available from Wine Australia's website.

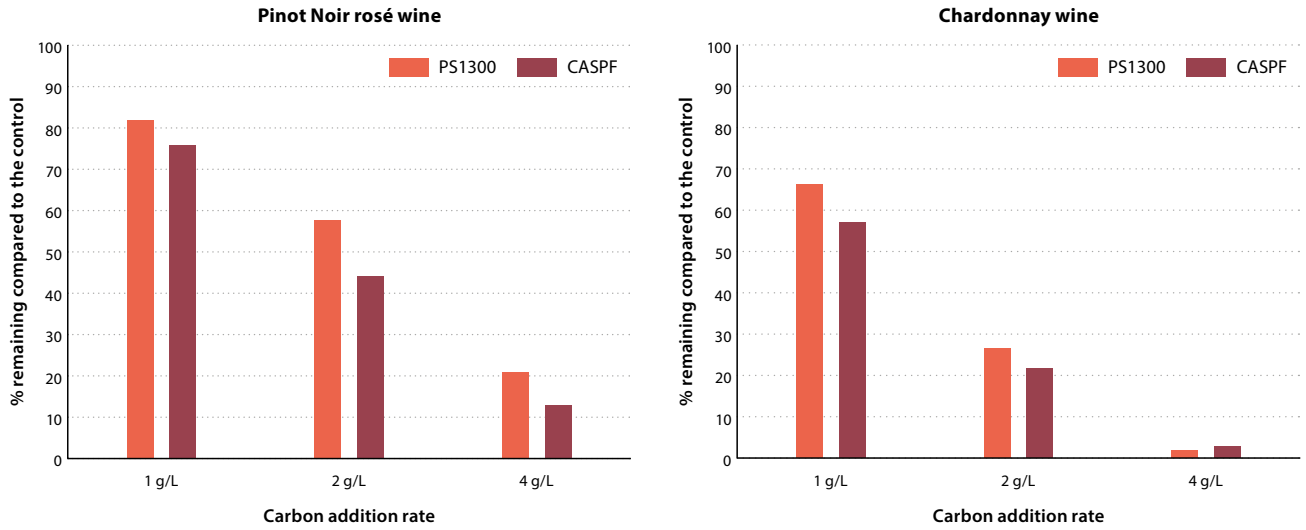


Figure 21. Percentage of total phenolic glycosides measured remaining in 2019 Pinot Noir rosé and Chardonnay wines after treatment of juice with activated carbon products PS1300 or CASPF at three dose rates, prior to fermentation

The project team is also collaborating with the University of Adelaide, PIRSA, Grain Producers SA, the SA Grain Industry Trust and La Trobe University to assess the potential impact of smoke from stubble burns on grapes and wine, with funding obtained from the South Australian Wine Industry Development Scheme. In addition, new 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.

Winemaking trials with activated carbon

Fining with activated carbon is one option for remediating smoke-affected juice and wine. Winemaking trials were performed with 2019 smoke-affected Chardonnay and Pinot Noir (rosé style) juices using two activated carbon products (PS1300 and CASPF) at three dose rates (1, 2 and 4 g/L). Juices were treated with the carbon products prior to fermentation, with bentonite added to assist in settling after a contact time of 48 hours. Six weeks post-bottling, the finished wines underwent sensory evaluation by a trained sensory panel using descriptive analysis. Activated carbon treatment at the highest dose rate (4 g/L) was shown to remove up to 87% and 98% of glycosides quantified for Pinot Noir rosé and Chardonnay, respectively (Figure 21). However, when fined at the higher carbon dose rates, the wines became stripped of flavour and aroma (both positive and negative) and very un-wine-like, described by the sensory panel as having a 'cooked vegetable'/'drain' character. At the lowest carbon dose rate (1 g/L), the smoke-related attributes in the Pinot Noir rosé wines were decreased while still maintaining some positive 'fruity' and 'confection' aromas (Figure 22). Consequently, a fine balance is needed to add activated carbon at a rate that will decrease smoke characters while still retaining some positive flavour and aroma attributes. Carbon-treated wines may also require additional blending with a non-affected wine to blend away any residual smoke characters while increasing varietal aromas and flavours.

The appropriate carbon addition for a particular situation will be dependent on the level of taint compounds in the juice. However, it is important to note that the OIV recommends using carbon additions of less than 1 g/L for both juices and wine, with fining rates of 50 to 500 mg/L typically used for the removal of odours. In addition, for some carbon types, the addition of larger quantities could result in the release of metals into the juice or wine. While all activated carbon products evaluated in this work were commercially available, it is recommended that wineries contact product manufacturers to ensure that their product adheres to the relevant food standards code for use in wine production.

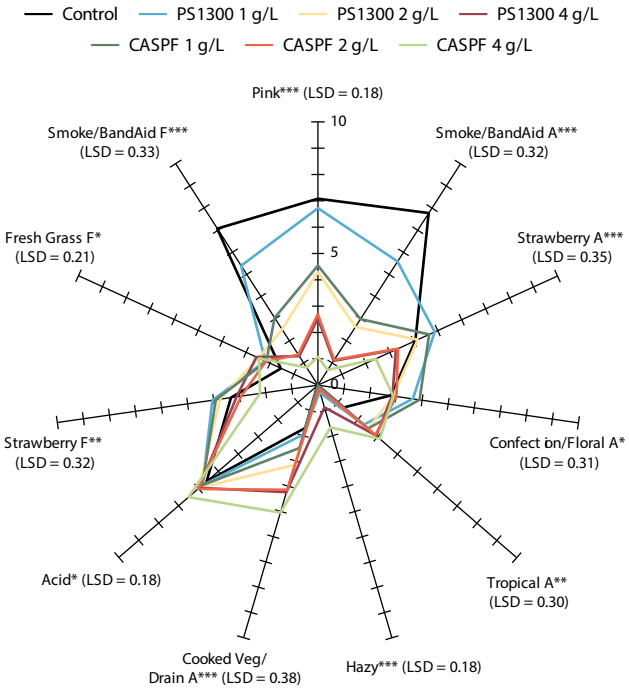


Figure 22. Mean attribute intensity scores for significant (*$P<0.05$; **$P<0.01$; ***$P<0.001$) sensory attributes for seven wines made from different activated carbon fining treatments of Pinot Noir rosé juice.

Dilution studies

Dilution with an unaffected wine is another option for managing a smoke-affected wine, with the goal of diminishing or eliminating smoke-related sensory characters. This option was evaluated using a smoke-affected 2019 Pinot Noir rosé wine. The smoke-affected 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: 100% smoke-affected wine, 50%, 25%, 12.5%, 6.25% and 0% (equivalent to 100% unaffected wine). Wines were assessed by members of the AWRI's technical quality panel for 'smoke' aroma and flavour and 'overall fruit' aroma and flavour (flavour data shown in Figure 23). As expected, the 100% smoke-affected wine was scored significantly higher ($P < 0.05$) in 'smoke' aroma and flavour than the unaffected wine

and was the lowest scoring wine for 'overall fruit' aroma and flavour. 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. Overall, this study with rosé wine confirmed that blending can be an effective option for the remediation of smoke-tainted wine and can decrease 'smoke' aroma scores in a linear manner associated with the volume of tainted wine in the blend (Figure 23).

Consumer acceptance of smoke characters in wine

As part of the work on dilution, a study was conducted to assess the impact of smoke characters on consumer acceptance. Five of the Pinot Noir rosé dilution series wines were assessed by consumers: the unaffected wine, the blends with 6.25%, 12.5%, and 25% of the smoke-affected wine and the 100% smoke-affected wine. Eighty-two regular consumers of rosé wine rated each wine for overall liking on a nine-point hedonic scale from 'dislike extremely' to 'like extremely'. The wines were assessed under blind tasting conditions and were presented in black glasses to avoid any visual cues. The consumers were not given any information about the purpose of the tasting.

A highly significant difference ($P<0.001$) was found among the wines, with the mean liking data shown in Figure 24. The liking score for the smoke-affected wine was very low, with a mean value of 3.7. In consumer testing using the hedonic scale, a value of 6.0 or above generally indicates a well-accepted product and a value less than 5.0 indicates a poorly accepted product. The unaffected commercially available Pinot Noir rosé wine was well-liked, as expected, with a score of 6.4. The liking scores for the unaffected wine and the same wine blended with 6.25% of the smoke-affected wine were similar, indicating that the addition of this proportion of the smoke-affected wine did not have a negative effect on consumer liking. The 12.5% and 25% blends were lower in liking score, with the 25% blend being well below the score of the unaffected wine. Overall, there was a strong negative correlation between the proportion of the smoke-affected wine in the blends tasted by the consumers and their liking score. Results from this study show that a smoke-affected wine is not accepted by consumers and provides evidence that even a small proportion of smoke-affected wine in a blend can seriously affect consumer acceptance. Only a minority of consumers did not respond negatively to smoke. Additional consumer studies would be required to determine if this finding holds true for other smoke-affected wines with differing degrees of smoke influence and of different varieties and styles.

Glycosidase enzyme and carbon treatment of wine

Glycosidase enzyme treatment followed by fining with activated carbons (PS1300 or FPS) was assessed in winery trials with a smoke-affected full-bodied Pinot Noir dry red wine, to determine if this would reduce the concentration of phenolic glycosides and volatile phenols in the wine. Treating the smoke-affected Pinot Noir wine with the Trenolin Bouquet enzyme product at its maximum recommended dose at 25°C for eight days reduced the concentrations of six phenolic glycosides by approximately 50%. Results mirrored those observed in laboratory studies, with the glucose-glucose glycosides (gentiobiosides) being predominantly cleaved by the glycosidase enzyme. The enzyme treatment increased the total volatile phenols compared to the control wine from 132 to 146 µg/L. Subsequently, the concentration of volatile phenols could be decreased by carbon fining in a dose-dependent manner. Mean smoke taint sensory scores for the control and treatments demonstrated that the carbon treatments (with or without prior glycosidase enzyme addition) were more effective in reducing smoke taint ratings than the enzyme treatment alone (Table 5). Wines that had been treated with the enzyme were still reported as having obvious 'smoke'-related aromas and flavours. While for many of the treatments a decrease of 'smoke' intensity was observed, wines were also described as appearing very stripped and lacking positive 'fruit' aromas and flavours, which is consistent with previous knowledge about sensory effects of carbon fining. Further work with wines of different varieties and different levels of taint is warranted to fully explore this option for treating smoke-affected wines.

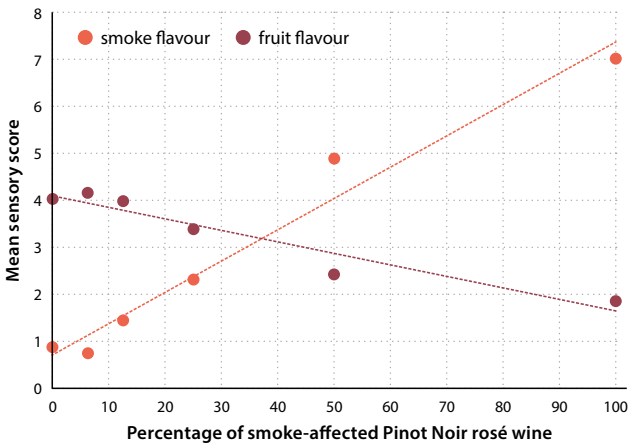


Figure 23. The relationship between the percentage of smoke-affected wine in the blend and mean scores for 'smoke' flavour and 'fruit' flavour for a dilution series of Pinot Noir rosé wines, made by diluting smoke-affected wine with increasing percentages of unaffected control Pinot Noir rosé wine

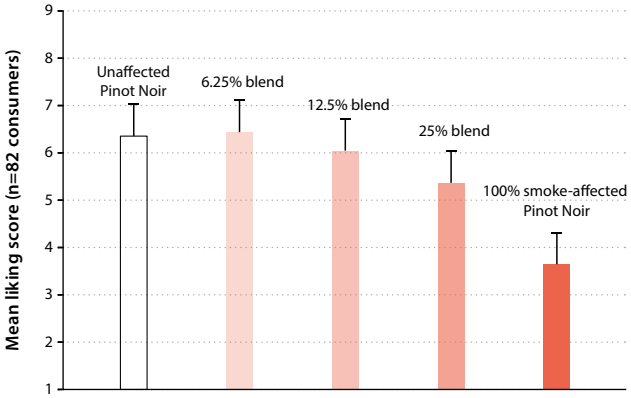


Figure 24. Mean consumer liking scores for an unaffected Pinot Noir wine and the same wine blended with 6.25%, 12.5% and 25% smoke-affected Pinot Noir wine, compared to the 100% smoke-affected wine. Consumers' liking response was measured using the standard nine-point hedonic scale: dislike extremely (1) to like extremely (9). Wines with mean values greater than 6.0 can be considered well-accepted.

Table 5. Mean smoke taint sensory scores from 12 judges for a 2019 smoke-affected Tasmanian full-bodied Pinot Noir dry red wine after treatment with either enzyme (Trenolin Bouquet Plus), carbon (PS1300 or FPS at 1 or 2 g/L) or a combination of both.

Treatment	Smoke taint score
Control	6.2
Enzyme only	6.9
Enzyme + FPS 1 g/L	2.7
Enzyme + FPS 2 g/L	1.6
Enzyme + PS1300 1 g/L	3.3
Enzyme + PS1300 2 g/L	2.3
FPS 1 g/L	2.8
FPS 2 g/L	1.5
PS1300 1 g/L	3.9
PS1300 2 g/L	1.6

Collaborative work

The AWRI is collaborating with the University of Adelaide's Industrial Transformation Training Centre on smoke taint research. During the year, assistance was provided for one PhD project investigating the uptake of smoke molecules in grapes.

A new two-year project with the University of Adelaide, PIRSA, Grain Producers SA, the SA Grain Industry Trust and La Trobe University commenced in 2019 to assess the potential impact of smoke from stubble burns on grapes and wine, with funding obtained from the South Australian Wine Industry Development Scheme.

In response to the Cudlee Creek, SA fires in December 2019, a new research project was initiated with funding provided by PIRSA to assess the impact of early-season smoke exposure on taint markers in grapes and wine, as well as wine sensory characters. Following the fire, grapes and leaves were collected from a total of 24 Chardonnay, Pinot Noir and Shiraz vineyards in the Adelaide Hills with different degrees of smoke exposure and fire damage. Additional analysis of Shiraz and Chardonnay berry and leaf samples from the Hunter Valley is complementing the Adelaide Hills research and will provide a better understanding of the effects on grape composition of cumulative smoke exposure over an extended period of time.

Michael Roach

Environment, sustainability and natural capital

The success of the Australian grape and wine industry is strongly tied to its long-term custodianship of the natural environment. Soil, water, biodiversity and climate all contribute to the success or failure of grapegrowing across Australia. Electricity, fuel, refrigeration and waste disposal are all major costs in winemaking. Projects under this theme aim to assist producers to improve environmental and economic performance; to adapt to the challenges of a variable climate; to make the most of the grapevine clonal resources available; to develop tools to verify the origin of Australian wines; and to improve management of pests and diseases.

Staff

Sheridan Barter, Dr Anthony Borneman, Kate Cuijvers, Dr Martin Day (to 31 October 2019), Dr Leigh Francis, Prof. Markus Herderich, Dr Mark Krstic, Dr Mardi Longbottom, Dr Cristobal Onetto, Wes Pearson, Dr Michael Roach, Dr Simon Schmidt, Dr Tracey Siebert, Steven van den Heuvel, Dr Cristian Varela, Dr Eric Wilkes.

Students

Lisa Hartmann (University of Adelaide).

Visiting students

Kristina Nobis (Technical University Dresden, Germany), Anton Vashchenko (University of Bonn, Germany).

Collaborators

Australian Grape & Wine (Tony Battaglene, Anna Hooper); Carr Consulting, USA (Tom Carr); CSIRO (Dr Rob Bramley, Dr Jason Kirby, Dr Gupta Vadakattu, Dr Christine Warwyk, Claire Wright); Department of Primary Industries and Regional Development Western Australia (Richard Fennessy); Food Agility Cooperative Research Centre (Karensa Menzies, Claire Rutherford); Foundation Viticulture (Nick Dry); Freshcare Ltd (Angela Steain); McLaren Vale Grape Wine & Tourism Association (MVGWTA) (Jennifer Lynch, Rachel Williams); Mount Langi Ghiran (Damien Sheehan); National Wine and Grape Industry Centre, Charles Sturt University (Dr John Blackman, Dr Andrew Hall, Dr Sijing Li, Prof. Leigh Schmidtke); Penn State University, USA (Dr Jessica Gaby, Dr John Hayes); SARDI (Suzanne McKay, Dr Victor Sadras); Tapanappa (Brian Croser); Wine Australia (Stuart Barclay, Andreas Clark, Steve Guy, Drea Hall, Alex Sas, Belinda van Eyssen).

Supporting the sustainability of grape and wine businesses and Australia's sustainability credentials

Background

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

Launch of Sustainable Winegrowing Australia

Sustainable Winegrowing Australia opened for membership on 1 July 2019. The total number of members increased with the combined memberships of earlier programs, Entwine Australia and Sustainable Australia Winegrowing; however, the proportion of Australia's vineyard area covered by the program decreased by approximately 5% compared to the previous year. These figures are expected to recover in 2020 as the industry gains familiarity with the program.

Trust mark, certification and marketing

The AWRI and Australian Grape & Wine co-invested in the development and protection of a trust mark in consultation with Wine Australia, the Sustainability Advisory Committee and other key industry stakeholders. The trust mark became available for use by certified members on wine labels and marketing materials in June 2020 and is a public endorsement of certified members' commitment to sustainable practices. Updates to the certification standards (the Australian Wine Industry Standards of Sustainable Practice – Viticulture and Winery) were finalised in June 2020, supporting the launch of the trust mark.

The AWRI worked with Wine Australia to develop sustainability stories from certified members for incorporation into targeted international trade and promotional activities to build awareness of Australia's sustainable approach from vine to wine. As part of the 'Australian Wine Made Our Way' program, stories will be featured on the strategic topics of water, energy, waste, vineyard practices, pest and disease, people and social responsibility. These stories will also be integrated into Wine Australia's education program and used with key influencers and wine tourism initiatives.

Sustainability projects

Two research projects that support Sustainable Winegrowing Australia were completed. 'Valuing nature in viticulture', a collaborative project with the Food Agility CRC, supported the incorporation of economic metrics into Sustainable Winegrowing Australia in 2019. Modelling of the data collected was used to investigate a sustainability index and to apply artificial intelligence to assess the value of models to predict 'sustainable' vineyards. Three grower case studies were also developed through the project. A project which mapped the data collected by Sustainable Winegrowing Australia against the United Nations Sustainable Development Goals also concluded. This project has enabled international benchmarking of the program and identification of both strengths and opportunities for future improvement.

Understanding the background and identity of the Gingin Chardonnay clone

Background

The Chardonnay clone Gingin is one of the oldest and most important Chardonnay clones in Australia. It arrived in Western Australia in 1957, simply called 'Pinot Chardonnay', most likely from the foundation vineyard at UC Davis in California, USA. Its popularity and spread in the late 1960s and early 1970s coincided with the introduction of the clones Mendoza and OF Chard, which were released in Australia in 1969 (DPIRD 2018). As all three were prone to millerandage, there was some confusion as to the origins of each clone.

The most likely source of Gingin was the UC Davis Armstrong foundation vineyard, where, at the time Gingin was sent to Australia (1956 or 1957), only four Chardonnay clones were cultivated. These were Chardonnay-1, which could be traced back in the vineyard to the early 1930s; Chardonnay-2, an import from France that was planted in 1951 and removed in 1959; and Chardonnays 430 and 439, which were recent imports only planted in 1956. The original source of Chardonnay-1 is unknown.

In 1961, a Chardonnay sample was received by UC Davis from Mendoza, Argentina labelled 'Pinot Chardonnay' (Hyland 1967). The sample from Argentina was planted in the Hopkins Road foundation vineyard at UC Davis and given the name FPS 01A. It was distributed under the name Chardonnay 01A and is known in Australia as the Mendoza clone. In the same year, Chardonnay-1 was sampled and heat-treated. The heat-treated sample of Chardonnay-1 was given the name FPS 02A, was distributed under the name Chardonnay 02A, and is known in Australia as OF Chard. Both were planted in 1964 and distributed from 1966. The origins of the sample from Argentina are not mentioned in any of the articles on this subject, or on the importation record. Mendoza and OF Chard were released from quarantine in Australia by CSIRO in 1969 (DPIRD 2018).

With the many gaps in the historic record surrounding Gingin, the true origins of this Chardonnay clone have been greatly debated for years. In Australia there is also lingering confusion about the relationship of Gingin and Mendoza because of their similarities in phenotype. This project aimed to build on the AWRI's Chardonnay whole-genome sequencing work already conducted across a range of Chardonnay clones, to determine if Gingin was the same as, or different from, the Mendoza clone.

Determining the origins of Gingin using whole-genome sequencing and clonal marker mutations

Two samples of Gingin vines were collected from Moondah Brook Vineyard in the Swan Valley, WA and two were collected from the Harvey Agricultural College at Wokalup, WA. These sites represent some of the earliest derivatives of Gingin, which were first planted at the WA Department of Agriculture's Swan Research Station. Two samples of OF Chard were provided by Yalumba Nursery, sourced from different planting years. Finally, samples were provided from the Tiers vineyard in the Adelaide Hills, SA which are thought to be OF Chard (Brian Croser, pers. comm.). Genome sequencing was performed on these samples and compared to genome data that was available for a number of Chardonnay clones (Roach et al. 2018).

Based on a collection of 1,333 clonal markers that were identified across the 27 Chardonnay samples investigated, phylogenetic analysis indicated that the Gingin, OF Chard and Mendoza clones formed a distinct clade, sharing most of their markers, while the Tiers 1 sample represented a novel clone (Figure 25). Gingin, OF Chard (Chardonnay 02A) and Mendoza (Chardonnay 01A) therefore share a common ancestor. Furthermore, the phylogeny is consistent with Gingin being a selection of Chardonnay-1, as OF Chard (Chardonnay 02A) represents a heat-treated and repropagated version of this very early clone. The phylogeny also shows Mendoza as sharing the same progenitor as both Gingin and OF Chard. However, there is no indication as to its origins prior to UC Davis receiving this clone in 1961. Distribution records were only kept from 1956 onwards at UC Davis (Sweet 2018). If what is known as the Mendoza clone today was in fact a selection of that sample from Argentina, then at some point prior to 1956, Chardonnay-1 was most likely supplied to Argentina. There it was propagated, selected and eventually sent back to UC Davis in 1961. In this scenario, serial propagations would account for the large accumulation of mutations in Mendoza compared to Gingin and OF Chard.

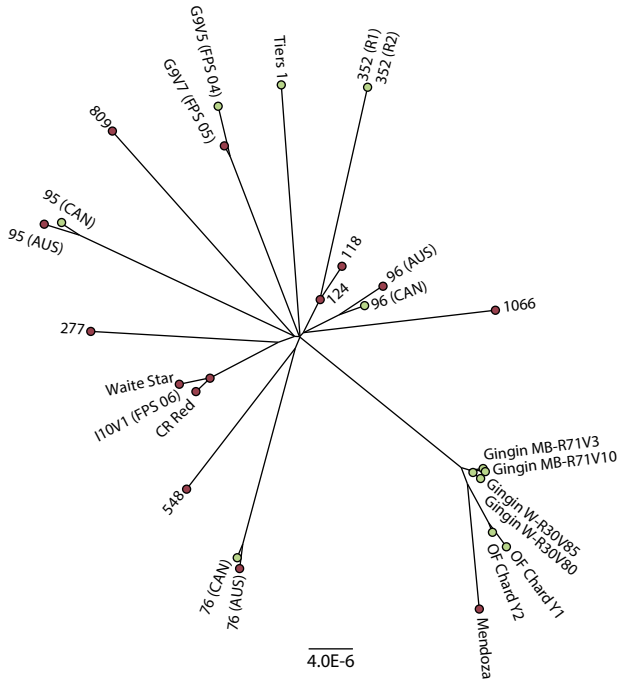


Figure 25. Unrooted phylogeny of Chardonnay clones. Purple nodes represent samples that were used in the original marker discovery analysis in Roach et al. (2018). Green nodes represent new samples that were included for this study. Clone names are indicated in black. Phylogeny is scaled by substitutions per site.

References

Department of Primary Industries and Regional Development (DPIRD) 2018. Timeline and distribution of Chardonnay clone 'Gingin'. *Wine Industry Newsletter.* Available from: https://agric.wa.gov.au/n/7170

Hyland, H.L. 1967. *Plant Inventory No. 169. USDA. Plant Material Introduced January 1 to December 31, 1961 (Nos. 270535 to 277783).* Available from: https://naldc.nal.usda.gov/catalog/39196

Roach, M.J., Johnson, D.L., Bohlmann, J., Van Vuuren, H.J.J., Jones, S.J.M., Pretorius, I.S., Schmidt, S.A., Borneman, A.R. 2018. Population sequencing reveals clonal diversity and ancestral inbreeding in the grapevine cultivar Chardonnay. *PLOS Genetics,* 14**:** e1007807.

Sweet, N.L. 2018. Winegrapes of UC Davis: Chardonnay. Available from: http://fps.ucdavis.edu/grapebook/winebook.cfm?chap=Chardonnay

Defining regional variability and uniqueness of premium Australian Shiraz

Background

This project aimed to define the sensory properties of Shiraz wines from several regions that contribute to their distinctive regional character, and to provide objective compositional markers for both grapes and wine for future use in vineyard and winery assessment. The project formed part of a collaborative study with NWGIC and was completed on 30 June 2020.

Chemical and climate measures that relate to regional sensory differences

As previously reported, detailed sensory and chemical examination of a large number of commercially produced wines from six regions (Barossa Valley, McLaren Vale, Heathcote, Yarra Valley, Canberra District and the Hunter Valley) was completed. This work involved characterising wines from each region from a sensory point of view, selecting representative examples and then quantifying their sensory attributes as a set. The sensory data were statistically related to almost 70 targeted compositional measures. The models generated were able to predict most key attributes well.

In conjunction with NWGIC researchers, this project showed there were distinctive region-specific sensory differences among wines sourced from six major Australian Shiraz-producing regions. Chemical compounds that related to key region-specific sensory attributes were identified. These compounds can be used as targets for future trials assessing viticultural, winemaking or detailed spatial effects on region-specific Shiraz flavour. In addition, links to climate indices for the wines were demonstrated, with rainfall variables, growing degree days, relative humidity minima and harvest date all being moderately well related to 'ripe' flavour attributes as opposed to 'green' flavour attributes. However, the amount of variability of the chemical measures explained by the climate data was relatively low, with only 18% variance explained, indicating other region-specific aspects also have a strong influence. With sensory profiles established, and with chemical compounds determined that contribute to the sensory differences between regions, producers can use this information to endeavour to sustain or increase regionally distinct characters.

Development of tools to verify origin and varietal nature of wines

Background

Wine is periodically the subject of substitution or counterfeiting. The aim of this project was to protect the reputation of Australian wine by developing a robust way to determine the provenance of an unknown wine sample using several isotope ratios and a matrix of elemental concentrations. The initial promising results achieved using strontium isotope ratios were improved, in conjunction with project partners at CSIRO, with the inclusion of data on the isotope ratios of boron, lithium and lead. This was the final full year for this project.

Identifying wine provenance

This project is in its final phase with the focus on completing the analysis of the data acquired, developing recommendations for industry and preparing results for publication. The project has successfully identified a combination of isotopic ratios that can be used to give a good indication if a wine is of Australian origin and provide pointers to the possible region within Australia it may have originated from. The


Wes Pearson

methodology developed does not give a simple in-market method to absolutely determine if an unknown wine is Australian. In fact, the research suggests that doing this with 100% confidence is unlikely without significant technology development and massively increased commitment to databases of isotopic ratios in wine, which was not the aim of the project. Instead, the method developed provides an important tool that can be used when provenance disputes arise in legal or regulatory environments.

The project has also identified the weaknesses of some elemental and isotopic tools currently in use for the assessment of wine provenance internationally. These include the impact of bentonite fining on the use of trace elemental or lead isotope analysis to identify the origin of white wines and some of the weaknesses of oxygen isotope ratios in accurately determining the addition of water to must and wine. A further outcome has been a clear understanding of the impact of the origin of glass wine bottles on the use of isotopic measurements for provenance, in particular the use of boron isotopes. While the current research project on the use of isotopic measurement for identifying provenance is winding up, the AWRI's involvement in the area will continue through a range of collaborations and some commercial activities.

Bioprospecting Australian microbial genetic diversity

Background

Differences in wine microbiota are likely to be an important aspect of terroir, particularly where spontaneous fermentations are performed. Traditional microbiological research has shown that both vineyards and uninoculated wine fermentations contain diverse mixtures of microbial species, often with species being represented by multiple strains. However, the inability to efficiently and accurately assess the large numbers of samples required to understand such a complex concept as terroir has limited further insights into this important area. This lack of information is also an impediment to the exploitation of native microbial germplasm and spontaneous fermentation by the Australian wine industry. Recent advances in culture-independent microbiological techniques such as metagenomics (genomic sequencing of mixed microbial communities) can address these issues by efficiently providing detailed identification of the species, and their proportions, in complex microbial mixtures.

Winemaking interventions to influence the microbial composition of wild ferments

Of the fermentation conditions that are readily modulated by winemakers, the addition of SO_2 represents the most broadly available intervention practice. Previous microbiological studies have shown that species (and strains) of the major wine yeasts can respond differently to the application of this antimicrobial agent. Typically, commercial strains of *Saccharomyces cerevisiae* display high tolerance to SO_2, while 'wild' yeasts display lower tolerances and are therefore thought to be broadly selected against through the application of moderate amounts of SO_2 prior to the start of fermentation.

Winemaking trials were performed across the 2018, 2019 and 2020 vintages, focusing on the ability of SO_2 additions to influence the microbial and chemical composition of wild fermentations. The addition of as little as 35 mg/L of SO_2 prior to the initiation of fermentation was shown to significantly, and reproducibly, alter the non-*Saccharomyces* yeast composition of the ferments. This was shown to be accompanied by changes in the final chemical composition of the wines, with significantly higher levels of acetate esters being observed in the wines made from SO_2-treated juice (Figure 26).

The ability to use SO_2 to predictably modulate the yeast community structure of a wild ferment, and the resulting chemical composition of the final wine, represents an important tool for winemakers to begin to be able to influence the sensory profile of wines made from wild fermentations.

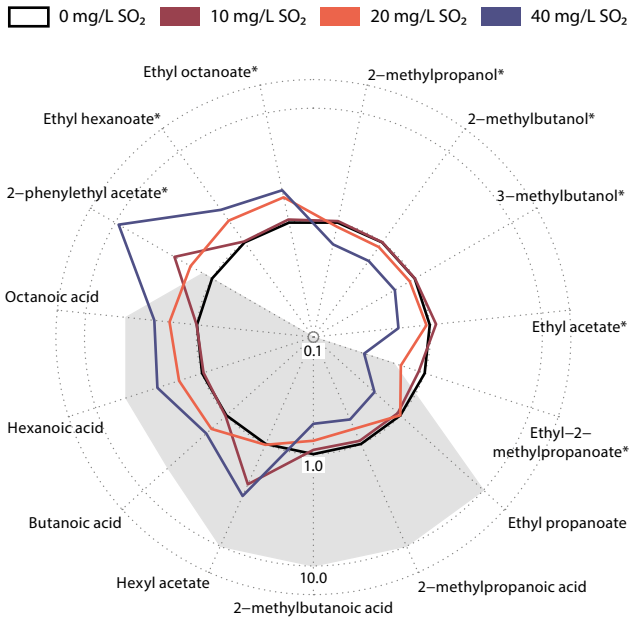


Figure 26. Chemical analysis of 2019 wild ferment Chardonnay wines treated with varying levels of SO_2 (10, 20 or 40 mg/L) prior to fermentation. Only those analytes that displayed a statistically significant change in concentration (ANOVA, $p < 0.001$) are shown. Values are presented as the ratio of the observed concentration relative to wine without SO_2 treatment. Grey shading indicates the odour activity (OAV) threshold for that compound. Analytes that exceed their OAV are marked with asterisks.

Bioprospecting

High-throughput assays have been used to screen a collection of more than 2,000 non-*Saccharomyces* yeast strains in order to identify isolates with winemaking potential. These screens include the ability for the isolates to grow on high-sugar substrates and in high-ethanol environments as well as the ability to produce several different enzyme activities that have been associated with the release of aroma compounds from non-volatile precursors in grape juice.

Genome sequencing of several wine isolates of the genus *Aureobasidium* has uncovered three potentially new species within this genus of yeast-like fungi that forms part of the natural flora of grapevines, and which may play an important role early in fermentation.

Rotundone and its role in defining terroir in iconic Australian cool climate 'peppery' Shiraz

Background

Rotundone is the potent, grape-derived compound responsible for 'black pepper' aroma in wine. Previous research demonstrated that the Grampians and Pyrenees regions in Victoria can produce wines with substantially higher levels of rotundone than other Shiraz-producing regions such as Barossa and McLaren Vale. Patterns of rotundone variation appear to be stable within an individual vineyard across different growing seasons. A collaborative project with CSIRO commenced in 2017, focusing on premium cool climate Shiraz, with the aim of defining features at the within-vineyard scale that contribute to rotundone formation. The research seeks to identify genetic and biophysical factors responsible for large differences in rotundone concentrations at harvest, and aims to provide insights into how the rotundone element of terroir, and grape aroma in general, may be influenced and managed at a range of scales.

Aroma compounds in cool climate Shiraz

Gas chromatography-mass spectrometry analysis confirmed the presence of the sesquiterpene, α-muurolene, in Shiraz grapes and wine. However, α-muurolene did not contribute any notable sensory attributes and model oxidation experiments did not provide evidence for the formation of obvious aroma compounds from α-muurolene. Instead, the oxidation of the grape sesquiterpene α-ylangene, a compound commonly found in grapes from 'peppery' vineyards, has been demonstrated to result in the formation of a new potent aroma compound present in wine where it contributes 'celery-like'/'spicy' characters.

The role of site characteristics in defining grape aroma compounds

Despite bushfires and COVID-19 restrictions, vintage 2020 field trials at Mount Langi Ghiran were completed as planned. In addition, sentinel grapes were also sourced and exposed to cold temperatures. For this model experiment, controlled conditions were chosen to replicate temperature profiles of cool climate vineyards observed in previous vintages. Some elevated concentrations of rotundone and its precursor α-guaiene have been observed and additional analyses are underway to corroborate the effects of ambient temperatures on grape metabolites.

Further understanding of sesquiterpene hydrocarbons in grapes

Most sesquiterpene hydrocarbons commonly found in grapes are absent from wine. It has now been shown that this is because these compounds are not extracted into wine-like hydroalcoholic solutions and are instead removed from juice as they bind back to solids from grapes. This means that sesquiterpene hydrocarbons can act as flavour precursors in grapes, but not in yeast fermentations.

Understanding the basis of agrochemical resistance in biotrophic grapevine pathogens

Background

Grapevine diseases caused by fungal/oomycete pathogens such as *Botrytis cinerea, Erysiphe necator* (powdery mildew) and *Plasmopara viticola* (downy mildew) are responsible for significant crop losses. Current control measures rely on spraying with agrochemicals; however, the development of resistance to agrochemicals is an ever-increasing problem in agriculture, and one from which the Australian wine sector is not immune.

Improving the understanding of agrochemical resistance in powdery mildew

Previous research showed that known resistance mutations to many commonly used agrochemicals are prevalent in both powdery and downy mildew. However, it is not yet fully understood how the presence of the mutations relates to loss of field efficacy for key agrochemicals. This is an important question to be answered before genetic tests can be used to inform viticultural practices. The AWRI is working with SARDI to use next-generation sequencing to track the prevalence of resistance alleles in both powdery and downy mildew. During the year, key resistance loci were genotyped across a number of powdery and downy mildew samples.

Techniques were also developed to extract DNA from spore traps, which can be used to monitor the presence of fungi in the vineyard (including pathogens) and to determine the species composition of the spore-trap sample via next-generation sequencing of 'DNA barcodes'.

Ella Robinson, Dan Johnson, Kate Beames, Chris Day, Sarah Ballantine

Foundational data and support services

The research, development and extension activities of the AWRI are underpinned by an efficient service capacity that provides and supports infrastructure; delivers research support and analytical services; manages governance, legal and financial affairs, information technology and workplace safety; and monitors trends in Australian wine composition and production practices.

Staff

Thomas Almond, Sarah Ballantine (to 30 September 2019), Sheridan Barter, Ida Batiancila, Kate Beames, Linda Bevin, Laura Bey, Eleanor Bilogrevic, Catherine Borneman, Mark Braybrook, Natalie Burgan, Alfons Cuijvers, Chris Day, Dr Zung Do, Shiralee Dodd, Damian Espinase Nandorfy, Dr Leigh Francis, Josephine Giorgio-Ion, John Gledhill, Robyn Gleeson, Dr Nuredin Habili, Jesse Hall, Thomas Hensel, Prof. Markus Herderich, Kieran Hirlam, Dr Josh Hixson, Adam Holland, Leanne Hoxey, Kinga Kiziuk (from 25 May 2020), Dr Vilma Hysenaj, Dr Dan Johnson (to 31 January 2020), Pauline Jorgensen, Dr Mark Krstic, Jillian Lee, Desireé Likos, Dr Natoiya Lloyd, Brigitte Lynch, Jacinta McAskill, Bryan Newell, Dr Luca Nicolotti, Dr Simon Nordestgaard, Jennifer O'Mahony, Kara Paxton, Shaley Paxton (from 21 April 2020), Wes Pearson, Lisa Pisaniello, Dr Amy Rinaldo, Ella Robinson, Mark Rullo (to 31 January 2020), Marco Schoeman, Neil Scrimgeour, Gina Sellars, Dr Tracey Siebert, Dean Smiley (from 10 March 2020), Mark Solomon, Pamela Solomon, Fang Tang, Dr Maryam Taraji, Randell Taylor, Deborah Thornton-Wakeford (to 10 October 2019), Heather Tosen, Dr Lieke van der Hulst (from 23 January 2020), Flynn Watson, Kylee Watson, Dr Matthew Wheal, Dr Eric Wilkes, Paul Witt (from 25 May 2020), Qi Wu, Amanda Ylia (to 24 March 2020).

Visiting researcher

Dr Jang Eun Lee (Korea Food Research Institute, South Korea).

Collaborators

AB Biotek (Dr Tina Tran); Australian Institute for Bioengineering and Nanotechnology (Dr Esteban Marcellin Saldana); Compusense, Canada (Ryan Corrick); Coriole Vineyards (Duncan Lloyd); CSIRO (Dr Everard Edwards); Fermentis, France (Etienne Dorignac); Lion (Jarret Rigg); Queen Victoria Museum & Art Gallery (Tracey Puklowski); SARDI (Dr Marcos Bonada, Dr Joanna Gambetta); University of Adelaide (Assoc. Prof. Cassandra Collins, Assoc. Prof. Paul Grbin, Dr Richard Muhlack, Assoc. Prof. Kerry Wilkinson); University of Melbourne (Prof. Malcolm McConville); University of Western Australia (Assoc. Prof. Michael Clarke).

Efficient administration

Background

The AWRI's management and administration is carried out by a dedicated team of specialists who work together to efficiently and effectively provide leadership, infrastructure, financial, human resources, legal, contract management, risk management, work health and safety, corporate governance and IT services across the organisation. The team's objective is to enable all AWRI staff to focus on their core capabilities to ensure that the organisation is able to meet its objectives, and in turn the expectations of its stakeholders. The team works closely with the AWRI Board, which provides additional leadership and oversight to all AWRI activities.

Finance

Core activities included financial management; budgeting; and reporting to the AWRI's management and Board, funding organisations (particularly Wine Australia) and various arms of government. Back office support was also provided to entities such as the Australian Wine Industry Technical Conference, Interwinery Analysis Group and the Wine Innovation Cluster. Other notable activities included managing the impacts of COVID-19 on the AWRI's asset base, cashflow and liquidity; assisting in the negotiation of favourable terms on a comprehensive suite of capital investments; and ensuring compliance with a raft of newly effective accounting standards relating to revenue, investments and leases.

Human resources

This capability maintains responsibility for a broad range of functions including recruitment, employment contract management, visas, payroll and compliance activities. In 2019/2020 the AWRI's ability to attract and retain world-class talent was enhanced through establishing the business case for, and then implementing, the migration of a majority of employees from fixed-term to permanent contracts of employment. This process included a comprehensive update to standard employment contract templates, assisted by external counsel. AWRI employees undertook a range of professional development activities during the year, a number of which were funded through many AWRI directors nominating for their directorship fees to be made available for such purposes, for which their support is gratefully acknowledged. The annual staff survey once again highlighted the AWRI's positive working environment, with 95% of respondents confirming that 'all things considered, the AWRI is a great place to work'. Themes which consistently contribute to this outcome include the diversity of work, the collaborative, productive and passionate workplace culture, close engagement with industry, as well as the AWRI's location and comprehensive modern facilities.

Operations

Many of the AWRI's operational challenges during the year related to COVID-19 and ensuring that the AWRI remained a safe and productive working environment for staff and others. These challenges were addressed through convening an internal COVID-19 response team made up of the senior management group and other key operational staff. To date, this team has identified, considered and addressed almost 100 discrete issues relating to COVID-19. In addition, cost-effective custom-designed and manufactured engineering solutions continued to be provided to support a range of AWRI projects, with recent examples including gas-dosing equipment for pilot-scale fermentations, specialised equipment for packaging trials, and installation of supporting infrastructure for new instrumentation – particularly relating to complex new analytical equipment within the Metabolomics node. Broader activities involved coordination of internal repainting of the majority of the AWRI's premises, installation of a comprehensive active exhaust system for key laboratory environments, and the development of further solutions to space constraints faced across the

Amy Rinaldo

AWRI's laboratory, office and storage areas, including the fit-out of new laboratory space expected to become occupied in 2020/2021. This year saw the employment of the AWRI's long-serving Operations Manager, Mark Braybrook, drawing to a close as he prepared to enter retirement in July 2020. Mark's unique skillset, positive attitude and commitment to AWRI values saw him make a substantial contribution to the AWRI throughout his tenure as a highly valued employee, and he is warmly thanked for his service. Mark provided a thorough handover over the latter part of the year to the current AWRI Research Laboratory Manager, Angus Forgan, who will take on an expanded role incorporating operations management activities following Mark's retirement.

Corporate governance and legal support

This capability assists the effective functioning of the AWRI Board while providing legal support to all teams within the organisation and ensuring that the AWRI continues to meet its legal obligations. A key activity this year included amendments to the AWRI's Constitution to remove the involvement of the Australian Government Department of Agriculture, Water and the Environment from the AWRI Board election process, following a recent change in practice within that Department. Other activities included the conduct of an external review of the Board and its processes, maintaining and updating the organisation's strategic and operational risk registers, general policy review and contract management.

Information technology

Throughout the year, delivery continued against a range of strategic initiatives contained in the AWRI's IT Strategic Plan 2019-2021, with key achievements including upgraded core network infrastructure, servers, desktops and the implementation of multi-factor authentication. Such enhancements continue to add considerable value to almost every aspect of the AWRI's operations. This plan, much like the previous iteration, is on track to be completed on time and on budget. Significant effort was also invested in responding to the challenges of COVID-19, primarily in assisting the majority of staff in migrating to remote working arrangements through testing and configuring remote access capabilities, procuring and deploying additional user hardware, and delivering a high level of user support to assist in adapting to this new paradigm. Responding to cybersecurity threats continues to increase in prominence, and proactively developing resilience towards such threats through 'hardening' the AWRI's IT systems and network represents a core strategic priority for future periods.

Information and knowledge management

Background

Knowledge is at the core of the AWRI's operations and an effective information and knowledge management (IKM) environment is therefore essential to the AWRI's core business. This project provides a flexible and agile IKM environment, which supports innovation and excellence at the AWRI. This is being achieved through harmonisation of existing IKM platforms and the information they contain; the adoption of emerging IKM technologies and solutions; improving access and collaboration capabilities; and the optimisation of business processes through the use of automated workflows.

Use of Office 365 and SharePoint Online

Office 365 and SharePoint Online are key collaboration tools used by AWRI staff to manage and share files and information. These cloud-based services enabled many staff to work efficiently from home during the COVID-19 lockdown period. In particular, the use of Microsoft Teams for meetings increased by 100% in April and May 2020, when many staff were working from home, compared to the previous two months.

Commercial Services

Background

AWRI Commercial Services continues to serve an important role in the Australian grape and wine industry, providing internationally recognised and accredited reference laboratory services, proof-of-performance testing, consulting services, microbiological auditing and the design and implementation of trials and research for industry, covering all parts of the production chain from viticulture to packaged wine. Commercial Services also continues to be actively involved in pre-competitively funded research projects in applied areas and provides services to the broader agricultural industry and producers of other foods and beverages.

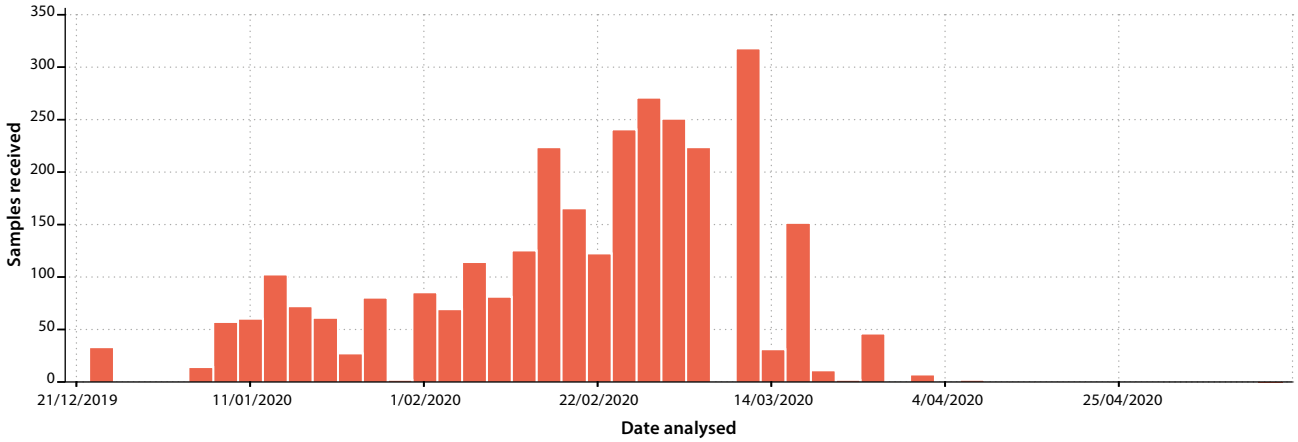


Figure 27. Numbers of grape samples received for smoke analysis between late December 2019 and early April 2020

Impacts of bushfires and COVID-19

The Commercial Services laboratories had another strong year with total sample numbers (26,561) for 2019/2020 13% higher than the historic three-year (2017-2019) average (23,450). There were 349 new customers in the 2019/2020 financial year – an increase of 93% from 2018/2019. Both of these increases were predominantly due to the significant sample numbers associated with smoke taint testing. The increase in smoke-related analyses was somewhat offset by a reduction in the volume of routine testing for standard wine analytes during the 2020 vintage.

The bushfires across Australia in the 2019/2020 summer saw AWRI Commercial Services called on to analyse more than 4,600 samples for smoke before the end of June 2020, with a peak of more than 1,500 samples in a two-week period in mid-February 2020 (Figure 27). This compares to a total of around 600 samples analysed for smoke in a typical year. Although turnaround times for results did become extended due to the numbers of samples, over 82% of samples were reported in less than the targeted ten-day limit, with more than half reported in under seven days. Meeting these extreme demands involved the cooperative efforts of the entire organisation, with work being carried out seven days a week and every available instrument turned over to the effort. In total, 71 different AWRI staff were involved in the testing and interpretation of smoke results and the capacity for analysing samples was increased by almost 100% to an average of more than 90 samples per day. Lessons from this year's fires will be used to improve services for future fire events, allowing higher capacities for analysing samples, more efficient processes to transport samples to the AWRI and smoother processes for reporting.

Just as the number of smoke testing samples was beginning to ease, the severity of the COVID-19 pandemic was becoming clear, with significant restrictions introduced to businesses around Australia. The Commercial Services laboratory functions were deemed an essential service and as such allowed to continue to operate to support the Australian grape and wine industry. A number of changes were introduced to ensure the safety of staff and the continuity of services. These included moving all non-laboratory staff to working from home, creating shifts within the trace laboratory to reduce staff numbers present at any one time, introducing processes to sanitise samples on arrival and severely limiting access to the facilities for customers and couriers delivering samples. These processes allowed AWRI Commercial Services to continue operating with very little disruption.

Increase in demand for biological testing

The demand for the services provided by the Applied Biosciences team has grown steadily this year, with total sample numbers exceeding the previous three-year average by 21%. The recently developed beer microbiological services have a been a large contributor to this increase, as well as the 1,468 samples that were received for virus testing. A major focus for the year has been the integration of the recently acquired virus testing service into AWRI Commercial Services. This has included movement of the virus testing staff and laboratory testing infrastructure into the AWRI premises and the expansion of quarantine CA12 certification to encompass the virus testing services. Co-location of this service with other Applied Biosciences team activities has improved efficiency, resulting in improved turnaround times for customers. Commercial biological project work completed during the year included multiple winery and bottling line microbiological audits, a project relating to beer foam stability for a large brewery, a validation project for a rapid *Brettanomyces* detection flow-cytometry commercial kit, and several yeast-related trials for commercial yeast companies.

Bringing new services and technologies to industry

AWRI Commercial Services continues to provide a broad range of technical support services to the Australian wine industry, to ensure that new technologies and products are fit for purpose and meet the expectations of the final users. These are supported by a comprehensive suite of physical, chemical and sensory analyses. During 2019/2020, a number of shelf-life studies were carried out, to better understand product integrity and development characteristics for new products. Some of these studies used controlled exposure to environmental variables, such as temperature, to accelerate impacts and provide rapid performance data. These trials have led to the development of a dedicated small-scale packaging facility with the ability to package both still and carbonated products in a range of different packaging formats.

A number of projects have involved the evaluation of innovative new technologies for the measurement of different wine attributes, including some assessed for their ability to provide rapid screening of potentially smoke-affected grapes and wines. These proof-of-performance studies are carried out in conjunction with Commercial Services' internationally recognised analytical laboratory, to ensure that reliable and accurate reference chemical analysis data is available for comparison purposes.

Research services

Background

The provision of complex analytical equipment and highly specialised methods is a basic element of modern scientific research. This project ensures access to expertise such as sensory analysis, development support, organic synthesis of rare compounds, statistical analysis and running of advanced chemical analytical instruments.

Sensory analysis

Twenty-six major sensory studies were completed in 2019/2020, mainly using quantitative sensory descriptive analysis, but with some studies involving more rapid methods such as projective mapping or Pivot© Profile. These studies generally used the AWRI's highly trained and experienced dedicated sensory panel, but some also involved winemaker panels.

Twenty-five triangle tests were completed for a range of projects, along with 32 technical quality panel sessions, predominantly for helpdesk investigations. Eleven sensory sessions were undertaken to assess smoke characters in wines made from grapes exposed to bushfire smoke, using a specialised panel rating 'smoke' aroma and flavour, in comparison to unaffected control wines. A study assessing the responses of a group of highly experienced winemakers to smoke-affected wines was completed, comparing their responses to that of the AWRI smoke panel. The results showed that both panels performed similarly and well, with the winemakers more prone to 'false positive' responses, giving some smoke ratings to unaffected wines. This highlighted the need to include controls in industry smoke assessments. A consumer preference test was completed to assess the degree of acceptability of wines with varied degrees of smoke flavour.

Synthetic organic chemistry

Several new deuterated analytical standards and replacement compounds were sourced. A number of synthetic options were reviewed for preparation of deuterated compounds.

Development activities

New procedures for sourcing grapes for research trials were developed and implemented for the 2020 vintage. This included an online form used by research staff to capture grape-related specifications and subsequent winemaking requirements, which was integrated with WIC Winemaking Services' systems. In addition, a grape supply agreement template was developed with input from industry suppliers and was implemented for the purchase of six grape parcels for 2020 vintage trials.

One powdered and one liquid aspergillopepsin enzyme preparation sourced from overseas suppliers were found to comply with the Australia New Zealand Food Standards Code in terms of purity and source (*Aspergillus niger*). In addition, no allergens were detected in either preparation when tested by two analytical methods. Sub-samples of the enzymes and a third powdered aspergillopepsin preparation already held by the AWRI were provided to a PhD candidate at the University of Adelaide ARC Industrial Transformation Training Centre for Innovative Wine Production, as part of ongoing support for a project examining the potential use of ultrafiltration in the protein stabilisation of wine. Sub-samples of the two powdered aspergillopepsin enzyme preparations were also provided under a Materials Transfer Agreement to a student at Flinders University, for use in a project related to the protein stabilisation of wine.

Support was provided to an AWRI project examining the application of Della Toffola Maceration Accelerator technology (DTMA) to Shiraz winemaking. Four McLaren Vale vineyard blocks were selected following extensive consultation with the collaborating industry partner, and five panels of twelve vines in each block were tagged and sampled weekly between veraison and harvest. Based on phenolics data from the analysis of the weekly samples, two blocks were chosen for commercial-scale DTMA treatment, and two days were spent in the industry partner's winery performing the treatment. Multiple sub-samples of DTMA-treated and non-treated musts were then transported to the Hickinbotham Roseworthy Wine Science Laboratory for winemaking.

WIC Winemaking

Background

Wine Innovation Cluster (WIC) Winemaking Services is based at the Hickinbotham Roseworthy Wine Science Laboratory and is a joint venture between the AWRI and the University of Adelaide that was established in 2010. Its location within the University of Adelaide's purpose-built small-lot and pilot-scale winemaking facility enables the delivery of high-quality research and small-scale commercial winemaking services.

2020 vintage

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 (56% in 2019) and 80% red wines (44% in 2019). Over the course of the vintage more than 10,900 operations were performed by WIC Winemaking staff, an average of 26 operations per wine. Several clients requested to freeze any excess juice and two clients took up the opportunity to use the new pro-rata service where processing operations only were provided, based on an hourly fee. Agrochemical studies will be conducted in the second half of the calendar year. Dr Lieke van der Hulst was appointed as Assistant Winemaker in January 2020. Lieke brings both research experience and practical cellar skills to the team and has already proven to be a highly valued and respected team member.

The 2020 vintage saw a later start to the season with cool conditions in spring and early summer, before many regions experienced fires and smoke. More than 25% of the projects completed by WIC Winemaking in 2020 were smoke-related, with fruit sourced from NSW, ACT, Victoria and SA. The smoke research also allowed WIC Winemaking to compare wines made using the AWRI 'bucket ferment' protocol with wines made from the same fruit under research/semi-commercial conditions. Opportunities to improve the 'bucket ferment' protocol have been identified and will be implemented and communicated to industry prior to the 2021 vintage. Use of the updated protocol will assist vineyard managers and winemakers to produce consistent quality 'bucket ferments' and provide a more accurate evaluation of potentially smoke-affected wine in future years.

WIC Winemaking Services was able to continue all scheduled work and meet trial outcomes during the COVID-19 restrictions. Specific protocols were developed to allow fruit intake and deliveries to continue and additional work was required as all external clients, service providers and personnel were prohibited from entering the winery.

In 2018/2019 WIC Winemaking Services expanded its services to include a capability to produce bottle-fermented sparkling wine. A total of 480 bottles of Chardonnay (16 bottles each of 30 different trial parameters) were made and this year, those wines were disgorged, dosaged and recapped using some makeshift disgorging equipment. The resulting wines were well received and free of faults.

Simon Nordestgaard

Metabolomics and bioinformatics service platforms

Background

The AWRI established the South Australian node of Metabolomics Australia (Metabolomics SA) in 2008 as part of a national network with partners in WA, Victoria and Queensland. Metabolomics SA operates as a collaborative service platform that provides public and private researchers and industries with support, service and training, as well as access to infrastructure and specialist expertise.

After a successful external review in 2018, Metabolomics SA secured substantial new investment to support its operations. Bioplatforms Australia, which manages funding through the Australian Government's National Collaborative Research Infrastructure Strategy (NCRIS), together with the South Australian Government and the AWRI announced a collective investment of $11.1m for metabolomics and associated activities at the AWRI from 2019 to 2023. 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 purchased to replace in-demand mass spectrometry instruments and develop new capabilities in high-resolution mass spectrometry and NMR spectroscopy for non-targeted metabolomics.

NCRIS-enabled Metabolomics Australia infrastructure services

In 2019/2020, instrument access and technical assistance were provided for projects across the food and beverage, environmental and biomedical sectors. The majority of users were within SA, with others from Tasmania, NSW, WA, Victoria and from overseas. Support was provided for smoke taint diagnostics for the grape and wine industry and also new material tests towards improved methods for volatile detection. Analytical methods were developed for profiling metabolites in aquatic organisms and for measuring plant biomarkers (to assist plant breeding). Volatile and/or non-volatile analyses conducted were for projects focused on optimising viticulture practices and refining whisky production processes. Statistics and modelling techniques were tested and applied to a human disease biomarker investigation.

Bioinformatics engagement

Together with an international bioinformatics working group, the team published a review paper 'MetaRbolomics' which summarises existing R tools for the metabolomics/bioinformatics community. The work was also prepared for presentation at the International Conference on Intelligent Systems for Molecular Biology 2020. MStractor, a user-friendly workflow for non-targeted pre-processing of LC-MS data, was rebuilt and converted into a user-friendly R package. The package is freely available to download on GitHub, an online software sharing platform.

Tracking trends in Australian wine composition and vineyard and winery practices

Background

It is important for the Australian wine sector to track how it is evolving – how common different production practices are and how wine composition is changing. This allows producers to compare their practices with their peers and helps organisations like the AWRI in choosing relevant research and extension activities. This project addresses these goals through a regular practices survey, aggregate analysis of chemical data from AWRI Commercial Services and other targeted activities.

Extension of knowledge gained through practices survey

Information from the AWRI Vineyard and Winery Practices Survey released in May 2019 has continued to be extended through a number of platforms with additional information and analysis. This included multiple posters, workshops and a presentation at the 17th AWITC and articles published in *Australian & New Zealand Grapegrower & Winemaker.*

Several articles have contrasted technologies that have been quite widely adopted in the Australian wine industry such as cross-flow filtration (Figure 28) and juice flotation with others such as in-tank fermentation progress sensors that have very low levels of adoption. Australian trends on many practices appear to be very similar to those in other wine-producing nations.

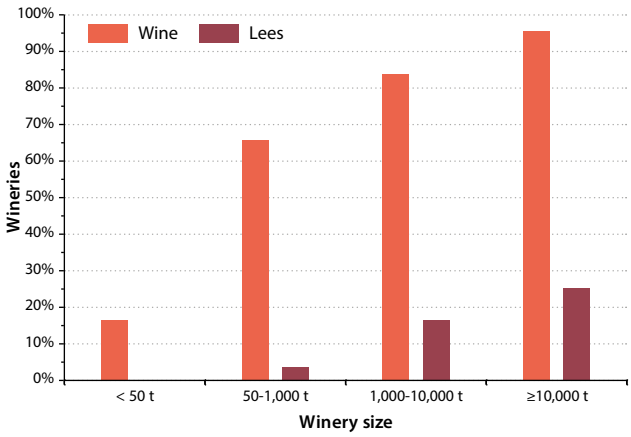


Figure 28. Use of cross-flow filtration for wine and lees filtration by Australian wineries in 2016, broken down by winery size

Other data from the report have been used by AWRI staff and other authors to provide background on diverse topics ranging from undervine weed management to inert gas use during grape pressing.

Financial statements – Directors' report

The directors present this report to the members of The Australian Wine Research Institute Limited (the Company) for the year ended 30 June 2020.

Directors

The names of each person who has been a director during the year and to the date of this report are:

	Date of appointment	Cessation date	Board meetings	
			A	B
Ms Louisa E. Rose (Chair)	1 Jan 2011	–	4	4
Mr Tobias J. Bekkers	1 Jan 2014	–	4	4
Ms Wendy Cameron	1 Jan 2018	–	4	4
Dr John S. Harvey	1 Jan 2016	31 Dec 2019	1	2
Dr Daniel L. Johnson	1 Dec 2011	31 Jan 2020	2	2
Mr Iain M. Jones	1 Jan 2018	–	3	4
Prof. Kiaran D. Kirk	1 Jan 2017	–	4	4
Dr Mark P. Krstic	1 Feb 2020	–	2	2
Ms Elizabeth A. Riley	1 Jan 2012	–	4	4
Mr Mark R. Watson	24 Jun 2008	–	3	4
Mr Marcus Y. Woods	19 Oct 2018	–	4	4

A – number of meetings attended
B – number of meetings held during the time the director held office during the year

Directors have been in office since the start of the financial year to the date of this report unless otherwise stated.

Overview of result

For the year ended 30 June 2020 the Company recorded a surplus of $1,545,122 (2019: deficit of $909,556). This surplus primarily relates to the recognition of $1,635,262 in funding for the purchase of capital equipment (2019: $226,699), and requiring recognition as income within the reported upon period in accordance with applicable accounting standards. Corresponding capital expenditure, funded through this capital income as well as internal sources, totalling $2,327,644 was incurred during the year (2019: $812,732) and will predominantly be expensed in future periods over those assets' useful lives.

Objectives and strategy

The organisation's long-term objective is to support the Australian grape and wine industry through world-class research, practical solutions and knowledge transfer.

The organisation's short-term objectives are reflected in its 8-Year Research, Development and Extension Plan *The AWRI 2017-2025* which was developed through a wide-ranging industry consultation process and formally commenced on 1 July 2017. This plan details 21 subthemes of activities designed to contribute to the achievement of the Company's mission, grouped within five main themes:

- Customers, consumers and markets
- Extension, adoption and education
- Performance, products and processes
- Environment, sustainability and natural capital
- Foundational data and support services.

Within these subthemes are 50 projects focusing upon specific outcomes. For each active project a project plan specifies relevant stakeholder needs, deliverables, approaches and methodologies as well as expected outcomes of benefit to the Australian wine industry. The consultation process with industry and other stakeholders remains ongoing, with active projects further developed and refined through Annual Operating Plans.

The Company's strategy for achieving the above objectives is to maximise its available funding to enable the delivery of projects within its Research, Development and Extension Plan, while optimising its internal operations and resources to ensure that such funding is applied as effectively and efficiently as possible. This strategy is implemented through a suite of initiatives, collectively described in the internal document *AWRI Directions – Business and Operational Initiatives 2018-2020*, clustered into four themes:

- World-class people and culture
- Expand the funding base and economic flexibility of the AWRI
- Improve infrastructure, systems and processes
- Build/retain relationships, strategic capabilities, services and partnerships.

The 8-Year Research, Development and Extension Plan *The AWRI 2017-2025*, together with a status summary of the 50 projects within the plan, is available online at awri.com.au.

Principal activities

The Company's principal activities during the year were:

Research activities that strive for scientific excellence and industry relevance;

Development activities that seek to bridge the gap between scientific discovery and value-adding technology or processes;

Extension activities that seek to disseminate research and development outcomes to facilitate rapid uptake by the viticultural and wine-making sectors; and

Commercial services aimed at providing competitive specific and/or tailored solutions for individual entities across all industry sectors which leverage the other key activities of the AWRI.

These activities collectively constitute a mechanism to implement the strategies outlined in *AWRI Directions – Business and Operational Initiatives 2018-2020*, enabling the achievement of the long- and short-term objectives of the organisation as articulated above.

Performance measures

The Company measures its performance through considering the number, quality and impact of the AWRI's scientific publications; its research and development outcomes; the extent to which those outcomes have been adopted by industry practitioners to improve the quality and consistency of wine produced in Australia; and the extent to which that new knowledge has enabled the Australian wine industry to be successful in established and emerging markets. Progress against specific objectives is monitored though the achievement of specific milestones, outputs and performance targets as articulated in *AWRI Directions – Business and Operational Initiatives 2018-2020*, the 8-Year Research, Development and Extension Plan *The AWRI 2018-2025* and individual project plans, combined with measures of use of the AWRI's extension platforms and feedback provided through surveys distributed to service end-users. Financial performance measures include the value of funding and grants received, demand for the organisation's commercial services and contract research capabilities and performance relative to budget. From time to time the Company or parts of its operations are subject to independent review against externally established criteria, with the outcome of such reviews contributing to the Company's assessment of its own performance.

Information on directors

Ms Louisa E. Rose, Chair (non-executive)
Qualifications: BAppSc (Oen), BSc, GAICD
Experience: Head of Winemaking The Yalumba Wine Company and Hill-Smith Family Vineyards, Chair the Alumni Council of the University of Adelaide and Chair of the Council of Barons of Barossa. Previously director of the Barossa Grape & Wine Association, member of Wine Barossa and Co-Chair of the South Australian Wine Industry Council. National wine show judge, 29 years' technical, winemaking, viticultural and commercial experience in the Australian wine industry.
Special Responsibilities: Ms Rose is the Chair of the Personnel committee.

Mr Tobias J. Bekkers, Non-executive director
Qualifications: BAppSc (Ag) (Hons), GradCert (Mgt)
Experience: Principal of Bekkers Consulting and Bekkers Wine. Active as a viticulture and wine business consultant across Australia. Twenty-six years' experience in viticulture and wine business. Formerly General Manager/Senior Viticulturist of Paxton Wines. Previously director of the McLaren Vale Grape, Wine and Tourism Association. Graduate of the Australian Wine Industry Future Leaders Program and Nuffield Farming Scholar (2017).
Special Responsibilities: Mr Bekkers is a member of the Audit committee.

Ms Wendy Cameron, Non-executive director
Qualifications: BAppSc (Biochem and Microbiol), MSc (Biochem), BAppSc (Wine Sci), GradDip (Ed), GradCert (Bus), DipModLang (French), MW
Experience: Winemaking consultant, previously Head of Winemaking at Brown Brothers Milawa Vineyards. Over 28 years' experience in the Australian wine sector including winemaking, wine show judging and wine business. Inaugural recipient of the ASVO Winemaker of the Year Award (2012) and Gourmet Traveller Wine Winemaker of the Year finalist (2015). Current PhD candidate at the University of Melbourne.

Dr John S. Harvey, Non-executive director (to 31 December 2019)
Qualifications: BSc (Hons), PhD, MBA, FAICD
Experience: Owner of Bathe Wines Pty Ltd. Former Australian Grape and Wine Authority regional mentor for McLaren Vale, past President of the Adelaide Hills Wine Region and previous Member of the South Australian Wine Industry Association Executive. Former Executive Director of the Grape and Wine Research and Development Corporation. Nineteen years' wine industry research, R&D management and commercial experience. Chair of the Can:Do Group, Independent Chair of Studio Nine Architects, Deputy Chair of Rural Business Support, Non-Executive Director of headspace and Revenir Winemaking Pty Ltd, SA Committee Member of the Winston Churchill Memorial Trust (Australia).

Dr Daniel L. Johnson, Managing Director (to 31 January 2020)
Qualifications: BSc (Hons), PhD, MBA, GAICD
Experience: To 31 January, 2020 Chair of the Australian Wine Industry Technical Conference, Director of the National Wine Foundation, member of the International Scientific Council of L'Institut des Sciences de la Vigne et du Vin (ISVV) Bordeaux (France), member of the *Australian Journal of Grape and Wine Research* Journal Advisory Committee, member of the *World of Fine Wine* Editorial Board, member of the Wine Innovation Cluster Leadership Group and member of the Waite Strategic Leadership Group. Graduate of the Harvard Business School Authentic Leadership Development Program, graduate of the Australian Wine Industry Future Leaders Program, graduate of the INSEAD Blue Ocean Strategy Program, graduate of the IESE Creative Negotiation program and graduate of the Oxford Advanced Management and Leadership Program, 23 years' experience in research, development and innovation. From 1 February 2020 Pro Vice Chancellor Research Innovation at Macquarie University and Honorary Fellow at the AWRI.

Mr Iain M. Jones, Non-executive director
Qualifications: BSc, MSc
Experience: General Manager – Technical Services at Treasury Wine Estates. Over 20 years' experience in the Australian wine sector across laboratory, quality assurance, environmental management, research and development, health and safety, engineering and lean business improvement functions. Member of Australian Grape and Wine Technical Advisory Committee.

Prof. Kiaran D. Kirk, Non-executive director
Qualifications: BSc (Hons), PhD, DPhil
Experience: Dean of the College of Science at the Australian National University (ANU), Chair of Clonakilla Wines. Previously Director of ANU Research School of Biology, Head of ANU Department of Biochemistry and Molecular Biology, and Research Fellow at University of Oxford. More than 24 years' experience in the Australian research sector with a publication record of over 160 research papers in the field of biochemistry.
Special Responsibilities: Prof. Kirk is a member of the Personnel committee.

Dr Mark P. Krstic, Managing Director (from 1 February 2020)
Qualifications: BAgSci (Hons), PhD, MBA
Experience: Chair of The Australian Wine Industry Technical Conference, Director of the National Wine Foundation, Director of the South Australian Genomics Centre, professional member of the ASVO, member of Hort Innovation's Table Grape Strategic Investment Advisory Panel, member of the National Viticulture Biosecurity Committee, Associate Editor of the *Wine & Viticulture Journal*, Committee Member of the Wine Innovation Cluster Leadership Group and the Waite Strategic Leadership Group, Honorary Senior Fellow at the University of Melbourne, Adjunct Professor at Macquarie University. Graduate of the Australian Wine Industry Future Leaders Program.

Ms Elizabeth A. Riley, Non-executive director
Qualifications: BAppSc (Wine Sci)
Experience: Nuffield Farming Scholar (1997), Managing Director and Viticulturist Vitibit Pty Ltd, professional member of the ASVO, associate member of the Hunter Valley Wine and Tourism Association and member of the Wine Innovation Forum, Executive member of the New South Wales Wine Industry Association and Chair of the Research and Development Committee, member of the National Wine Biosecurity Committee. Previously a Viticulturist with Southcorp Wines between 1993 and 1999 in national and NSW-based roles, 27 years' experience in the Australian wine industry. 2017 ASVO Viticulturist of the Year.

Mr Mark R. Watson, Non-executive director
Qualifications: BEc, MBA, CA, RITP, MAICD
Experience: Director of SRG Partners, having previously held a range of senior management and finance roles including Chief Executive Officer of Radiology SA and Water Utilities Australia, and Chief Financial Officer of Wirra Wirra.
Special Responsibilities: Mr Watson is the Chair of the Audit committee.

Mr Marcus Y. Woods, Non-executive director
Qualifications: BAppSc (Vit), MBA
Experience: Wine Supply Director at Pernod Ricard Winemakers. Over 19 years' viticultural and operational management experience in the Australian sector managing vineyards, wineries and distilleries including with Hardy's, Accolade Wines and the Bickford's Group. Previously a lecturer in Winery Business Management at the University of Adelaide and committee member of the Clare Region Winegrape Growers Association.
Special Responsibilities: Mr Woods is a member of the Personnel committee and the Audit committee.

Indemnification of officers and auditors

During the financial year, the Company paid a premium in respect of a contract insuring the directors of the Company (named above), the Company Secretary, all members of the Company's Executive Management Group and members of the Biosafety Committee (a committee including two representatives who are not employees of the Company, charged with oversight of matters pertaining to the development and use of genetically modified organisms and required to be appropriately indemnified by the Office of the Gene Technology Regulator) against a liability incurred in their capacity as a director, secretary, executive or committee member to the extent permitted by the *Corporations Act 2001*. The contract of insurance prohibits disclosure of the nature of the liability and the amount of the premium.

The Company has not otherwise, during or since the end of the financial year, except to the extent permitted by law, indemnified or agreed to indemnify an officer or auditor of the Company or of any related body corporate against a liability incurred as such an officer or auditor.

Members' guarantee

In accordance with the Company's constitution, each member (both during the time he or she is a member and within one year afterwards) is liable to contribute $2 in the event that the Company is wound up. The total amount members would contribute is $22 (2019: $20).

Auditor's independence

The auditor's independence declaration as required under section 60-40 of the *Australian Charities and Not-for-profits Commission (ACNC) Act 2012* is attached and forms part of the directors' report for the financial year ended 30 June 2020.

Dated at Urrbrae on this the 17th day of September 2020.

This report is made in accordance with a resolution of the directors, pursuant to subsection 60.15(2) of the *Australian Charities and Not-for-profits Commission Regulation 2013*.

Louisa E. Rose
Chair

Mark P. Krstic
Managing Director

Declaration of independence

Declaration of independence under section 60-40 of the *Australian Charities and Not-for-profits Commission Act 2012* by Paul Gosnold to the responsible entities of The Australian Wine Research Institute Limited

As lead auditor of The Australian Wine Research Institute Limited for the year ended 30 June 2020, I declare that, to the best of my knowledge and belief, there have been:

1. No contraventions of the auditor independence requirements of the *Australian Charities and Not-for-profits Commission Act 2012* in relation to the audit; and

2. No contraventions of any applicable code of professional conduct in relation to the audit.

Paul Gosnold
Director
BDO Audit (SA) Pty Ltd
Adelaide, 17 September 2020

The Australian Wine Research Institute Limited

A Company limited by guarantee

Statement of profit or loss and other comprehensive income

For the year ended 30 June 2020

	Note	2020	2019
Revenue from operating activities			
Wine Australia			
Investment agreement project funding		8,659,568	8,632,873
Investment agreement capital funding		27,126	67,693
Other project funding		154,385	499,472
Other capital funding		–	150,000
Capital specific grant funding		1,608,136	9,006
Other grant funding		1,043,436	611,912
Commercial services analytical and consulting income		4,382,865	3,350,350
Contract research and other commercial income		1,042,600	1,249,407
Other revenue		258,762	160,245
Total revenue		17,176,877	14,730,959
Other income	2	253,219	(2,758)
Expenses from operating activities			
Personnel expenses	3	10,804,561	10,469,699
Analytical and project operating expenses		2,562,484	2,753,764
Infrastructure and general services expenses		1,535,954	1,385,694
Depreciation and amortisation expense	8,9	1,079,297	1,070,325
Travel expenses		326,142	523,588
Total expenses		16,308,438	16,203,070
Results from operating activities		1,121,658	(1,474,869)
Finance income		423,464	565,313
Profit/(loss) for the period		1,545,122	(909,556)
Other comprehensive income			
Items that will not be reclassified subsequently to profit or loss			
Gain (loss) on revaluation of financial assets at fair value through other comprehensive income		(420,240)	315,857
Total comprehensive income for the period		1,124,882	(593,699)

The notes on pages 62 to 70 are an integral part of these financial statements.

The Australian Wine Research Institute Limited

A Company limited by guarantee

Statement of changes in equity

For the year ended 30 June 2020

	Retained earnings	Co-investment reserve	Strategic IT investment reserve	Financial assets at fair value through OCI reserve	Total equity
Balance at 1 July 2018	14,123,720	794,949	42,179	342,142	15,302,990
Total comprehensive income for the period					
Profit or loss	(909,556)	–	–	–	(909,556)
Other comprehensive income					
Gain on revaluation of financial assets at fair value through other comprehensive income	–	–	–	315,857	315,857
Total other comprehensive income	–	–	–	315,857	315,857
Total comprehensive income for the period	(909,556)	–	–	315,857	(593,699)
Transfers between retained earnings and other reserves					
Transfers to (from) reserves	–	(80,420)	167,025	66,497	153,102
Transfers to (from) retained earnings	(153,102)	–	–	–	(153,102)
Balance at 30 June 2019	13,061,062	714,529	209,204	724,496	14,709,291
Balance at 1 July 2019	13,061,062	714,529	209,204	724,496	14,709,291
Total comprehensive income for the period					
Profit or loss	1,545,122	–	–	–	1,545,122
Other comprehensive income					
Gain (loss) on revaluation of financial assets at fair value through other comprehensive income	–	–	–	(420,240)	(420,240)
Total other comprehensive income	–	–	–	(420,240)	(420,240)
Total comprehensive income for the period	1,545,122	–	–	(420,240)	1,124,882
Transfers between retained earnings and other reserves					
Transfers to (from) reserves	–	(48,133)	(198,029)	105,669	(140,493)
Transfers to (from) retained earnings	140,493	–	–	–	140,493
Balance at 30 June 2020	14,746,677	666,396	11,175	409,925	15,834,173

Nature and purpose of reserves

Co-investment reserve

The objective of the co-investment reserve is to provide funds for co-investment in specific funding opportunities, enabling the Company to access certain funding programs subject to the following requirements:

(i) That any co-investment be matched on at least an equal basis from externally sourced funds

(ii) That co-investments create value over the medium to long term for the ultimate benefit of the Australian grape and wine sector

(iii) That co-investments be made only in instances whereby the overall grant funds available to the Australian grape and wine sector are expanded – that is, excluding grant funding programs which already exist for the benefit of that industry.

Strategic IT investment reserve

The objective of the strategic information technology (IT) investment reserve is to ensure that sufficient funds are available for appropriate strategic investment in the Company's IT capabilities, consistent with relevant strategic plans as developed and amended from time to time, approved by the Board of Directors. Resourcing to meet the Company's day-to-day operational IT requirements, as distinct from its strategic IT requirements, is provided by other funding sources as identified within the statement of profit or loss and other comprehensive income.

Financial assets at fair value through other comprehensive income reserve

The reserve is used to recognise increments and decrements in the fair value of financial assets at fair value through other comprehensive income.

The notes on pages 62 to 70 are an integral part of these financial statements.

The Australian Wine Research Institute Limited

A Company limited by guarantee

Statement of financial position

As at 30 June 2020

	Note	2020	2019
Assets			
Cash and cash equivalents	4	3,694,044	2,012,775
Term deposits	5	–	1,600,000
Trade and other receivables	6	1,048,265	1,280,553
Inventories	7	143,595	94,000
Prepayments		293,607	341,532
Total current assets		5,179,511	5,328,860
Financial assets at fair value through OCI	5	9,599,301	9,533,476
Property, plant and equipment	8	3,759,307	2,193,352
Intangible assets	9	236,040	4,305,310
Right of use assets	10	3,742,599	–
Total non-current assets		17,337,247	16,032,138
Total assets		22,516,758	21,360,998
Liabilities			
Payables and accruals	11	3,427,812	3,499,970
Contract liability	12	1,337,547	1,219,180
Provisions	13	1,725,599	1,814,729
Total current liabilities		6,490,958	6,533,879
Provisions	14	191,627	117,828
Total non-current liabilities		191,627	117,828
Total liabilities		6,682,585	6,651,707
Net assets		15,834,173	14,709,291
Equity			
Retained earnings		14,746,677	13,061,062
Co-investment reserve		666,396	714,529
Strategic IT investment reserve		11,175	209,204
Fair value reserve		409,925	724,496
Total equity		15,834,173	14,709,291

The notes on pages 62 to 70 are an integral part of these financial statements.

The Australian Wine Research Institute Limited

A Company limited by guarantee

Statement of cash flows

For the year ended 30 June 2020

	Note	2020	2019
Cash flows from operating activities			
Cash receipts from project grants and other income		15,823,546	13,885,050
Cash paid to suppliers and employees		(15,028,597)	(14,777,190)
Net cash from operating activities		794,949	(892,140)
Cash flows from investing activities			
Cash receipts from capital specific funding		1,635,262	217,693
Interest received		220,157	309,697
Dividends and imputation credits received		259,297	240,453
Proceeds from sale of property, plant and equipment		44,538	136
Acquisition of property, plant, equipment and intangibles		(2,324,501)	(980,033)
(Acquisition)/proceeds from disposal of term deposits		1,600,000	550,000
Acquisition of financial assets		(498,798)	(1,008)
Payment of transaction costs related to financial investments		(49,636)	(46,056)
Net cash used in investing activities		886,319	290,883
Net increase (decrease) in cash and cash equivalents		1,681,268	(601,258)
Cash and cash equivalents at 1 July		2,012,775	2,614,033
Cash and cash equivalents at 30 June	4	3,694,043	2,012,775

The notes on pages 62 to 70 are an integral part of these financial statements.

Notes to and forming part of the financial statements

1. Significant accounting policies

The Australian Wine Research Institute Limited (the "Company") is a company limited by guarantee, domiciled in Australia, incorporated under the *Corporations Act 2001*, registered as a charity under the *Australian Charities and Not-for-profits Commission Act 2012* (ACNC Act) and endorsed by the Australian Tax Office (ATO) as a Deductible Gift Recipient (DGR) organisation under the general DGR category of 'Approved Research Institute'. The address of the Company's registered office is the corner of Hartley Grove and Paratoo Road, Urrbrae, South Australia.

The financial statements were authorised for issue by the Board of Directors on the 17th day of September 2020.

Australian Accounting Standards set out accounting policies that the AASB has concluded would result in financial statements containing relevant and reliable information about transactions, events and conditions. Material accounting policies adopted in the preparation of these financial statements are presented below and have been applied consistently to all periods presented in these financial statements, and have been applied consistently by the Company.

Where necessary, comparative information has been reclassified to achieve consistency in disclosure with current financial year amounts and disclosures.

(a) Basis of preparation

(i) Statement of compliance

The financial statements of the Company are Tier 2 general purpose financial statements which have been prepared in accordance with Australian Accounting Standards – Reduced Disclosure Requirements (AASB-RDRs) (including Australian Interpretations) adopted by the Australian Accounting Standards Board (AASB) and the *Australian Charities and Not-for-profits Commission Act 2012* and *Regulation 2013*. The Company is a not-for-profit entity for financial reporting purposes under Australian Accounting Standards.

The Company is exempt from income tax under Section 50-5 of the *Income Tax Assessment Act 1997*, and accordingly no provision for income tax is included in these financial statements.

(ii) Basis of measurement

The financial statements, except for the cash flow information, have been prepared on an accruals basis and are based on historical costs except for some financial assets which are measured at fair value, and do not take into account changing money values.

(iii) Functional and presentation currency

The financial statements are presented in Australian dollars, which is the Company's functional currency.

The Company is of a kind referred to in ASIC Legislative Instrument 2016/191 dated 1 April 2016 and, in accordance with that Legislative Instrument, all financial information presented has been rounded to the nearest dollar unless otherwise stated.

(iv) Use of estimates and judgements

The preparation of financial statements in conformity with Australian Accounting Standards requires management to make judgements, estimates and assumptions that affect the application of accounting policies and the reported amount of assets, liabilities, income and expenses. The estimates and associated assumptions are based on historical experience and various other factors that are believed to be reasonable under the circumstances, the results of which form the basis of making judgements about the carrying value of assets and liabilities that are not readily apparent from other sources.

The estimates and underlying assumptions are reviewed on an ongoing basis. Revisions to accounting estimates are recognised in the period in which the estimates are revised. The Company has identified the allowance for expected credit loss in respect of trade receivables (note 6), the useful lives of property, plant and equipment (note 8), amortisation period of intangible assets (note 9), right of use assets including its interest in the WIC building (note 10) and provisions for employee entitlements (note 13) and their respective note 1 accounting policies as areas under which significant judgements, estimates and assumptions are made, and where actual results may differ from those estimates under different assumptions and conditions.

(v) Changes in accounting policies

The Company has adopted all of the new or amended Accounting Standards and Interpretations issued by the Australian Accounting Standards Board (AASB) that are mandatory for the current reporting period. The following Accounting Standards and Interpretations are most relevant to the entity:

AASB 15 Revenue from Contracts with Customers

The Company has adopted AASB 15 from 1 July 2019. The standard provides a single comprehensive model for revenue recognition. The core principle of the standard is that an entity shall recognise revenue to depict the transfer of promised goods or services to customers at an amount that reflects the consideration to which the entity expects to be entitled in exchange for those goods or services. The standard introduced a new contract-based revenue recognition model with a measurement approach that is based on an allocation of the transaction price. This is described further in the accounting policies below. Credit risk is presented separately as an expense rather than adjusted against revenue. Contracts with customers are presented in an entity's statement of financial position as a contract liability, a contract asset, or a receivable, depending on the relationship between the entity's performance and the customer's payment. Customer acquisition costs and costs to fulfil a contract can, subject to certain criteria, be capitalised as an asset and amortised over the contract period.

AASB 1058 Income of Not-for-Profit Entities
The Company has adopted AASB 1058 from 1 July 2019. The standard replaces AASB 1004 'Contributions' in respect to income recognition requirements for not-for-profit entities. The timing of income recognition under AASB 1058 is dependent upon whether the transaction gives rise to a liability or other performance obligation at the time of receipt. Income under the standard is recognised where: an asset is received in a transaction, such as by way of grant, bequest or donation; there has either been no consideration transferred, or the consideration paid is significantly less than the asset's fair value; and where the intention is to principally enable the entity to further its objectives. For transfers of financial assets to the entity which enable it to acquire or construct a recognisable non-financial asset, the entity must recognise a liability amounting to the excess of the fair value of the transfer received over any related amounts recognised. Related amounts recognised may relate to contributions by owners, AASB 15 revenue or contract liability recognised, lease liabilities in accordance with AASB 16, financial instruments in accordance with AASB 9, or provisions in accordance with AASB 137. The liability is brought to account as income over the period in which the entity satisfies its performance obligation. If the transaction does not enable the entity to acquire or construct a recognisable non-financial asset to be controlled by the entity, then any excess of the initial carrying amount of the recognised asset over the related amounts is recognised as income immediately.

AASB 16 Leases
The Company has adopted AASB 16 from 1 July 2019. The standard replaces AASB 117 'Leases' and for lessees eliminates the classifications of operating leases and finance leases. Except for short-term leases and leases of low-value assets, right of use assets and corresponding lease liabilities are recognised in the statement of financial position. Straight-line operating lease expense recognition is replaced with a depreciation charge for the right of use assets (included in operating costs) and an interest expense on the recognised lease liabilities (included in finance costs). In the earlier periods of the lease, the expenses associated with the lease under AASB 16 will be higher when compared to lease expenses under AASB 117. However, EBITDA (Earnings Before Interest, Tax, Depreciation and Amortisation) results improve as the operating expense is now replaced by interest expense and depreciation in profit or loss. For classification within the statement of cash flows, the interest portion is disclosed in operating activities and the principal portion of the lease payments are separately disclosed in financing activities. For lessor accounting, the standard does not substantially change how a lessor accounts for leases.

Impact of adoption
AASB 15, AASB 16 and AASB 1058 were adopted using the modified retrospective approach and as such comparatives have not been restated. There was no impact on opening retained profits as at 1 July 2019. The only impact on adoption of these standards was the change in asset classification of the Company's interest in the WIC building. Previously this was recognised as an intangible asset, but is now covered by the scope of AASB 16 so is recognised as a right of use asset. The Company contributed $6.1m towards the construction of the WIC building and simultaneously entered into a separate but inextricably linked lease agreement for $1. As there is no ongoing lease payments, no lease liability has been recognised. Not-for-profit entities have been 'temporarily' relieved of the obligation to fair value leases through AASB2018-8 which allows them to continue to measure their lease obligations at cost.

(b) Financial assets

Financial assets are initially measured at fair value. Transaction costs are included as part of the initial measurement, except for financial assets at fair value through profit or loss. Such assets are subsequently measured at either amortised cost or fair value depending on their classification. Classification is determined based on both the business model within which such assets are held and the contractual cash flow characteristics of the financial asset unless an accounting mismatch is being avoided.

Financial assets are derecognised when the rights to receive cash flows have expired or have been transferred and the Company has transferred substantially all the risks and rewards of ownership. When there is no reasonable expectation of recovering part or all of a financial asset, its carrying value is written off.

Financial assets at fair value through profit or loss
Financial assets not measured at amortised cost or at fair value through other comprehensive income are classified as financial assets at fair value through profit or loss. Typically, such financial assets will be either: (i) held for trading, where they are acquired for the purpose of selling in the short-term with an intention of making a profit, or a derivative; or (ii) designated as such upon initial recognition where permitted. Fair value movements are recognised in profit or loss.

Financial assets at fair value through other comprehensive income
Financial assets at fair value through other comprehensive income include equity investments which the Company intends to hold for the foreseeable future and has irrevocably elected to classify them as such upon initial recognition.

Impairment
The Company recognises a loss allowance for expected credit losses on financial assets which are either measured at amortised cost or fair value through other comprehensive income. The measurement of the loss allowance depends upon the Company's assessment at the end of each reporting period as to whether the financial instrument's credit risk has increased significantly since initial recognition, based on reasonable and supportable information that is available, without undue cost or effort to obtain.

Where there has not been a significant increase in exposure to credit risk since initial recognition, a 12-month expected credit loss allowance is estimated. This represents a portion of the asset's lifetime expected credit losses that is attributable to a default event that is possible within the next 12 months. Where a financial asset has become credit impaired or where it is determined that credit risk has increased significantly, the loss allowance is based on the asset's lifetime expected credit losses. The amount of expected credit loss recognised is measured on the basis of the probability weighted present value of anticipated cash shortfalls over the life of the instrument discounted at the original effective interest rate.

For financial assets measured at fair value through other comprehensive income, the loss allowance is recognised within other comprehensive income. In all other cases, the loss allowance is recognised in profit or loss.

(c) Property, plant and equipment

(i) Recognition and measurement

Items of property, plant and equipment are measured at cost less accumulated depreciation and accumulated impairment losses. Cost includes expenditure that is directly attributable to the acquisition of the asset, including borrowing costs directly attributable to the acquisition, construction or production of a qualifying asset. Cost also may include transfers from other comprehensive income of any gain or loss on qualifying cash flow hedges of foreign currency purchases of property, plant and equipment. Purchased software that is integral to the functionality of the related equipment is capitalised as part of that equipment.

When parts of an item of property, plant and equipment have different useful lives, they are accounted for as separate items (major components) of property, plant and equipment.

Gains and losses on disposal of an item of property, plant and equipment are determined by comparing the proceeds from disposal with the carrying amount of property, plant and equipment and are recognised net within other income in profit or loss.

(ii) Subsequent costs

The cost of replacing a part of an item of property, plant and equipment is recognised in the carrying amount of the item if it is probable that the future economic benefits embodied within the part will flow to the Company, and its cost can be measured reliably. The carrying amount of the replaced part is derecognised. The costs of the day to day servicing of property, plant and equipment are recognised in profit or loss as incurred.

(iii) Depreciation

Depreciation is calculated over the depreciable amount, which is the cost of an asset, or other amount substituted for cost, less its residual value.

Depreciation is recognised in profit or loss on a straight-line basis over the estimated useful lives of each part of an item of property, plant and equipment, since this most closely reflects the expected pattern of consumption of the future economic benefits embodied in the asset. Leased assets are depreciated over the shorter of the lease term and their useful lives unless it is reasonably certain that the Company will obtain ownership by the end of the lease term.

The estimated useful lives for the current and comparative periods are as follows:

• buildings and improvements	30 years
• plant and machinery	3 – 10 years
• office furniture and IT	3 – 10 years
• laboratory equipment	3 – 10 years

Depreciation methods, useful lives and residual values are reviewed at each financial year-end and adjusted if appropriate.

(d) Intangible assets

Intangible assets that are acquired by the Company and have finite useful lives are measured at cost less accumulated amortisation and accumulated impairment losses.

Amortisation is calculated over the cost of the asset, or another amount substituted for cost, less its residual value. Amortisation is recognised in profit or loss on a straight-line basis over the estimated useful lives of intangible assets from the date that they are available for use, since this most closely reflects the expected pattern of consumption of the future economic benefits embodied in the asset. Amortisation methods, useful lives and residual values are reviewed at each financial year-end and adjusted if appropriate.

(e) Leased assets

Lease liabilities

A lease liability is recognised at the commencement date of a lease. The lease liability is initially recognised at the present value of the lease payments to be made over the term of the lease, discounted using the interest rate implicit in the lease or, if that rate cannot be readily determined, the entity's incremental borrowing rate. Lease payments comprise of fixed payments less any lease incentives receivable, variable lease payments that depend on an index or a rate, amounts expected to be paid under residual value guarantees, exercise price of a purchase option when the exercise of the option is reasonably certain to occur, and any anticipated termination penalties. The variable lease payments that do not depend on an index or a rate are expensed in the period in which they are incurred.

Lease liabilities are measured at amortised cost using the effective interest method. The carrying amounts are remeasured if there is a change in the following: future lease payments arising from a change in an index or a rate used; residual guarantee; lease term; certainty of a purchase option and termination penalties. When a lease liability is remeasured, an adjustment is made to the corresponding right of use asset, or to profit or loss if the carrying amount of the right of use asset is fully written down.

(f) Inventories

Inventories are measured at the lower of cost and net realisable value. The cost of inventories includes expenditure incurred in acquiring the inventories and other costs incurred in bringing them to their existing location and condition. Net realisable value is the estimated selling price in the ordinary course of business, less selling expenses.

(g) Impairment

The carrying amounts of the Company's non-financial assets are reviewed at each reporting date to determine whether there is any indication of impairment. If any such indication exists, then the asset's recoverable amount is estimated.

The recoverable amount of an asset is the greater of its value in use and its fair value less costs to sell. Value in use is determined as the current replacement cost of an asset.

An impairment loss is recognised if the carrying amount of an asset exceeds its estimated recoverable amount. Impairment losses are recognised in profit or loss. Impairment losses recognised in prior periods are assessed at each reporting date for any indications that the loss has decreased or no longer exists. An impairment loss is reversed if there has been a change in the estimates used to determine the recoverable amount. An impairment loss is reversed only to the extent that would have been determined, net of depreciation or amortisation, if no impairment loss had been recognised.

(h) Employee benefits

(i) Defined contribution plans
A defined contribution plan is a post-employment benefit plan under which an entity pays fixed contributions into a separate entity and will have no legal or constructive obligation to pay further amounts. Obligations for contributions to defined contribution plans are recognised as an employee benefit expense in profit or loss in the periods during which services are rendered by employees.

(ii) Other long-term employee benefits
The Company's net obligation in respect of long-term employee benefits is the amount of future benefit that employees have earned in return for their service in the current and prior periods plus related on-costs. The liability is measured such that it is not materially different from the estimate determined by discounting using market yields at the reporting date on corporate bonds with terms to maturity and currencies that match, as closely as possible, the estimated future cash outflows.

(iii) Termination benefits
Termination benefits are recognised as an expense when the Company is demonstrably committed, without realistic probability of withdrawal, to a formal detailed plan to either terminate employment before the normal retirement date, or to provide termination benefits as a result of an offer made to encourage voluntary redundancy. Termination benefits for voluntary redundancies are recognised as an expense if the Company has made an offer of voluntary redundancy, it is probable that the offer will be accepted, and the number of acceptances can be estimated reliably. If benefits are payable more than 12 months after the reporting period, then they are discounted to their present value.

(iv) Short-term benefits
Short-term employee benefit obligations are measured on an undiscounted basis and are expensed as the related service is provided.

A liability is recognised for the amount expected to be paid under short-term bonus plans if the Company has a present legal or constructive obligation to pay this amount as a result of past service provided by the employee and the obligation can be measured reliably. Such liabilities represent the best estimate of the amounts required to settle the obligation at the end of the reporting period.

(i) Revenue recognition

The Company recognises revenue as follows:

(i) Revenue from contracts with customers
Revenue is recognised at an amount that reflects the consideration to which the Company is expected to be entitled in exchange for transferring goods or services to a customer. For each contract with a customer, the Company: identifies the contract with a customer; identifies the performance obligations in the contract; determines the transaction price which takes into account estimates of variable consideration and the time value of money; allocates the transaction price to the separate performance obligations on the basis of the relative stand-alone selling price of each distinct good or service to be delivered; and recognises revenue when or as each performance obligation is satisfied in a manner that depicts the transfer to the customer of the goods or services promised.

(ii) Donations
Donations are assessed to determine whether they carry sufficiently specific performance obligations and meet other criteria for recognition in accordance with AASB 15 *Revenue from Contracts with Customers*, where this is not the case donations are recognised on receipt in accordance with AASB 1058 *Income of Not-for-Profit Entities*.

(iii) Grants
Grant revenue is recognised in profit or loss when the Company satisfies the performance obligations stated within the funding agreements.

If conditions are attached to the grant which must be satisfied before the Company is eligible to retain the contribution, the grant will be recognised in the statement of financial position as a liability until those conditions are satisfied.

(iv) Finance income
Finance income comprises interest income and dividends. Interest income is recognised as it accrues in profit or loss using the effective interest rate method. Dividend income is recognised in profit or loss on the date on which the Company's right to receive payment is established.

(v) Other revenue
Other revenue is recognised when it is received or when the right to receive payment is established.

(j) Goods and services tax

Revenue, expenses and assets are recognised net of the amount of goods and services tax (GST), except where the amount of GST incurred is not recoverable from the taxation authority. In these circumstances, the GST is recognised as part of the cost of acquisition of the asset or as part of the expense.

Receivables and payables are stated with the amount of GST included. The net amount of GST recoverable from, or payable to, the ATO is included as a current asset or current liability in the statement of financial position.

Cash flows are included in the statement of cash flows on a gross basis. The GST components of the cash flows arising from investing and financing activities which are recoverable from, or payable to, the ATO are classified as operating cash flows.

(k) Trade and other receivables

Trade receivables are initially recognised at fair value and subsequently measured at amortised cost using the effective interest method, less any allowance for expected credit losses. Trade receivables are generally due for settlement within 30 days. The company has applied the simplified approach to measuring expected credit losses, which uses a lifetime expected loss allowance. To measure the expected credit losses, trade receivables have been grouped based on days overdue. Other receivables are recognised at amortised cost, less any allowance for expected credit losses.

(I) Right of use assets

A right of use asset is recognised at the commencement date of a lease. The right of use asset is measured at cost, which comprises the initial amount of the lease liability, adjusted for, as applicable, any lease payments made at or before the commencement date net of any lease incentives received, any initial direct costs incurred, and, except where included in the cost of inventories, an estimate of costs expected to be incurred for dismantling and removing the underlying asset, and restoring the site or asset.

Right of use assets are depreciated on a straight-line basis over the unexpired period of the lease or the estimated useful life of the asset, whichever is the shorter. Where the Company expects to obtain ownership of the leased asset at the end of the lease term, the depreciation is over its estimated useful life. Right of use assets are subject to impairment or adjusted for any remeasurement of lease liabilities.

The Company has elected not to recognise a right of use asset and corresponding lease liability for short-term leases with terms of 12 months or less and leases of low-value assets. Lease payments on these assets are expensed to profit or loss as incurred.

2. Other income

	2020	2019
Net gain/(loss) on sale of property, plant and equipment	14,474	(2,758)
Forgiveness of liabilities	238,745	–
	253,219	(2,758)

3. Personnel expenses

	2020	2019
Wages and salaries	9,414,458	9,274,996
Other associated personnel expenses	526,786	324,675
Contributions to defined contribution plans	863,317	870,028
	10,804,561	10,469,699

4. Cash and cash equivalents

	2020	2019
Cash on hand	500	377
Bank deposits at-call	3,693,544	2,012,398
Cash and cash equivalents in the statement of cash flows	3,694,044	2,012,775

5. Other investments

	2020	2019
Current		
Term deposits	–	1,600,000
Non-current		
Financial assets at fair value through OCI, comprising listed investments at fair value in:		
Interest rate securities	5,095,152	5,892,842
Equity securities	4,504,149	3,640,634
	9,599,301	9,533,476

All equity securities and interest rate securities are quoted on the Australian Securities Exchange. Interest rate securities include corporate bonds, subordinated notes and convertible and reset preference securities. Equity securities include direct shareholdings, exchange traded funds and managed funds.

6. Trade and other receivables

	2020	2019
Trade receivables due from those other than related parties	773,019	803,059
Trade receivables due from related parties	11,345	10,045
Other receivables	263,901	467,449
	1,048,265	1,280,553

Trade receivables are shown net of expected credit losses amounting to $22,830 (2019: $23,313) at reporting date. This allowance account is used to record expected credit losses until the Company is satisfied that no recovery of the amount owing is possible; at that point the amounts are considered irrecoverable and are written off against the financial asset directly.

The movement in the allowance for expected credit losses in respect of trade receivables during the year was as follows:

	2020	2019
Balance at 1 July	23,313	7,498
Payments received in relation to previous expected credit loss balances	(2,674)	–
Expected credit loss for the year	51,594	15,815
Written off during the year	(49,403)	–
Balance at 30 June	22,830	23,313

7. Inventories

	2020	2019
Course materials on hand – wine	105,978	94,000
Contingency supply of laboratory consumables	37,617	–
	143,595	94,000

8. Property, plant and equipment

	Plant and machinery	Office furniture and IT	Laboratory equipment	Capital WIP	Total
Cost					
Balance at 1 July 2019	635,036	1,187,172	10,389,259	–	12,211,467
Additions	76,680	153,248	1,898,990	198,726	2,327,644
Transfers	–	–	–	–	–
Disposals	(36,529)	(166,877)	(215,018)	–	(418,424)
Balance at 30 June 2020	675,187	1,173,543	12,073,231	198,726	14,120,687
Depreciation and impairment losses					
Balance at 1 July 2019	433,336	971,232	8,613,547	–	10,018,115
Depreciation charge for the year	62,856	111,911	556,858	–	731,625
Transfers	–	–	–	–	–
Disposals	(6,465)	(166,877)	(215,018)	–	(388,360)
Balance at 30 June 2020	489,727	916,266	8,955,387	–	10,361,380
Carrying amounts					
at 1 July 2019	201,700	215,940	1,775,712	–	2,193,352
at 30 June 2020	185,460	257,277	3,117,844	198,726	3,759,307

9. Intangible assets

	Interest in WIC building	Computer software	Intangible assets under development	Total
Cost				
Balance at 1 July 2019	6,100,140	686,242	37,462	6,823,844
Additions	–	21,000	–	21,000
Transfers	–	37,462	(37,462)	–
Disposals	–	(8,750)	–	(8,750)
Recognition as right of use asset	(6,100,140)			(6,100,140)
Balance at 30 June 2020	–	735,954	–	735,954
Amortisation and impairment losses				
Balance at 1 July 2019	2,154,203	364,331	–	2,518,534
Amortisation charge for the year	–	144,333	–	144,333
Disposals	–	(8,750)	–	(8,750)
Recognition as right of use asset	(2,154,203)			(2,154,203)
Balance at 30 June 2020	–	499,914	–	499,914
Carrying amounts				
at 1 July 2019	3,945,937	321,911	37,462	4,305,310
at 30 June 2020	–	236,040	–	236,040

Computer software

Computer software assets are recognised as the attributable software licence and development costs paid to third parties, and do not include employee costs or an attribution of relevant overheads, as only an immaterial component of software development and testing processes are performed in-house. These software assets are amortised over periods of between three and five years, based upon their estimated useful lives and expected technical obsolescence.

10. Right of use assets

	2020	2019
Buildings (WIC) – right of use		
Cost		
Balance at 1 July	–	–
Recognition as right of use asset	6,100,140	–
Balance at 30 June	6,100,140	–
Depreciation and impairment losses		
Balance at 1 July	–	–
Recognition as right of use asset	2,154,203	–
Depreciation charge for the year	203,338	–
Balance at 30 June	2,357,541	–
Carrying amount	3,742,599	–

The interest in the WIC building previously recognised in note 9 as an intangible asset is now recognised as a right of use asset in accordance with AASB 16 *Leases*. There has been no change in the value of the right of use asset or the period over which it is being depreciated, which remains at 30 years, this being the point at which the term of occupancy is reviewable based on the remaining economic life of the building.

Interest in WIC building

The Company has a 50-year nominal occupancy right to approximately 53% of the space in the Wine Innovation Cluster (WIC) Central building owned by the University of Adelaide. The other occupants are currently the University of Adelaide and Fight Food Waste Cooperative Research Centre. The term of occupancy is reviewable after 30 years based on the remaining economic life of the building. The value assigned to the AWRI's interest in the building is net of amounts contributed by Wine Australia (WA). The building cost is being depreciated over a period of 30 years from the date of practical completion (26 November 2008).

11. Payables and accruals

	2020	2019
Current		
Trade payables due to those other than related parties	1,531,596	283,175
Trade payables due to related parties	–	397
PAYG and GST	273,457	463,141
Non-trade payables and accrued expenses	1,622,759	2,753,257
	3,427,812	3,499,970

12. Contract liability

Any unexpended WA funding is reimbursable to WA, except where WA agrees that amounts can be retained by the AWRI for purposes approved by WA, at which point such amounts are considered to be committed towards that purpose. Project underspends recorded in the year ended 30 June 2020 may be reduced or eliminated by overspends recorded within those projects in prior years – where applicable, the unexpended funds detailed below have been reduced by such amounts.

There were no unexpended investment agreement funds for the current year (2019: none), and no unexpended funds from other WA contracts for the current year (2019: none).

During the year $41,694 in unspent prior years' funds previously approved by WA for retention by the Company to be provided to project collaborators in future periods were utilised for that purpose (2019: $55,566). During the year no unspent prior years' funds relating to WA projects were returned to WA (2019: none).

	2020	2019
Unexpended funds carried forward to satisfy future performance obligations		
WA current year's investment agreement funding unexpended	–	–
WA current year's other contract funding unexpended	–	–
WA prior years' funding unexpended	–	41,694
	–	41,694
Income received in advance	1,337,547	1,177,486
	1,337,547	1,219,180

13. Provisions

	2020	2019
Current		
Employee entitlements	1,725,599	1,814,729
Non-current		
Employee entitlements	191,627	117,828
Number of employees (full-time equivalents)	103.9	104.2

14. Operating leases

Leases as lessee

Non-cancellable operating lease rentals are payable as follows:

	2020	2019
Within one year	3,432	3,432
One year or later and no later than five years	6,006	9,438
Later than five years	–	–
	9,438	12,870

The Company did not enter into any new operating lease agreements during the year.

During the year ended 30 June 2020 an amount of $3,432 was recognised as an expense in respect of operating leases (2019: $12,841).

Leases as lessor

The Company leases out part of its interest in the WIC building (refer note 10) to the Australian Wine Industry Technical Conference Incorporated. Associated lease payments are included within the transactions with related parties disclosed within note 16. The future minimum lease payments under non-cancellable leases are receivable as follows:

	2020	2019
Within one year	8,000	8,000
One year or later and no later than five years	32,000	1,333
Later than five years	9,333	–
	49,333	9,333

During the year ended 30 June 2020 an amount of $8,602 was recognised as rental income (2019: $8,464).

15. Capital commitments

	2020	2019
Property, plant and equipment		
Contracted but not provided for and payable		
Within one year	502,834	80,560
One year or later and no later than five years	–	–
Later than five years	–	–
	502,834	80,560
Computer software development		
Contracted but not provided for and payable		
Within one year	95,300	80,560
One year or later and no later than five years	–	–
Later than five years	–	–
	95,300	80,560

16. Related parties

Key management personnel compensation

Key management personnel comprises the directors of the Company and other persons having authority and responsibility for planning, directing and controlling the activities of the Company. Key management personnel compensation comprised:

	2020	2019
Total remuneration	1,823,890	1,888,087

During the year non-executive directors became entitled to compensation totalling $91,750 (2019: $88,500). A number of directors voluntarily elected not to receive $58,500 of this entitlement (2019: $54,750), instead redirecting such amounts to support otherwise unfunded activities of the Company relating to individual and group professional development for AWRI staff, undertaken both domestically and internationally, as well as providing support to visiting scientists.

Key management personnel and director transactions

A number of key management personnel, or their related parties, hold positions in other entities that result in them having control or significant influence over the financial or operating policies of these entities.

A number of these entities transacted with the Company in the reporting period. The terms and conditions of the transactions with key management personnel and their related parties were no more favourable than those available, or which might reasonably be expected to be available, on similar transactions to non-key management personnel related entities on an arm's length basis.

Related parties arising through relationships with key management personnel:

Arrivo Wine
Bathe Wines Pty Ltd
Oenologie Requin Pty Ltd (trading as Bekkers Wine)
Revenir Winemaking Pty Ltd
Vitibit Pty Ltd

Other related party transactions

During the year the Company provided administrative services and leased office premises to a jointly controlled entity, The Australian Wine Industry Technical Conference Incorporated.

Other related parties:
The Australian Wine Industry Technical Conference Incorporated

Transactions with related parties

	Transactions value for the year ended 30 June		Balance outstanding as at 30 June	
	2020	2019	2020	2019
Services received from related parties	54,153	3,453	–	397
Services provided to related parties	251,490	134,336	11,345	10,045

17. Contingencies

In the opinion of the Directors, there were no material or significant contingent liabilities at 30 June 2020 (2019: none).

18. Subsequent events

In July 2020 the Company received confirmation from its principal funding provider, Wine Australia, that the 2020 wine-grape harvest was estimated to be sufficiently small to enliven revenue reduction provisions contained within the AWRI-Wine Australia Investment Agreement, with the AWRI's funding for the year ending 30 June 2022 expected to be reduced by a net amount of $672,389 as a result. There has not arisen in the interval between the end of the financial year and the date of this report any other item, transaction or event of a material and unusual nature likely to significantly affect the operations of the Company, the results of those operations, or the state of affairs of the Company, in subsequent financial years.

19. Limited liability

In accordance with the Company's constitution, each member (both during the time he or she is a member and within one year afterwards) is liable to contribute $2 in the event that the Company is wound up. The total amount members would contribute is $22 (2019: $20).

Responsible persons' declaration

The directors of The Australian Wine Research Institute Limited (the Company) declare that, in the directors' opinion:

(a) the financial statements, comprising the statement of profit or loss and other comprehensive income, statement of financial position, statement of cash flows, statement of changes in equity, and accompanying notes, are in accordance with the *Australian Charities and Not-for-profits Commission Act 2012* and:

(i) comply with Australian Accounting Standards – Reduced Disclosure Requirements and the *Australian Charities and Not-for-profits Commission Regulation 2013*

(ii) give a true and fair view of the entity's financial position as at 30 June 2020 and of its performance for the year ended on that date

(b) there are reasonable grounds to believe that the Company will be able to pay all of its debts, as and when they become due and payable.

Signed in accordance with subsection 60.15(2) of the *Australian Charities and Not-for-profits Commission Regulation 2013*.

Louisa E. Rose
Chair

Mark P. Krstic
Managing Director

Dated at Urrbrae on this the 17th day of September 2020.

Independent auditor's report to the members of The Australian Wine Research Institute Limited

Report on the Audit of the Financial Report

Opinion

We have audited the financial report of The Australian Wine Research Institute Limited (the registered entity), which comprises the statement of financial position as at 30 June 2020, the statement of profit or loss and other comprehensive income, the statement of changes in equity and the statement of cash flows for the year then ended, and notes to the financial report, including a summary of significant accounting policies, and the responsible entities' declaration.

In our opinion the accompanying financial report of The Australian Wine Research Institute Limited is in accordance with Division 60 of the *Australian Charities and Not-for-profits Commission Act 2012,* including:

(i) Giving a true and fair view of the registered entity's financial position as at 30 June 2020 and of its financial performance for the year then ended; and

(ii) Complying with Australian Accounting Standards – Reduced Disclosure Requirements and Division 60 of the *Australian Charities and Not-for-profits Commission Regulation 2013.*

Basis for opinion

We conducted our audit in accordance with Australian Auditing Standards. Our responsibilities under those standards are further described in the *Auditor's responsibilities for the audit of the Financial Report* section of our report. We are independent of the registered entity in accordance with the auditor independence requirements of the *Australian Charities and Not-for-profits Commission Act 2012* (ACNC Act) and the ethical requirements of the Accounting Professional and Ethical Standards Board's APES 110 *Code of Ethics for Professional Accountants (including Independence Standards)* (the Code) that are relevant to our audit of the financial report in Australia. We have also fulfilled our other ethical responsibilities in accordance with the Code.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Other information

Those charged with governance are responsible for the other information. The other information obtained at the date of this auditor's report is information included in The Australian Wine Research Institute Limited's annual report, but does not include the financial report and our auditor's report thereon.

Our opinion on the financial report does not cover the other information and accordingly we do not express any form of assurance conclusion thereon.

In connection with our audit of the financial report, our responsibility is to read the other information and, in doing so, consider whether the other information is materially inconsistent with the financial report or our knowledge obtained in the audit or otherwise appears to be materially misstated.

If, based on the work we have performed on the other information obtained prior to the date of this auditor's report, we conclude that there is a material misstatement of this other information, we are required to report that fact. We have nothing to report in this regard.

Responsibilities of responsible entities for the Financial Report

The responsible entities of the registered entity are responsible for the preparation and fair presentation of the financial report in accordance with Australian Accounting Standards – Reduced Disclosure Requirements and the ACNC Act, and for such internal control as the responsible entities determine is necessary to enable the preparation of the financial report that is free from material misstatement, whether due to fraud or error.

In preparing the financial report, responsible entities are responsible for assessing the registered entity's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless the responsible entities either intends to liquidate the registered entity or to cease operations, or has no realistic alternative but to do so.

Those charged with governance are responsible for overseeing the registered entity's financial reporting process.

Auditor's responsibilities for the audit of the Financial Report

Our objectives are to obtain reasonable assurance about whether the financial report as a whole is free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with the Australian Auditing Standards will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of this financial report.

A further description of our responsibilities for the audit of the financial report is located at the Auditing and Assurance Standards Board website (http://www.auasb.gov.au/Home.aspx) at: http://www.auasb.gov.au/auditors_responsibilities/ar4.pdf

This description forms part of our auditor's report.

BDO Audit (SA) Pty Ltd

Paul Gosnold
Director

Adelaide, 23 September 2020

Memorial funds

Consisting of (and collectively the "Trusts"):

The John Fornachon Memorial Library Endowment Fund
The Thomas Walter Hardy Memorial Trust Fund
The H. R. Haselgrove Memorial Trust Fund
The Stephen Hickinbotham Memorial Research Trust

Statement by directors of the trustee company

The Australian Wine Research Institute Limited (the "Trustee") acts as unrewarded trustee for the above listed Trusts. As detailed in note 2 to these financial statements, the Trusts are not reporting entities because, in the Trustee's opinion, it is unlikely that users exist who are unable to command the preparation of reports tailored so as to satisfy, specifically, all of their information needs. This is a special purpose financial report that has been prepared to meet the reporting obligations of the Trustee.

In the opinion of the directors of The Australian Wine Research Institute Limited (the Trustee):

(a) (i) the statements of profit or loss and other comprehensive income give a true and fair view of each Trust's profit or loss for the year ended 30 June 2020; and
(ii) the statements of financial position give a true and fair view of each Trust's state of affairs as at 30 June 2020.

(b) at the date of this statement, there are reasonable grounds to believe that the Trusts will be able to pay their debts as and when they fall due.

This statement is made in accordance with a resolution of the directors of the trustee company and is signed for and on behalf of the directors by:

Louisa E. Rose
Chair

Dated at Urrbrae on this the 17th day of September 2020.

Notes to the financial statements

1. Nature and purpose of the Trusts

(a) The John Fornachon Memorial Library Endowment Fund was established on 30 September 1970, to provide for the establishment and maintenance of the Fornachon Memorial Library, for the promotion of study and general knowledge of the wine industry. The Fund was established by way of public appeal on a memorial to the late John Charles Macleod Fornachon, the Director of Research of The Australian Wine Research Institute Limited from 1955 to 1968.

(b) The Thomas Walter Hardy Memorial Trust Fund was established on 29 June 1993 to assist in the communication of information within the wine industry and associated activities, allied to the wine industry on behalf of the Trust. The Trust was established in memory of the late Thomas Walter Hardy.

(c) The H.R. Haselgrove Memorial Trust Fund was established on 12 December 1979 to provide for the promotion and encouragement of wine research by, or under the direction of, The Australian Wine Research Institute Limited as a memorial to the late Harry Ronald Haselgrove.

(d) The Stephen Hickinbotham Memorial Research Trust was established on 7 October 1986 to provide financial assistance and support in the pursuit of scientific research and associated activities, allied to the wine industry. The Trust was established in memory of the late Stephen John Hickinbotham. The Australian Wine Research Institute Limited assumed responsibility for the Trust on 25 May 1992.

2. Statement of accounting policies

In the opinion of the Trustee, the Trusts are of a type identified in Statement of Accounting Concepts 1 as non-reporting entities. Accordingly, the financial statements constitute 'special purpose financial reports' which have been prepared solely to meet the reporting obligations of the Trustee, and the limited information needs of the Trusts' members.

The financial statements have been prepared in accordance with accounting standards, except as stated below, and other mandatory professional reporting requirements.

The following accounting standards have not been adopted because, in the opinion of the Trustee, the cost of compliance outweighs the benefit of the resultant information:

- AASB 7 Financial Instruments: Disclosures
- AASB 107 Statement of Cash Flows
- AASB 124 Related Party Disclosures
- AASB 132 Financial Instruments: Presentation

The financial statements have been prepared on an accrual basis.

Accounting policies have been consistently applied, with the only significant policy being in relation to investments.

Investments interest rate securities and exchange traded funds, all of which are quoted on the Australian Securities Exchange and recorded at fair value through other comprehensive income. Investment income is brought to account as earned, with accrued earnings at balance date being included in the statement of financial position as receivables.

Statements of profit or loss and other comprehensive income	The John Fornachon Memorial Library Endowment Fund		The Thomas Walter Hardy Memorial Trust Fund		The H. R. Haselgrove Memorial Trust Fund		The Stephen Hickinbotham Memorial Research Trust	
For the year ended 30 June 2020	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**
Income								
Investments	5,785	5,230	4,016	3,492	3,962	3,379	4,514	4,053
Donations and other income	–	–	–	–	–	–	–	–
Total income	5,785	5,230	4,016	3,492	3,962	3,379	4,514	4,053
Expenses								
Investment management expenses	723	508	486	355	508	349	569	396
Contribution towards Library Management System	4,192	1,565	–	–	–	–	–	–
Sponsorship of 17th Australian Wine Industry Technical Conference	–	–	10,000	–	–	–	7,000	–
Total expenses	4,915	2,073	10,486	355	508	349	7,569	396
Profit/(loss) from ordinary activities	870	3,157	(6,470)	3,137	3,454	3,030	(3,055)	3,657
Other comprehensive income								
Items that will not be reclassified subsequently to profit or loss:								
Gain (loss) on revaluation of financial assets at fair value through other comprehensive income	(5,768)	6,815	(3,450)	4,592	(3,711)	4,412	(4,416)	5,272
Total comprehensive income for the period	(4,898)	9,972	(9,920)	7,729	(257)	7,442	(7,471)	8,929
Statements of financial position								
As at 30 June 2020	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**
Assets								
Cash at bank	2,312	4,787	1,550	3,056	6,728	3,194	1,872	3,840
Investments	–	–	–	–	–	–	–	–
Receivables	1,499	1,432	996	957	973	925	1,169	1,109
Total current assets	3,811	6,219	2,546	4,014	7,701	4,119	3,042	4,949
Investments	131,306	139,271	85,109	93,561	86,545	90,385	102,683	108,247
Total non-current assets	131,306	139,271	85,109	93,561	86,545	90,385	102,683	108,247
Total assets	135,117	145,490	87,655	97,575	94,246	94,504	105,725	113,196
Liabilities								
Committed funding contribution	–	5,474	–	–	–	–	–	–
Total current liabilities	–	5,474	–	–	–	–	–	–
Net assets	135,117	140,016	87,655	97,575	94,246	94,504	105,725	113,196
Trust funds								
Settled sum	12,785	12,785	50	50	20,000	20,000	50	50
Founders donation	–	–	25,000	25,000	–	–	–	–
	12,785	12,785	25,050	25,050	20,000	20,000	50	50
Accumulated surplus								
Opening balance	120,229	117,259	67,805	64,796	69,967	67,061	107,721	104,217
Profit/(loss) for the year	870	3,157	(6,470)	3,137	3,454	3,030	(3,055)	3,657
Transfers to (from) accumulated surplus	(429)	(187)	273	(128)	(388)	(125)	(224)	(153)
Closing balance	120,670	120,229	61,608	67,805	73,033	69,967	104,442	107,721
Financial assets at fair value through other comprehensive income reserve								
Opening balance	7,002	–	4,720	–	4,537	–	5,426	–
Gain (loss) on revaluation of financial assets at fair value through other comprehensive income	(5,769)	6,815	(3,450)	4,592	(3,712)	4,412	(4,416)	5,272
Transfers to (from) reserve	429	187	(273)	128	388	125	224	153
Closing balance	1,662	7,002	997	4,720	1,213	4,537	1,233	5,426
Total trust funds	135,117	140,016	87,655	97,575	94,246	94,504	105,725	113,196

APPENDIX 1

External presentations

Staff	Title of presentation	Presented to and where	Date
M.P. Krstic	Setting the scene	AWRI Pinot Noir Symposium, Melbourne, Vic	4 Jul 2019
	Summary of the day		
G.D. Cowey	Masterclass and palate calibration of wine taints and faults	Sommeliers Australia masterclass, Sydney, NSW	16 Jul 2019
S. Nordestgaard	Introduction to dissolved gas management	17th AWITC workshop program, Adelaide, SA	21 Jul 2019
R. Gawel	Effects of carbon dioxide on taste/texture		
S.A. Schmidt	Introduction of oxygen into red ferments		
I.L. Francis	Existing sensory methods and practical issues		
D. Espinase Nandorfy	Projective mapping/napping		
W.P. Pearson	Pivot© Profile		
K.A. Bindon	Maceration as a tool to manage phenolic extraction		
M.P. Day	Whole bunch fermentation: Shiraz and Pinot Noir		
	Macro-oxygenation during red winemaking: use and impacts		
A.R. Rinaldo	Grapevine virus diagnostics		
M. Essling	Controlling exotic pests in Australian vineyards		
A.J. Hoare	Chemical-free weed control		
E.N. Wilkes	Measuring up to requirements		
	Fraud prevention in wine – where to now?		
J.R. Bellon	Breeding new life into the ancient art of winemaking		
C.A. Varela	Discovering the microbiome: potential applications for novel non-conventional wine yeasts		
A.G. Cordente	Stop and smell the roses: novel yeast that impart 'floral' aromas in wine		
N. Scrimgeour	Wine taints, faults and remediation		
G.D. Cowey	Introduction to wine taints and faults		
N. Scrimgeour	Taint and fault proficiency assessment		
G.D. Cowey	Wine taints and faults remediation		
W.P. Pearson	Understanding regionality in Shiraz: sensory profiles of Shiraz wines from six Australian regions		
I.L. Francis	What chemical measures relate to regional sensory differences?		
M.Z. Bekker	Fruity vs stinky: how to manage varietal and 'reductive' thiols during winemaking		
T.G. Cordente	Modulation of 'fruity' thiols by yeast during fermentation		
D. Espinase Nandorfy	Sensory effects of 'positive' thiols as fruit enhancers or tropical impact aromas		
M.Z. Bekker	Managing and remediating 'reductive' aromas in wine		
D. Espinase Nandorfy	Sensory effects of 'negative' sulfides		
S.A. Schmidt	Genomic technologies in clone identification: current status and future potential		
E.N. Wilkes	Process-driven analysis		

Staff	Title of presentation	Presented to and where	Date
E.N. Wilkes	How to choose the 'right' equipment	17th AWITC workshop program, Adelaide, SA	21 Jul 2019
S. Nordestgaard	Introduction to grape sorting technology		
A.R. Borneman	Getting to know wild yeasts		
N. Scrimgeour	Closures and packaging: getting it right and maximising shelf life		
	History and trends in packaging		
D. Espinase Nandorfy	Trial design and effective use of sensory evaluation techniques		
K.C. Hirlam	Controlling oxygen at packaging and during bottle ageing		
N. Scrimgeour	Understanding wine development in packaging studies		
J.M. McRae	Handling the heat: tips and tricks for reliable heat test results		
E.N. Wilkes	Cold stability, not so cool		
K.C. Hirlam	Potassium polyaspartate (KPA): the new kid on the block		
E.N. Wilkes	Conductivity testing – a cautionary tale		
T.M. Parker	Modulating monoterpenes and glycosides for wine style and flavour		
J.L. Hixson	Are tropical thiols varietal?		
T.E. Siebert	'Apricot' aroma in white wine: contributors and influencers		
S.R. Barter	Rotundone and the inability to smell it		
R.G. Dambergs	Multispectral systems to measure disease at the weighbridge		
M.L. Longbottom	Sustainability and Australian grape and wine production		
	The business case for sustainability		
J.A. Culbert	Evaluating activated carbons for removal of phenols and their glycoconjugates from smoke-affected juice and wine	17th AWITC plenary program, Adelaide, SA	23 Jul 2019
C.E. Bartel	Is *Brettanomyces bruxellensis* becoming more SO_2 tolerant in industry?		
W.P. Pearson	Understanding regionality in Shiraz: sensory and chemical profiles of Shiraz wines from six Australian regions		
T.M. Parker	Phenolic-free glycosides from grape marc can increase wine flavour	17th AWITC student forum 'In the wine light', Adelaide, SA	
		17th AWITC plenary program, Adelaide, SA	24 Jul 2019
E.O. Bilogrevic	Whole bunch fermentation of Shiraz and Pinot Noir: influence on 'green' characters and astringency		
A.C. Kulcsar	Stopping the stink: an evaluation of five common 'reductive' aroma remediation strategies		
M.J. Roach	Population sequencing reveals clonal diversity and ancestral inbreeding in the grapevine cultivar Chardonnay		
S. Nordestgaard	Inspirations from the past and opportunities for the future		
J.M. McRae	New techniques and technologies for protein stabilisation of wine		
M. Essling	Agrochemicals update	Murray Valley Winegrowers pre-season checklist workshop, Swan Hill, Vic	1 Aug 2019
A.J. Hoare	Scale, mealybug and grapevine virus – economic thresholds		
M. Essling	Agrochemicals update	Murray Valley Winegrowers pre-season checklist workshop, Mildura, Vic	2 Aug 2019
A.J. Hoare	Scale, mealybug and grapevine virus – economic thresholds		
M. Essling	Sustainable Winegrowing Australia program update	Pernod Ricard Winemakers growers' meeting, Riverland, SA	6 Aug 2019
A.J. Hoare	Controlling weeds without using synthetic chemicals		
M. Essling	Agrochemicals update	Farmer John's growers' meeting, Barossa Valley, SA	8 Aug 2019
T.E. Siebert	Australian Shiraz: pepper and provenance	WSET scholarship group visit, Adelaide, SA	9 Aug 2019

Staff	Title of presentation	Presented to and where	Date
M. Essling	Sustainable Winegrowing Australia program update	Pernod Ricard Winemakers growers' meeting, Barossa Valley, SA	14 Aug 2019
A.J. Hoare	Controlling weeds without using synthetic chemicals		
E.N. Wilkes	What's in that bottle? Is 'wine fingerprinting' really a thing?	Romeo Bragato National Conference, Napier, New Zealand	29 Aug 2019
M.G. Holdstock	Regional snapshot	AWRI roadshow seminar, Rutherglen, Vic	10 Sep 2019
A.J. Hoare	How to get the most out of your planting material		
	Organic and conventional practices compared – what's stopping you from going organic?		
M.G. Holdstock	Regional snapshot	AWRI roadshow seminar, Bendigo, Vic	11 Sep 2019
A.J. Hoare	Can weeds be controlled without synthetic chemicals?		
	Organic and conventional practices compared – what's stopping you from going organic?		
M.G. Holdstock	Regional snapshot	AWRI roadshow seminar, Avoca, Vic	12 Sep 2019
A.J. Hoare	How to minimise your chances of frost damage		
	Organic and conventional practices compared – what's stopping you from going organic?		
C.J. Day	Staying a step ahead of scammers in managing your business's finances – observations from the coalface	Rotary Club of Mitcham, Adelaide, SA	
C.A. Varela	Is *Brettanomyces bruxellensis* becoming more SO_2 tolerant in industry?	University of Santiago, Department of Food Science and Technology, Chile	13 Sep 2019
D. Espinase Nandorfy	The neuroscience of wine tasting	Neuroscience at night, Adelaide, SA	16 Sep 2019
A.J. Hoare	Vineyard floor management	Mornington Peninsula Vignerons Association under-vine and mid-row crop management field day, Mornington Peninsula, Vic	17 Sep 2019
	How weeds influence a vineyard	AWRI webinar	19 Sep 2019
C.A. Varela	Discovering the microbiome: potential applications for novel non-conventional wine yeasts	3rd International Flavor and Fragrance Conference, Vina del Mar, Chile	1 Oct 2019
M.G. Holdstock	Evaluation of winemaking treatments in Australian Cabernet Sauvignon	Cabernet Sauvignon winemaking trial tasting, Barossa Valley, SA	
K.A. Bindon	Using maceration techniques to tailor red wine styles	AWRI webinar	3 Oct 2019
G.D. Cowey	Flavours from wine regions and grape varieties	Chinese Wine Association tasting, Adelaide, SA	4 Oct 2019
	Wine taints and faults and oak flavours		
	AWRI research update		
J.L. Hixson	Modulating tropical character in the vineyard	Advanced Viticulture Course #1, Adelaide, SA	14 Oct 2019
A.R. Rinaldo	Grapevine virus elimination		
A.R. Borneman	Genome sequence reveals Chardonnay parentage and clonal markers		
M.L. Longbottom	Sustainable Winegrowing Australia		
C.A. Varela	Discovering the indigenous yeast microbiota associated with Australian Aboriginal and Torres Strait Islander fermentations	University of Santiago, Department of Biology, Santiago, Chile	
M.G. Holdstock	Regional snapshot	AWRI roadshow seminar, Orange, NSW	15 Oct 2019
M. Essling	Can weeds be controlled without synthetic chemicals?		
K.A. Bindon	How can you predict wine tannin and colour in the vineyard?		
M.P. Day	Managing 'reductive' aromas in wine		
M. Essling	Organic and conventional practices compared – what's stopping you from going organic?		

Staff	Title of presentation	Presented to and where	Date
M.G. Holdstock	Regional snapshot	AWRI roadshow seminar, Southern Highlands, NSW	16 Oct 2019
M. Essling	Drones and lasers: novel bird control options		
K.A. Bindon	How can you predict wine tannin and colour in the vineyard?		
M.P. Day	The beneficial style and performance effects of oxygen addition during fermentation		
M. Essling	Can weeds be controlled without synthetic chemicals?		
M.G. Holdstock	Regional snapshot	AWRI roadshow seminar, Canberra, ACT	17 Oct 2019
M. Essling	How to improve fruit set in cool climates		
K.A. Bindon	How can you maximise the phenolic potential of grapes through innovative winemaking?		
	How can you predict wine tannin and colour in the vineyard?		
M.P. Day	The beneficial style and performance effects of oxygen addition during fermentation		
M.L. Longbottom	Sustainable Winegrowing Australia	Treasury Wine Estates grower meeting, McLaren Vale, SA	
		Treasury Wine Estates grower meeting, Tanunda, SA	18 Oct 2019
C.A. Varela	Discovering the indigenous yeast microbiota associated with Australian Aboriginal and Torres Strait Islander fermentations	Catholic University, Department of Chemical Engineering and Bioprocesses, Santiago, Chile	23 Oct 2019
A.R. Borneman	Genome sequence reveals Chardonnay parentage and clonal markers	Langton's Chardonnay Symposium, Yarra Valley, Vic	31 Oct 2019
C.A. Simos	Evaluation of winemaking treatments in Australian Cabernet Sauvignon	Cabernet Sauvignon winemaking trial tasting, Swan Valley, WA	1 Nov 2019
S.R. Barter	Australian Shiraz: pepper and provenance	Wine Australia Europe, Middle East and Africa group visit, Adelaide, SA	
M.L. Longbottom	Sustainable Winegrowing Australia		
S.A. Schmidt	Why filter? And managing risk when you don't!	Wine Tasmania Symposium, Hobart, Tas	5 Nov 2019
K.A. Bindon	Enzymes, do they work? Extraction vs clarification		
A.D. Coulter	Calcium tartrate instability		
M.Z. Bekker	Managing 'reductive' aromas in wines	AWRI webinar	7 Nov 2019
S. Nordestgaard	Membrane contactors for dissolved gas management		8 Nov 2019
P.W. Godden	Regional snapshot	AWRI roadshow seminar, Clare Valley, SA	12 Nov 2019
M.Z. Bekker	Using copper sulfate without unwanted side effects		
J.L. Hixson	The flavour of bottle-aged Riesling – predicting and controlling future chemistry		
M.Z. Bekker	The beneficial style and performance effects of oxygen addition during fermentation		
A.J. Hoare	Controlling weeds without using synthetic chemicals		
	Organic and conventional practices compared – what's stopping you from going organic?		
P.W. Godden	Regional snapshot	AWRI roadshow seminar, Barossa Valley, SA	13 Nov 2019
A.J. Hoare	Can weeds be controlled without synthetic chemicals?		
	Scale and mealybug – what can I do to control these sap-sucking insects?		
E.N. Wilkes	Using copper sulfate without unwanted side effects		
P.W. Godden	Regional snapshot	AWRI roadshow seminar, McLaren Vale, SA	14 Nov 2019
S.A. Schmidt	Causes and management of stuck fermentations		

Staff	Title of presentation	Presented to and where	Date
A.J. Hoare	Drones and lasers: novel bird control options	AWRI roadshow seminar, McLaren Vale, SA	14 Nov 2019
W.P. Pearson	Wine flavours, faults and taints	Institute of Masters of Wine one-day wine assessment course, Adelaide, SA	
G.D. Cowey	Smoke taint Q&A	Smoke taint Q&A session, Perth Hills, WA	26 Nov 2019
		Smoke taint Q&A session, Blackwood Valley, WA	28 Nov 2019
		Smoke taint Q&A session, Mount Barker, WA	29 Nov 2019
M.P. Krstic	Soil health checklist – what to measure to assess soil health	AWRI webinar	
W.P. Pearson	Wine flavours, faults and taints	Advanced Wine Assessment Course (AWAC 50), Adelaide, SA	2 Dec 2019
M.L. Longbottom, M. Coles	Sustainable Winegrowing Australia	Regional update, Barossa Valley, SA	
M.L. Longbottom		Margaret River Sustainability Committee, Margaret River, WA	3 Dec 2019
M.L. Longbottom, M. Coles		Regional update, McLaren Vale, SA	4 Dec 2019
M.L. Longbottom		Mornington Peninsula Technical Committee, Mornington Peninsula, Vic	
M.L. Longbottom, M. Coles		Regional update, Oakbank, SA	5 Dec 2019
R. Gawel	Palate performance and statistical evaluation	Advanced Wine Assessment Course (AWAC 50), Adelaide, SA	
C.A. Varela	Discovering the indigenous yeast microbiota associated with Australian Aboriginal and Torres Strait Islander fermentations	YPD 2019 – 8th Yeast: Products and Discovery meeting, Sydney, Australia	6 Dec 2019
A.R. Borneman	Is SO_2 tolerance in *Brettanomyces bruxellensis* a developing concern?		
D. Espinase Nandorfy	Determining the major volatile compounds directing white wine aroma attributes through sensory-directed experimental design approaches	Australasian Association for Chemo-Sensory Science Conference 2019, Rotorua, New Zealand	
M.G. Holdstock	Evaluation of winemaking treatments in Australian Pinot Noir	Red winemaking trial, Pernod Ricard Winemakers, Barossa Valley, SA	19 Dec 2019
C.A. Simos, E.-M. Panagis	Smoke taint Q&A	Smoke taint Q&A session, Hunter Valley, NSW	20 Dec 2019
M.L. Longbottom	Assessing and managing fire-damaged grapevines	Cudlee Creek Fire Response and Recovery Adelaide Hills Horticulture and Viticulture Industry Information Meeting, Adelaide Hills, SA	2 Jan 2020
C.A. Simos	Smoke taint Q&A	Smoke taint Q&A session, Canberra, ACT	6 Jan 2020
		Smoke taint Q&A session, Orange, NSW	
		Smoke taint Q&A session, Mudgee, NSW	7 Jan 2020
M.L. Longbottom	Assessing and managing fire-damaged grapevines	AWRI webinar	
C.A. Simos	Smoke taint Q&A	Smoke taint Q&A session, King Valley, Vic	15 Jan 2020

Staff	Title of presentation	Presented to and where	Date
C.A. Simos	Smoke taint Q&A	Smoke taint Q&A session, Tumbarumba, NSW	15 Jan 2020
P.W. Godden	Evaluation of winemaking treatments in Australian Chardonnay	Chardonnay winemaking trial tasting, Barossa Valley, SA	
		Chardonnay winemaking trial tasting, Langhorne Creek, SA	16 Jan 2020
C.A. Simos	Smoke taint Q&A	Smoke taint Q&A session, Griffith, NSW	
		Smoke taint Q&A session, Yarra Valley, Vic	17 Jan 2020
		Smoke taint Q&A session, Mornington Peninsula, Vic	
P.W. Godden	Evaluation of winemaking treatments in Australian Chardonnay	Chardonnay winemaking trial tasting, McLaren Vale, SA	
C.A. Simos	Smoke taint Q&A	Smoke taint Q&A session, Barossa Grape & Wine Association, Barossa Valley, SA	20 Jan 2020
		Smoke taint Q&A session, Pernod Ricard Winemakers, Barossa Valley, SA	22 Jan 2020
		Smoke taint Q&A session, Treasury Wine Estates, Barossa Valley, SA	
		Smoke taint Q&A session, Accolade Wines, McLaren Vale, SA	24 Jan 2019
D. Espinase Nandorfy	Smoke taint sensory evaluation	Smoke taint screening tasting, Hunter Valley, NSW	
		Smoke taint screening tasting, Adelaide Hills, SA	29 Jan 2020
C.A. Simos	Smoke taint Q&A	Smoke taint Q&A session, Adelaide Hills, SA	
M.L. Longbottom	Assessing and managing fire-damaged grapevines	NSW Wine Industry Association vineyard fire assessment workshop, Tumbarumba, NSW	30 Jan 2020
C.A. Simos	Smoke taint Q&A	Smoke taint Q&A session, McLaren Vale, SA	
		Smoke taint Q&A session, Gippsland, Vic	31 Jan 2020
M.G. Holdstock		Smoke taint Q&A session, Cellarmasters, Barossa Valley, SA	
W.P. Pearson	Smoke taint sensory evaluation	Smoke taint screening tasting, Treasury Wine Estates, Barossa Valley, SA	
G.D. Cowey	Evaluation of winemaking treatments in Australian Chardonnay	Chardonnay winemaking trial tasting, Margaret River, WA	
D. Espinase Nandorfy	Smoke taint sensory evaluation	Smoke taint screening tasting, Mudgee, NSW	4 Feb 2020
C.A. Simos	Winemaking and handling of fruit in drought conditions	Orange Region Vignerons Association Drought Forum, Orange, NSW	
	Coordinated sample collection for assessment of smoke taint		
D. Espinase Nandorfy	Smoke taint sensory evaluation	Smoke taint screening tasting, Orange, NSW	5 Feb 2020
	Avoiding sulfur compound off-flavours in red wine: sensory and compositional effects of several winemaking strategies	NZOZ Sensory and Consumer Science Symposium, Melbourne, Vic	11 Feb 2020

Staff	Title of presentation	Presented to and where	Date
J.A. Culbert	Mitigation of climate change impacts on the national wine industry by reduction in losses from controlled burns and wildfires	Managing Bushfire Risk 2020 Forum, Hobart, Tas	11 Feb 2020
		Managing Bushfire Risk 2020 Forum, Launceston, Tas	12 Feb 2020
P.W. Godden	Evaluation of winemaking treatments in Australian Chardonnay	Chardonnay winemaking trial tasting, Coonawarra, SA	
D. Espinase Nandorfy	Smoke taint sensory evaluation	Smoke taint screening tasting, Yarra Valley, Vic	14 Feb 2020
P.O. Williamson		Smoke taint screening tasting, Canberra, ACT	19 Feb 2020
D. Espinase Nandorfy		Smoke taint screening tasting, Accolade Wines, Barossa Valley, SA	3 Mar 2020
		Smoke taint screening tasting, Clare Valley, SA	4 Mar 2020
M.L. Longbottom	Sustainable Winegrowing Australia	Online presentation to Wine Australia, Adelaide, SA	20 Mar 2020
J. Gledhill	Evaluation of winemaking treatments in Australian Cabernet Sauvignon	Cabernet Sauvignon winemaking trial tasting, University of Adelaide, Adelaide, SA	30 Apr 2020
N. Scrimgeour	Understanding and mitigating the development of reductive characters in canned wines	Enartis, USA webinar: Canned wine – new information for preparing wines for canning	22 May 2020
E.N. Wilkes	Wine in cans? A tale of two metals		
D. Espinase Nandorfy	Adaption of sensory research methods to support research sustainability	Australian Institute of Food Science and Technology Virtual Convention	25 Jun 2020
E.N. Wilkes	Understanding the carbon footprint of the wine industry	ASVO online seminar: Australian wine – winning the long game	29 Jun 2020
J.A. Culbert	Remedial options for grapes exposed to smoke		30 Jun 2020
M.J. Herderich	Early insights into ripening smoke exposure from the Adelaide Hills fires		

APPENDIX 2

Events organised by AWRI staff

Staff	Title of event	Held	Date
M.P. Krstic, V.F. Phillips	AWRI Pinot Noir Symposium	Melbourne, Vic	4 Jul 2019
G.D. Cowey, E.-M. Panagis	Sommeliers Australia masterclass	Sommeliers Australia, Sydney, NSW	16 Jul 2019
M.P. Krstic, J. Scudds	AWRI vine pruning workshop	King Valley, Vic	17 Jul 2019
S. Nordestgaard	Advances in dissolved gas management – W01	17th AWITC workshop program, Adelaide, SA	21 Jul 2019
I.L. Francis	Talking sense: new sensory methods for wine evaluation – W02		
K.A. Bindon	Using maceration techniques to tailor red wine styles – W05		
A.J. Hoare	Chemical-free undervine weed control – W08		
E.N. Wilkes	Regulatory challenges for the production and marketing of Australian wine – W09		
C.A. Varela	Novel yeast for new wine styles – W10		
N. Scrimgeour	Wine faults, taints and remediation – W13		

Staff	Title of event	Held	Date
M.Z. Bekker	Fruity vs stinky: how to manage varietal and 'reductive' thiols during winemaking – W15	17th AWITC workshop program, Adelaide, SA	21 Jul 2019
E.N. Wilkes	Making your laboratory work for you – W20		
S. Nordestgaard	Advances in grape sorting technology – W23		
A.R. Borneman	Bringing science to wild wine – W24		
E.N. Wilkes	Ensuring wine stability – W26		
J. Gledhill	Muscat of Rutherglen masterclass – W27		
J.L. Hixson	What makes a wine tick? New advances in understanding flavour compounds – W28		
M.L. Longbottom	Sustainability in the Australian grape and wine sector – W33		
C.A. Simos, E.-M. Panagis, T.E. Siebert	WSET scholarship group visit	Adelaide, SA	9 Aug 2019
M.G. Holdstock, V.F. Phillips, A.J. Hoare	AWRI roadshow seminar	Rutherglen, Vic	10 Sep 2019
		Bendigo, Vic	11 Sep 2019
		Avoca, Vic	12 Sep 2019
D. Espinase Nandorfy, E.O. Bilogrevic, D. Likos, L.E. Bey, J.R. Bellon, S.R. Barter, L. Pisaniello, F.T. Watson, M. Rullo, M.P. Day, M.R. Solomon, J.L. Hixson, A.G. Cordente, A.J. Hoare, E.-M. Panagis	From vine to mind: following wine production from vineyard to taster (National Science Week event)	Adelaide, SA	15 Sep 2019
M.G. Holdstock	Cabernet Sauvignon winemaking trial tasting	Barossa Valley, SA	1 Oct 2019
G.D. Cowey, E.-M. Panagis	Chinese Wine Association tasting	Adelaide, SA	4 Oct 2019
A.J. Hoare, M.P. Krstic, M.L. Longbottom, J. Scudds, C.A. Simos, F. Blefari, E.-M. Panagis	Advanced Viticulture Course #1		14–16 Oct 2019
C.A. Simos, M.G. Holdstock, V.F. Phillips, M. Essling, K.A. Bindon, M.P. Day	AWRI roadshow seminar	Orange, NSW	15 Oct 2019
		Southern Highlands, NSW	16 Oct 2019
		Canberra, ACT	17 Oct 2019
S.R. Barter, G.D. Cowey, M.L. Longbottom, E.-M. Panagis, V.P. Phillips, J. Scudds	Wine Australia Europe, Middle East and Africa group visit	Adelaide, SA	1 Nov 2019
C.A. Simos, V.F. Phillips	Cabernet Sauvignon winemaking trial tasting	Swan Valley, WA	
M. Essling, V.F. Phillips	Spray application workshop	Frankland River, WA	5 Nov 2019
		Margaret River, WA	6 Nov 2019
		Swan Valley, WA	7 Nov 2019
C.A. Simos, V.F. Phillips, P.W. Godden, M.Z. Bekker, J.L. Hixson, A.J. Hoare	AWRI roadshow seminar	Clare Valley, SA	12 Nov 2019
C.A. Simos, V.F. Phillips, P.W. Godden, A.J. Hoare, E.N. Wilkes		Barossa Valley, SA	13 Nov 2019
C.A. Simos, V.F. Phillips, P.W. Godden, S.A. Schmidt, A.J. Hoare		McLaren Vale, SA	14 Nov 2019
C.A. Simos, E.-M. Panagis, W.P. Pearson	Institute of Masters of Wine one-day wine assessment course	Adelaide, SA	
M.L. Longbottom	Sustainable Winegrowing Australia certification training		20 Nov 2019
G.D. Cowey	Smoke taint Q&A session	Perth Hills, WA	26 Nov 2019
		Blackwood Valley, WA	28 Nov 2019
		Mount Barker, WA	29 Nov 2019

Staff	Title of event	Held	Date
C.A. Simos, F. Blefari, W.P. Pearson, E.-M. Panagis, J. Scudds, M.G. Holdstock, G.D. Cowey, V.F. Phillips, D. Likos. E.O. Bilogrevic	Advanced Wine Assessment Course (AWAC 50)	Adelaide, SA	2-5 Dec 2019
M.G. Holdstock, J. Scudds	Red winemaking trial, Pernod Ricard Winemakers	Barossa Valley, SA	19 Dec 2019
C.A. Simos, E.-M. Panagis	Smoke taint Q&A session	Hunter Valley, NSW	20 Dec 2019
		Canberra, ACT	6 Jan 2020
		Orange, NSW	
		Mudgee, NSW	7 Jan 2020
		King Valley, Vic	15 Jan 2020
		Tumbarumba, NSW	
P.W. Godden, E.-M. Panagis	Chardonnay winemaking trial tasting	Barossa Valley, SA	
C.A. Simos, E.-M. Panagis	Smoke taint Q&A session	Griffith, NSW	16 Jan 2020
P.W. Godden, E.-M. Panagis	Chardonnay winemaking trial tasting	Langhorne Creek, SA	
C.A. Simos, E.-M. Panagis	Smoke taint Q&A session	Yarra Valley, Vic	17 Jan 2020
		Mornington Peninsula, Vic	
P.W. Godden, E.-M. Panagis	Chardonnay winemaking trial tasting	McLaren Vale, SA	
C.A. Simos, E.-M. Panagis	Smoke taint Q&A session – Barossa Grape & Wine Association	Barossa Valley, SA	20 Jan 2020
	Smoke taint Q&A session – Pernod Ricard Winemakers		22 Jan 2020
	Smoke taint Q&A session – Treasury Wine Estates		
	Smoke taint Q&A session – Accolade Wines	McLaren Vale, SA	24 Jan 2020
M.G. Holdstock, E.-M. Panagis, D. Espinase Nandorfy	Smoke taint screening tasting	Hunter Valley, NSW	
C.A. Simos, E.-M. Panagis	Smoke taint Q&A session	Adelaide Hills, SA	29 Jan 2020
C.A. Simos, E.-M. Panagis, D. Espinase Nandorfy	Smoke taint screening tasting		
C.A. Simos, J. Scudds	Smoke taint Q&A session	McLaren Vale, SA	30 Jan 2020
C.A. Simos, E.-M. Panagis		Gippsland, Vic	31 Jan 2020
M.G. Holdstock, E.-M. Panagis, D. Espinase Nandorfy	Smoke taint Q&A session – Cellarmasters	Barossa Valley, SA	
C.A. Simos, E.-M. Panagis, W.P. Pearson	Smoke taint screening tasting – Treasury Wine Estates		
G.D. Cowey, J. Scudds	Chardonnay winemaking trial tasting	Margaret River, WA	
C.A. Simos, E.-M. Panagis, D. Espinase Nandorfy	Smoke taint screening tasting	Mudgee, NSW	4 Feb 2020
		Orange, NSW	5 Feb 2020
C.A. Simos, V.F. Phillips, P.W. Godden	Chardonnay winemaking trial tasting	Coonawarra, SA	12 Feb 2020
C.A. Simos, E.-M. Panagis, D. Espinase Nandorfy	Smoke taint screening tasting	Yarra Valley, Vic	14 Feb 2020
M.G. Holdstock, J. Scudds, P.O. Williamson		Canberra, ACT	19 Feb 2020
M.L. Longbottom, E.-M. Panagis	Sustainable Winegrowing Australia certification training	McLaren Vale, SA	20 Feb 2020
C.A. Simos, J. Scudds, D. Espinase Nandorfy	Smoke taint screening tasting – Accolade Wines	Barossa Valley, SA	3 Mar 2020
	Smoke taint screening tasting	Clare Valley, SA	4 Mar 2020
C.A. Simos, E.-M. Panagis, J. Gledhill	Cabernet Sauvignon winemaking trial tasting	University of Adelaide, Adelaide, SA	30 Apr 2020

APPENDIX 3

Posters

Staff	Title of poster	Presented at	Date
K.C. Hirlam, J.L. Hixson, T.J. Abbott[1], S. Lapidge[2]	Transformation opportunities of industry waste and potential routes to market: a snapshot	17th AWITC, Adelaide, SA	21–24 Jul 2019
K.C. Hirlam, N. Scrimgeour, E.N. Wilkes	Orientation and temperature cycling impacts on the oxygen transmission rate of wine closures		
M.L. Downie, L.M. Bevin, A.D. Lord	Library and information services for the Australian grape and wine industry		
P. Zhang[3], Y. Fei[3], A. Pang[3], M.P. Krstic, T. Lewis[4], C. Lee[4], O. Barrie[4], H. Robinson[5], N. Dry[6], P. Clingeleffer[1], D. Chen[3], K.S. Howell[3]	Which grapevine rootstock performs the best for Mornington Peninsula Pinot Noir?		
P.R. Petrie[7,8,9], W. Jiang, K.A. Bindon, V. Sadras[7,8]	When do grapes stop accumulating sugar?		
M.J. Roach, D.L. Johnson, J. Bohlmann[10], H.J.J. van Vuuren[10], S.J.M. Jones[11], I.S. Pretorius[12], S.A. Schmidt, A.R. Borneman	Population sequencing reveals clonal diversity and ancestral inbreeding in the grapevine cultivar Chardonnay		
J.A. Culbert, W. Jiang, M.P. Krstic, M.J. Herderich	Does the application of horticultural products to grapes form a protective barrier against smoke taint?		
E. Romanini[13], D. Colangelo[13], M. Lambri[13], J.M. McRae	Grape seed powder as a novel and sustainable bentonite alternative		
N. Scrimgeour, K.C. Hirlam, J.M. McRae, T.J. Abbott[1], E.N. Wilkes	Changes in metal ion concentration from bentonite treatment		
A. Mierczynska-Vasilev, S. Wahono[14], P.A. Smith[15], K.A. Bindon, K. Vasilev[14]	Protein stabilisation of white wines using natural zeolites		
T.C. Almond, K.C. Hirlam, N. Scrimgeour, E.N. Wilkes	Cold stabilisation with potassium polyaspartate		
G. Gnoinski[16], K. Goemann[17], T. Pinfold[17], S.A. Schmidt, D. Close[16], F.L. Kerslake[16]	Visualisation of effects on lees from novel methods to induce autolysis in sparkling winemaking		
K.M. Cuijvers, R. Sanders[8,18], A.C. Kulcsar, M.Z. Bekker, D.L. Capone[8,18], D.W. Jeffery[8,18], S.A. Schmidt	Yeast strain-dependent effects of glutathione addition on wine chemistry		
M.P. Day, A.M. Barker, M.Z. Bekker, K.A. Bindon, P.A. Smith[15], S.A. Schmidt	Positive sensory and chemical outcomes from oxygen addition during red wine fermentation		
K.M. Cuijvers, S. van den Heuvel, A.R. Borneman	Wild wine: metagenomic analysis of microbial communities during wine fermentation		
K. Sumby[8,18], C. Collins[8,18], E.J. Bartowsky[18,19], A.R. Borneman, K. Chalmers[18,20], V. Jiranek[8]	Defining and exploiting the indigenous microflora of grapes		
S.A. Schmidt, R. Kolouchova, J. McCarthy, A.H. Forgan, A.R. Borneman	Evaluation of *Saccharomyces cerevisiae* wine yeast competitive fitness in oenologically relevant environments by barcode sequencing		
C.A. Onetto, A.R. Borneman, S.A. Schmidt	*Aureobasidium pullulans*: how much is known about its effect on grape juice composition?		
A.R. Rinaldo, E.J. Bartowsky[19], J. Amos[19], N. Scrimgeour	Rapid assessment of wine yeast viability and vitality during fermentation using flow cytometry		
C.A. Varela, L. Alperstein[8], J. Sundstrom[8], K.M. Cuijvers, M. Brady[21], V. Jiranek[8], A.R. Borneman	Discovering the indigenous microbiota associated with Australian Aboriginal and Torres Strait Islander fermentations		
M.P. Day, B. Thoman[22], S.A. Schmidt	Study of the effectiveness of several industry-scale oxygen introduction techniques into red fermenters		

Staff	Title of poster	Presented at	Date
K.C. Hirlam, T.J. Abbott[1], E.N. Wilkes	Fermentation's clean little secret	17th AWITC, Adelaide, SA	21–24 Jul 2019
P.J. Costello, M. Rullo, C. Jordans, R. Kolouchova, S.A. Schmidt	MLF and SO_2 stress – what are the real limits for malolactic bacteria?		
J.R. Bellon, M.R. Solomon, S.A. Schmidt	When less is more: streamlining the interspecific hybrid yeast genome for improved fermentation		
A.H. Forgan, S.J. Dillon	The AWRI Wine Microorganism Culture Collection: securing the future of Australian wine microorganisms		
A.G. Cordente, M.R. Solomon, C.E. Bartel, A. Schulkin, S.A. Schmidt	A rose by any other name: novel wine yeast that impart floral aromas		
L.A. Hartmann, S.A. Schmidt, A.R. Borneman	Bioprospecting the regional diversity of Australian wine microbiota		
T.M. Parker, A.M. Barker, J.L. Hixson, I.L. Francis	Phenolic-free glycosides from grape marc can increase wine flavour		
S. Sawyer[16], R. Longo[16], M.R. Solomon, L. Nicolotti, H. Westmore[16], A. Merry[16], G. Gnoinski[16], A.L. Ylia, R.G. Dambergs, F.L. Kerslake[16]	Is it the age or the autolysis? Pulling apart where sparkling wine character comes from		
R. Gawel, A. Schulkin, J.M. McRae, J. Hack, W.P. Pearson, D. Espinase Nandorfy, P.A. Smith[15]	Beyond phenolic bitterness: tryptophol-bisulfites identified as a potential new class of bitter compounds in white wine		
S.R. Barter, R.G.V. Bramley[1], M.P. Krstic, T.E. Siebert, M.J. Herderich	Unravelling the complex pattern of 'pepperiness' in cool-climate Shiraz		
M.P. Day, D.L. Capone[18], E.O. Bilogrevic, D. Espinase Nandorfy, S. Kassara, F.T. Watson, I.L. Francis, K.A. Bindon	Whole bunch fermentation of Shiraz and Pinot Noir: influence on 'green' characters and astringency		
R. Gawel, A. Schulkin, D. Espinase Nandorfy, P.A. Smith[15], J.M. McRae	The effect of dissolved carbon dioxide on the taste and texture of still wine		
K.M. Cuijvers, R. Sanders[8,18], A.C. Kulcsar, M.Z. Bekker, D.L. Capone[8,18], D. Espinase Nandorfy, D.W. Jeffery[8,18], S.A. Schmidt	The effect of pre-ferment glutathione addition on Chardonnay and Riesling wine characteristics		
E.O. Bilogrevic, D. Espinase Nandorfy, P.O. Williamson, D. Likos, I.L. Francis	Shiraz, Sangiovese or Saperavi? Consumer preferences for alternative red wine varieties assessed using projective mapping		
A.C. Kulcsar, A. Faucon[23], P.A. Smith[15], M.Z. Bekker	Stopping the stink: an evaluation of five common 'reductive' aroma remediation strategies		
D. Espinase Nandorfy, T.E. Siebert, E.O. Bilogrevic, L. Pisaniello, D. Likos, I.L. Francis	What causes apricot aroma in white wines? Unravelling the contribution of multiple volatile compounds		
M.Z. Bekker, G. Kreitman[24], D.W. Jeffery[8], J. Danilewicz[25]	Polysulfanes as latent sources of hydrogen sulfide during wine storage		
R. Longo[16], R.G. Dambergs [16,26], M.R. Solomon, L. Nicolotti, A.L. Ylia, H. Westmore[16], A. Merry[16], G. Gnoinski[16], F.L. Kerslake[16]	Manipulation of yeast autolysis by physical treatments: effects on volatile profiles of Méthode Champenoise sparkling wines		
M.R. Solomon, P.R. Petrie[7], D.L. Capone[18], D. Espinase Nandorfy, E.O. Bilogrevic, I.L. Francis, J.L. Hixson	Tropical enhancement through topical application: tailoring wine style by foliar application of nitrogen and sulfur		
J. Hildebrandt, M. de Barros Lopes[14], J.L. Hixson	Understanding the chemical basis of jam character in red wine and grapes		
C. Szeto[8,18], V. Pagay[8,18], R. Ristic[8,18], W. Jiang, J.A. Culbert, M.J. Herderich, K. Wilkinson[8,18]	Does in-canopy misting mitigate the intensity of smoke taint in grapes and wine?		
T.M. Parker, C. Onetto, J.L. Hixson, M.J. Herderich, M. de Barros Lopes[14], I.L. Francis	Glycoside flavour release in-mouth: the role of oral bacterial populations		
Y. Grebneva, C.A. Black[27], P.R. Petrie[7], M.P. Krstic, M.J. Herderich, J.L. Hixson	Manipulating bunch zone light quality to optimise ageing potential of Riesling wine		

Staff	Title of poster	Presented at	Date
J.L. Hixson, S. Kassara, P.A. Smith[15], K.A. Bindon	Maceration additions of marc differently modulate Shiraz wine texture depending on grape harvest timing	17th AWITC, Adelaide, SA	21–24 Jul 2019
S. van den Heuvel, S. McKay[7], B. Hall[7], A.R. Borneman	Molecular-based testing of fungicide resistance in grapevine pathogens		
Q. Wu, M. Schoeman, A.R. Rinaldo, N. Habili	Elimination of grapevine viruses *in vitro* using a combination of thermotherapy and chemotherapy		
N. Habili, Q. Wu, A.R. Rinaldo, M.L. Longbottom, A.J. Hoare	Potential risks associated with top-working a desirable grape-vine variety onto an unwanted non-symptomatic variety		
M. Essling, P.R. Petrie[7,8,9]	Analysing spray diaries to understand powdery mildew control in Australian viticulture		
Q. Wu, N. Habili, A.R. Rinaldo, C. Kinoti[28], F. Constable[28], S. Tyerman[8]	Molecular epidemiology and physiology of Shiraz disease in South Australia		
M.P. Day, C. Warwyk[1], J. Kirby[1], E.N. Wilkes	Does the type or origin of bottle glass affect boron isotope ratios used for wine authentication?		
K.C. Hirlam, T.J. Abbott[1], N. Scrimgeour, E.N. Wilkes	A new screening method for H_2S formation in wine samples		
E.N. Wilkes, M. Wheal	A periodic table of wine composition		
E.N. Wilkes, B. Newell	Impact of storage conditions on SO_2 and colour of packaged wines		
E.N. Wilkes, P.W. Godden, S. Guy[15], L. Hoxey, B. van Eyssen[15]	Trends in Australian wine composition		
S. Li[29], L. Schmidtke[29], A. Hall[29], W.P. Pearson, I.L. Francis, U. Vrhovsek[30], S. Carlin[30], J. Blackman[29]	Unravelling regional typicality of Australian premium Shiraz through an untargeted metabolomics approach		
R.G. Dambergs, W. Jiang, S. Nordestgaard, E.N. Wilkes, P.R. Petrie[7,8,9]	Hyperspectral imaging of *Botrytis* in grapes		
M.P. Day, C. Wright[1], C. Warwyk[1], J. Kirby[1], E.N. Wilkes	Australian wine provenance testing using novel isotope ratios: differentiation of production regions and country		
N. Kontoudakis[29], M. Smith, P.A. Smith[15], E.N. Wilkes, A.C. Clark[29]	The colorimetric measurement of total Cu concentration in wine		
J.A. Culbert, W. Jiang, M.P. Krstic, M.J. Herderich	Evaluating activated carbon products for removal of phenols and their glycoconjugates from smoke-affected juice and wine		
M.P. Day, C. Wright[1], J. Kirby[1], E.N. Wilkes	Does bentonite fining in white wines compromise the utility of lead isotope ratios in wine provenance testing?		
P.W. Godden	Sooty mould and its impact on wine processing, composition and sensory attributes		
K.C. Hirlam, N. Scrimgeour, E.N. Wilkes	Using cross-linked polymers to reduce metal concentrations in commercial wines		
N. Scrimgeour, K.C. Hirlam, A.C. Clark[29], N. Kodoudakis[29], E.N. Wilkes	Evaluating the forms of copper removed during cross-linked polymer treatment of wines		
G. Gnoinski[16], B. Lima[3], K.S. Howell[3], C.G. Viejo[3], S. Fuentes[3], S.A. Schmidt, D. Close[16], F.L. Kerslake[16]	Influences of traditional and novel winemaking practices on foaming properties of sparkling wine		
N.D.R. Lloyd, C.S. Stockley, M.R. Solomon, E. Kristianto, M.J. Herderich	Monitoring the effects of resveratrol-enhanced de-alcoholised red wine consumption by LC-QTOF-MS		
C.E. Bartel, C.A. Varela, A.R. Borneman	Is *Brettanomyces bruxellensis* becoming more SO_2 tolerant in industry?		
N. Scrimgeour, K.C. Hirlam, E.N. Wilkes	Extending the shelf life of commercial canned wines through manipulation of transition metals content		
Y. Hayasaka, G.D. Cowey, A.D. Coulter	A tool for catching mice in wine: the detection of mousy off-flavour compounds in wine		

Staff	Title of poster	Presented at	Date
N. Scrimgeour, K.C. Hirlam, L.E. Bey, T.J. Abbott[1], E.N. Wilkes	Understanding the development of reductive compounds in commercial canned wines	17th AWITC, Adelaide, SA	21–24 Jul 2019
S. Nordestgaard, E.N. Wilkes	Cold stabilisation: past and present		
S. Nordestgaard	Tannin extracts and oak alternatives: past and present		
	Flotation: past and present		
S. Nordestgaard, T.J. Abbott[1]	In-tank fermentation monitoring: past and present		
S. Nordestgaard	Filtration: past and present		
	Mixing red ferments using gas: past and present		
	Tank design: past and present		
	Continuous processes and fermentation: past and present		
S. Nordestgaard, E.N. Wilkes	Heat stabilisation: past and present		
S. Nordestgaard	Centrifugation: past and present		
E.O. Bilogrevic, D. Espinase Nandorfy, P.O. Williamson, D. Likos, I.L. Francis	Using projective mapping based on choice to untangle consumer attitudes to unfamiliar red wine types	13th Pangborn Sensory Science Symposium, Edinburgh, UK	28 Jul–1 Aug 2019

Affiliations of non-AWRI authors: [1]CSIRO, [2]Fight Food Waste Cooperative Research Centre, [3]University of Melbourne, [4]Mornington Peninsula Vignerons Association, [5]Peninsula Vinecare, [6]Yalumba Nursery, [7]SARDI, [8]University of Adelaide, [9]UNSW, [10]University of British Columbia, Canada, [11]Michael Smith Genome Sciences Centre, Canada, [12]Macquarie University, [13]Università Cattolica del Sacro Cuore, Italy, [14]University of South Australia, [15]Wine Australia, [16]Tasmanian Institute of Agriculture, [17]University of Tasmania, [18]ARC Training Centre for Innovative Wine Production, [19]Lallemand Australia, [20]Chalmers Wines Australia Pty Ltd, [21]Centre for Aboriginal Economic Policy Research, Australian National University, [22]Pernod Ricard Winemakers, [23]Montpellier SupAgro, France, [24]New Jersey, USA, [25]Canterbury, UK, [26]Wine TQ Consulting, [27]BDG Synthesis, New Zealand, [28]Agriculture Victoria, Department of Jobs, Precincts and Regions, [29]National Wine and Grape Industry Centre, [30]Fondazione Edmund Mach, Italy

APPENDIX 4

Teaching responsibilities (lectures) of AWRI staff

Institution	Subject number	Subject name	No of lectures	Staff member
University of Adelaide	3046WT/7046WT	Fermentation technology	2	I.L. Francis
			1	E.N. Wilkes
	3003WT/7004WT	Wine packaging and quality management	1	
	7038WT	Viticultural methods and procedures	1	M. Essling
	2502WT	Sensory studies II	1	G.D. Cowey

APPENDIX 5

Student supervision responsibilities of AWRI staff

Student	Supervisors	Source of funds
PhD		
Lisa Hartmann	A.R. Borneman, S.A. Schmidt	University of Adelaide, Wine Australia
Jana Hildebrandt	J.L. Hixson, I.L. Francis, M.J. Herderich, M.A. de Barros Lopes[1]	Wine Australia, Australian Government Research Training Program Scholarship
Yevgeniya Grebneva	M.J. Herderich, J.L. Hixson, M. Stoll[2], D. Rauhut[2]	Hochschule Geisenheim University, AWRI
Wes Pearson	I.L. Francis, J. Blackman[3], L. Schmidtke[3]	Wine Australia
Stipe Zekanovic	S.A. Schmidt, I. Dawes[4], G. Perrone[5]	Wine Australia, Western Sydney University
Gail Gnoinski	S.A. Schmidt, D. Close[6], F.L. Kerslake[6]	University of Tasmania
Colleen Szeto	K.L. Wilkinson[7], V. Pagay[7], M.J. Herderich	ARC Training Centre for Innovative Wine Production, University of Adelaide
Naomi Verdonk	K.L. Wilkinson[7], K. Pearce[1], R. Ristic[7], J.A. Culbert	University of Adelaide, Wine Australia
Yihe (Eva) Sui	K.L. Wilkinson[7], P.W. Godden, K.A. Bindon	University of Adelaide
Andres Zhou Tsang	M. Walker[8], M. Gilliham[7], A.R. Borneman	ARC Training Centre for Innovative Wine Production, University of Adelaide
Qi Wu	S.D. Tyerman[7], N. Habili, F.E. Constable[9], A.R. Rinaldo	University of Adelaide, Wine Australia
Damian Espinase Nandorfy	I.L. Francis, R. Keast[10], R. Shellie[10], J. Bekkers[11]	Wine Australia

Affiliations of non-AWRI supervisors: [1]University of South Australia, [2]Hochschule Geisenheim University, Germany, [3]Charles Sturt University, [4]UNSW, [5]Western Sydney University, [6]University of Tasmania, [7]University of Adelaide, [8]CSIRO, [9]Agriculture Victoria, [10]Deakin University, [11]Australian National University

APPENDIX 6

Media interviews

Date	Staff member	Discussed	Media
5 Jul 2019	D.L. Johnson	Shipwreck yeast and 'The Wreck' beer	*FiveAA*
10 Jul 2019	M.P. Krstic	Vine pruning workshop	Shane Douthie, *Wangaratta Chronicle*
22 Jul 2019	M.L. Longbottom	Sustainable Winegrowing Australia	Andrew Spence, *The Lead South Australia*
24 Jul 2019	A.R. Rinaldo	Co-location of brewing activities in wineries	Paul LeLacheur, *Australian & New Zealand Grapegrower & Winemaker*
5 Aug 2019	K.A. Bindon	Grape and wine R&D	Bianca Nogrady, *Freelance science journalist*
9 Aug 2019	M.L. Longbottom	Sustainable Winegrowing Australia	Sandra Taylor, *Wine Review Online*
19 Aug 2019	P.W. Godden	AWRI research	Clint Carter, *Men's Journal, Men's Health, Wall Street Journal, New York Magazine* Kiera Carter, *Marie Claire, Women's Health, Shape*

Date	Staff member	Discussed	Media
3 Sep 2019	D.L. Johnson	New infrastructure funding for metabolomics	Paula Thompson, *The Advertiser*
4 Sep 2019			Paul LeLacheur, *Australian & New Zealand Grapegrower & Winemaker*
18 Sep 2019	T.M. Parker	Glycoside research, UniSA PhD experience and Australian Women in Wine Awards	Cyndal King and Candy Gibson, *UniSA News*
	M.L. Longbottom	Carbon footprint of wine	Kelly Pigram, *The Guardian Australia*
23 Oct 2019	M.P. Krstic	Glyphosate	Jamie Goode, *Meininger's Wine Business International*
		Transfer of volatiles from plants near vineyards	Kerana Todorov, *Wine Business Monthly*
30 Oct 2019		Regional Program	Jacquie van Santen, *Wine Australia RD&E news*
31 Oct 2019	D.L. Johnson	The AWRI's impact and future challenges	Richard Whitehead, *Beverage Daily*
22 Nov 2019	M.L. Longbottom	Sustainable Winegrowing Australia	Sophie Taylor-Price, *sophietaylorprice.com.au*
25 Nov 2019		Sustainable production of grapes and wine	Allison Jess, *ABC national radio*
		Impacts and responses to climate change	Olivia Gagan, *Raconteur*
3 Dec 2019	C.A. Simos	50th Advanced Wine Assessment Course	Samuel Squire, *Australian & New Zealand Grapegrower & Winemaker*
24 Dec 2019		Recent fires and smoke events	Max Allen, wine writer
14 Jan 2020	M.P. Krstic	Smoke research at the AWRI	Mike Cherney, *Wall Street Journal*
16 Jan 2020	M.J. Herderich	New research on early-season smoke exposure with Adelaide Hills producers	Andrew Spence, *The Lead SA*
22 Jan 2020	M.P. Krstic	Smoke research at the AWRI	Mike Cherney, *Wall Street Journal*
			Richard Whitehead, *BeverageDaily*
24 Jan 2020	N.D.R. Lloyd	Metabolomics approaches to smoke taint research	Jacquie van Santen, *Wine Australia RD& E News*
31 Jan 2020	W.P. Pearson	Terroir project	
11 Feb 2020	S. Nordestgaard	Winery automation and wineries of the future	Samuel Squire, *Australian & New Zealand Grapegrower & Winemaker*
20 Feb 2020	M.P. Krstic	Managing Director role and the importance of research for the wine-grape industry	Christine Webber, *Murray Valley Winegrowers News & Views*
26 Feb 2020		Smoke taint testing	Prue Adams, *ABC Landline*
			Paula Thompson, *The Advertiser*
28 Feb 2020			David Sly, *Decanter UK*
	C.A. Simos	Smoke taint	Isabella Pittaway, *ABC Country Hour*
27 Mar 2020	J.A. Culbert	Dilution of smoke-affected wine	Jacquie van Santen, *Wine Australia RD& E News*
20 Apr 2020	M.P. Krstic	Smoke taint	Bryce Eishold, *Stock and Land*
21 Apr 2020	G.D. Cowey, C.A. Simos, E.N. Wilkes	Smoke taint testing	Steve Leszczynski, *QWineReviews.com*
11 May 2020	K.A. Bindon	Nanotechnology for protein stabilisation	Belinda Willis, *The Lead SA*
12 May 2020			Bridget Hermann, *ABC South East*
13 May 2020			Rita Erlich, *Travel Writers Radio*
25 May 2020	M.L. Longbottom	Carbon farming and climate change	Andrew Graham, *Australian Wine Review*

APPENDIX 7

Papers published by AWRI staff recorded during 2019/2020

2109 Essling, M. Ask the AWRI: Regulatory changes to the use of botrytis agrochemical. *Aust. N.Z. Grapegrower Winemaker* (668): 48-49; 2019.

2110 Bindon, K.A., Kassara, S., Solomon, M., Bartel, C., Smith, P.A., Barker, A., Curtin, C. Commercial *Saccharomyces cerevisiae* yeast strains significantly impact Shiraz tannin and polysaccharide composition with implications for wine colour and astringency. *Biomolecules* 9(9): 466; 2019.

2111 Coulter, A., Cowey, G., Essling, M., Hoare, T., Holdstock, M., Longbottom, M., Simos, C., Johnson, D. Vintage 2019 – observations from the AWRI helpdesk. *Wine Vitic. J.* 34(4): 27-29; 2019.

2112 Dry, P. Corvina. *Wine Vitic. J.* 34(4): p. 59; 2019.

2113 Stanstrup, J., Broeckling, C.D., Helmus, R., Hoffmann, N., Mathé, E., Naake, T., Nicolotti, L., Peters, K., Rainer, J., Salek, R.M., Schulze, T., Schymanski, E.L., Stravs, M.A., Thévenot, E.A., Treutler, H., Weber, R.J.M., Willighagen, E., Witting, M., Neumann, S. The metaRbolomics Toolbox in Bioconductor and beyond. *Metabolites* 9(10): 200; 2019.

2114 Ratnayake, S., Stockdale, V., Grafton, S., Munro, P., Robinson, A.L., Pearson, W., McRae, J.M., Bacic, A. Carrageenans as heat stabilisers of white wine. *Aust. J. Grape Wine Res.* 25(4): 439-450; 2019.

2115 Walker, R.R., Blackmore, D.H., Clingeleffer, P.R., Holt, H., Pearson, W., Francis, I.L. Effect of rootstock on yield, grape composition and wine sensory attributes of Shiraz grown in a moderately saline environment. *Aust. J. Grape Wine Res.* 25(4): 414-429; 2019.

2116 Parker, M., Onetto, C., Hixson, J., Bilogrevic, E., Schueth, L., Pisaniello, L., Borneman, A., Herderich, M., de Barros Lopes, M., Francis, L. Factors contributing to interindividual variation in retronasal odor perception from aroma glycosides: the role of odorant sensory detection threshold, oral microbiota and hydrolysis in saliva. *J. Agric. Food Chem.* 68(38): 10299-10309; 2020.

2117 Cowey, G. Ask the AWRI: What does the latest research say about barrel sanitation against Brett? *Aust. N.Z. Grapegrower Winemaker* (669): 76-77; 2019.

2118 Romanini, E., McRae, J.M., Colangelo, D., Lambri, M. First trials to assess the feasibility of grape seed powder (GSP) as a novel and sustainable bentonite alternative. *Food Chem.* 305: 125484; 2019.

2119 Longbottom, M. Ask the AWRI: Sustainable Winegrowing Australia. Supporting the nation's growers and winemakers in demonstrating and improving their sustainability. *Aust. N.Z. Grapegrower Winemaker* (670): 45-46; 2019.

2120 Scrimgeour, N., Wilkes, E., Bartowsky, E. Making sense of yeast assimilable nitrogen (YAN). *Aust. N.Z. Grapegrower Winemaker* (670): 47-50; 2019.

2121 Wilkes, E., Wheal, M. Elements of wine … nearly every known naturally occurring element has been found in at least some wines… *Chem. Aust.* (November/December): p. 37; 2019.

2122 Pearson, W., Schmidtke, L., Francis, I.L., Blackman, J.W. An investigation of the Pivot© Profile sensory analysis method using wine experts: comparison with descriptive analysis and results from two expert panels. *Food Qual. Pref.* 83: 103858; 2019.

2123 Hirlam, K., Scrimgeour, N., Wilkes, E. The impact of temperature fluctuations on closure performance. *Aust. N.Z. Grapegrower Winemaker* (671): 59-61; 2019.

2124 Godden, P. Ask the AWRI: Grape solids in white winemaking. *Aust. N.Z. Grapegrower Winemaker* (671): 73-74; 2019.

2125 Johnson, D. 2019 Report. *Aust. N.Z. Grapegrower Winemaker* (671): 4p.; 2019.

2126 Watson, F.T., Smernik, R.J., Doolette, A.L. Thermal degradation of phytate produces all four possible inositol pentakiphosphates as determined by ion chromatography and ^{1}H and ^{31}P NMR spectroscopy. *Phosphorus Sulfur Silicon Relat. Elem.* 194(12): 1140-1148; 2019.

2127 Luo, M., Li, H., Chakraborty, S., Morbitzer, R., Rinaldo, A., Upadhyaya, N., Bhatt, D., Louis, S., Richardson, T., Lahaye, T., Ayliffe, M. Efficient TALEN-mediated gene editing in wheat. *Plant Biotechnol. J.* 17(11): 2026-2028; 2019.

2128 Robinson, S.P., Pezhmanmehr, M., Speirs, J., McDavid, D.A.J., Hooper, L.C., Rinaldo, A.R., Bogs, J., Ebadi, A., Walker, A.R. Grape and wine flavonoid composition in transgenic grapevines with altered expression of flavonoid hydroxylase genes. *Aust. J. Grape Wine Res.* 25(3): 293-306; 2019.

2129 Kang, W., Muhlack, R.A., Bindon, K.A., Smith, P.A., Niimi, J., Bastian, S.E.P. Potato protein fining of phenolic compounds in red wine: A study of the kinetics and the impact of wine matrix components and physical factors. *Molecules* 24(24): 4578; 2019.

2130 Miercynska-Vasilev, A., Qi, G., Bindon, K., Vasilev, K. Regeneration of magnetic nanoparticles used in the removal of pathogenesis-related proteins from white wines. *Foods* 9(1): 1; 2020.

2131 Simos, C., Krstic, M. I can smell smoke – now what? *Aust. N.Z. Grapegrower Winemaker* (672): 28-31; 2020.

2132 Hoare T. Ask the AWRI: Reworking vineyards. *Aust. N.Z. Grapegrower Winemaker* (672): 49-50; 2020.

2133 Bindon, K., Kassara, S., Nandorfy, D.E., Nicolotti, L., Do, Z., Johnson, D. Identifying objective measures for Barossa Valley Shiraz grapes. *Wine Vitic. J.* 35(1): 31-34; 2020.

2134 Dry, P. Chenin Blanc. *Wine Vitic. J.* 35(1): p. 61; 2020.

2135 Essling, M. Ask the AWRI: Spray application. *Aust. N.Z. Grapegrower Winemaker* (673): 36-37; 2020.

2136 Godden, P. Tasting compares six wines sealed with both corks and screwcaps. *Aust. N.Z. Grapegrower Winemaker* (673): 62-65; 2020.

2137 Onetto, C.A., Borneman, A.R., Schmidt, S.A. Investigating the effects of *Aureobasidium pullulans* on grape juice composition and fermentation. *Food Microbiol.* 90: 103451; 2020.

2138 Schmidt, S.A., Kolouchova, R., Forgan, A.H., Borneman, A.R. Evaluation of *Saccharomyces cerevisiae* wine yeast competitive fitness in enologically relevant environments by barcode sequencing. *G3: Genes, Genomes, Genetics* 10(2): 591-603; 2020.

2139 Gawel, R., Schulkin, A., Smith, P.A., Espinase, D., McRae, J.M. Effect of dissolved carbon dioxide on the sensory properties of still white and red wines. *Aust. J. Grape Wine Res.* 26(2): 172-179; 2020.

2140 Coulter A. Ask the AWRI: Discrepancies in analytical results for volatile acidity. *Aust. N.Z. Grapegrower Winemaker* (674): p. 64; 2020.

2141 Roach, M.J., Borneman, A.R. New genome assemblies reveal patterns of domestication and adaption across *Brettanomyces* (*Dekkera*) species. *BMC Genomics* 21: 194; 2020.

2142 Mosinska, M., Stepińska, N., Maniukiewicz, W., Rogowski, J., Mierczynska-Vasilev, A., Vasilev, K., Szynkowska, M.I., Mierczynski, P. Hydrogen production on Cu-Ni catalysts via the oxy-steam reforming of methanol. *Catalysts* 10: 273; 2020.

2143 Verdonk, N., Ristic, R., Culbert, J., Pearce, K., Wilkinson, K. Understanding Australian wine consumers' preferences for different sparkling wine styles. *Beverages* 6: 14; 2020.

2144 Kontoudakis, N., Smith, M., Smith, P.A., Wilkes, E.N., Clark, A.C. The colorimetric determination of copper in wine: total copper. *Aust. J. Grape Wine Res.* 26(2): 121-129; 2020.

2145 Teng, B., Petrie, P.R., Smith, P.A., Bindon, K.A. Comparison of water addition and early-harvest strategies to decrease alcohol concentration in *Vitis vinifera* cv. Shiraz wine: impact on wine phenolics, tannin composition and colour properties. *Aust. J. Grape Wine Res.* 26(2): 158-171; 2020.

2146 Longbottom, M. Ask the AWRI: Promoting grapevine recovery after fire damage. *Aust. N.Z. Grapegrower Winemaker* (675): 66-67; 2020.

2147 Scrimgeour, N., Almond, T., Wilkes, E. Is KPA the magic bullet for tartrate instability in wines? *Aust. N.Z. Grapegrower Winemaker* (675): 68-70; 2020.

2148 Petrie, P.R., Jiang, W., Bindon, K.A., Sadras, V.O. When do grapes stop accumulating sugar? Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 17th Australian Wine Industry Technical Conference: Adelaide, South Australia, 21–24 July 2019*. Urrbrae, SA: The Australian Wine Industry Technical Conference Inc.: 37-39; 2020.

2149 Culbert, J.A., Jiang, W., Krstic, M.P., Herderich, M.J. Evaluating activated carbons for removal of phenols and their glycosides from smoke-affected juice and wine. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 17th Australian Wine Industry Technical Conference: Adelaide, South Australia, 21–24 July 2019*. Urrbrae, SA: The Australian Wine Industry Technical Conference Inc.: 45-48; 2020.

2150 Bartel, C.E., Borneman, A.R., Curtin, C.D., Varela, C.A. Is *Brettanomyces bruxellensis* becoming more SO_2 tolerant in industry? Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 17th Australian Wine Industry Technical Conference: Adelaide, South Australia, 21–24 July 2019*. Urrbrae, SA: The Australian Wine Industry Technical Conference Inc.: 50-51; 2020.

2151 Sawyer, S., Longo, R., Solomon, M. Nicoletti, L. Westmore, H., Merry, A., Gnoinski, G., Ylia, A., Dambergs, R., Kerslake, F. Is it age or the autolysis? Pulling apart where sparkling wine character comes from. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 17th Australian Wine Industry Technical Conference: Adelaide, South Australia, 21–24 July 2019*. Urrbrae, SA: The Australian Wine Industry Technical Conference Inc.: 52-55; 2020.

2152 Pearson, W., Schmidtke, L., Francis, L., Li, S., Blackman, J., Carr, T. Understanding the role of regionality in Shiraz – sensory and chemical profiles of Shiraz wines from six different regions. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 17th Australian Wine Industry Technical Conference: Adelaide, South Australia, 21–24 July 2019*. Urrbrae, SA: The Australian Wine Industry Technical Conference Inc.: 75-77; 2020.

2153 Day, M.P., Capone, D.L., Kassara, S., Bilogrevic, E.O., Espinase Nandorfy, D., Watson, F.T., Francis, I.L., Bindon, K.A. Whole bunch fermentation of Shiraz and Pinot Noir: influence on 'green' characters and astringency. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 17th Australian Wine Industry Technical Conference: Adelaide, South Australia, 21–24 July 2019*. Urrbrae, SA: The Australian Wine Industry Technical Conference Inc.: 94-96; 2020.

2154 Bekker, M.Z., Espinase Nandorfy, D., Kulcsar, A.C., Faucon, A., Smith, P.A. Remediating 'reductive' characters in wine. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 17th Australian Wine Industry Technical Conference: Adelaide, South Australia, 21–24 July 2019*. Urrbrae, SA: The Australian Wine Industry Technical Conference Inc.: 97-99; 2020.

2155 Roach, M.J., Johnson, D.L., Bohlmann, J., van Vuuren, H.J.J., Jones, S.J.M., Pretorius, I.S., Schmidt, S.A., Borneman, A.R. Population sequencing reveals clonal diversity and ancestral inbreeding in the grapevine cultivar Chardonnay. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 17th Australian Wine Industry Technical Conference: Adelaide, South Australia, 21–24 July 2019*. Urrbrae, SA: The Australian Wine Industry Technical Conference Inc.: 111-114; 2020.

2156 Nordestgaard, S., Wilkes, E.N. Inspirations from the past and opportunities for the future. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 17th Australian Wine Industry Technical Conference: Adelaide, South Australia, 21–24 July 2019*. Urrbrae, SA: The Australian Wine Industry Technical Conference Inc.: 115-124; 2020.

2157 McRae, J.M. New techniques and technologies for wine protein stabilisation. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 17th Australian Wine Industry Technical Conference: Adelaide, South Australia, 21–24 July 2019*. Urrbrae, SA: The Australian Wine Industry Technical Conference Inc.: 125-126; 2020.

2158 Bindon, K.A., Teng, B., Smith, P.A., Espinase Nandorfy, D., Solomon, M., Petrie, P.R. Winemaking with high Baume juice: optimising fermentation and extraction. Beames, K.S., Robinson, E.M.C., Dry, P.R., Johnson, D.L. (eds.) *Proceedings of the 17th Australian Wine Industry Technical Conference: Adelaide, South Australia, 21–24 July 2019*. Urrbrae, SA: The Australian Wine Industry Technical Conference Inc.: 131-133; 2020.

2159 Delgado, L., Parker, M., Fisk, I., Paradisi, F. Performance of the extremophilic enzyme *BglA* in the hydrolysis of two aroma glucosides in a range of model and real wines and juices. *Food Chem.* 323: 126825; 2020.

2160 Scrimgeour, N., Hirlam, K., Bey, L., Wilkes, E. Extending the shelf life of canned wines. *Aust. N.Z. Grapegrower Winemaker* (674): 68-70; 2020.

2161 Carew, A.L., Kerslake, F.L., Bindon, K.A., Smith, P.A., Close, D.C., Dambergs, R.G. Viticultural and controlled phenolic release treatments affect phenolic concentration and tannin composition in Pinot noir wine. *Am. J. Enol. Vitic.* doi:10.5344/ajev.2020.19003: 1-29; 2020.

2162 Day, M., Bindon, K., Capone, D., Kassara, S., Bilogrevic, E., Espinase Nandorfy, D., Watson, F., Francis, L., Krstic, M. Going green with whole bunches. *Wine Vitic. J.* 35(2): 29-30; 2020.

2163 Dry, P. Carignan. *Wine Vitic. J.* 35(2): p. 50; 2020.

2164 Godden, P. Ask the AWRI: Pre-fermentation skin contact. *Aust. N.Z. Grapegrower Winemaker* (676): 52-53; 2020.

2165 Nordestgaard, S. Inspirations from the past and opportunities for the future. Part 1: Crossflow filtration and flotation. *Aust. N.Z. Grapegrower Winemaker* (676): 58-63; 2020.

2166 Visalakshan, R.M., González García, L.E., Benzigar, M.R., Ghazaryan, A., Simon, J., Mierczynska-Vasilev, A., Michl, T.D., Vinu, A., Mailänder, V., Morsbach, S., Landfester, K., Vasilev, K. The influence of nanoparticle shape on protein corona formation. *Small* 2000285; 2020.

2167 Longbottom, M. Ask the AWRI: Understanding the factors that influence grapevine yield. *Aust. N.Z. Grapegrower Winemaker* (677): 34-35; 2020.

2168 Nordestgaard, S. Inspirations from the past and opportunities for the future. Part 2: In-tank fermentation monitoring and continuous processes. *Aust. N.Z. Grapegrower Winemaker* (677): 50-56; 2020.

2169 Pereira-Caro, G., Gaillet, S., Mena, P., Bresciani, L., Bindon, K.A., Del Rio, D., Rouanet, J.-M., Moreno-Rojas, J.M., Crozier, A. Bioavailability of red wine and grape seed proanthocyanidins in rats. *Food Funct.* 11: 3986-4001; 2020.

2170 Hixson, J., Bilogrevic, E., Capone, D., Espinase Nandorfy, D., Francis, L., Petrie, P., Solomon, M., Krstic, M. Enhancing tropical fruit flavour in Chardonnay and Shiraz through foliar nutrient sprays. *Wine Vitic. J.* 35(3): 30-33; 2020.

2171 Cuijvers, K., van den Heuvel, S., Varela, C., Rullo, M., Solomon, M., Schmidt, S., Borneman, A. Alterations in yeast species composition of uninoculated wine ferments by the addition of sulphur dioxide. *Fermentation* 6(2): 62; 2020.

2172 Cowey, G. Ask the AWRI: Amber wine. *Aust. N.Z. Grapegrower Winemaker* (678): 49-50; 2020.

2173 Nordestgaard, S. Inspirations from the past and opportunities for the future. Part 3: Volume measurement, product movements and gas adjustment. *Aust. N.Z. Grapegrower Winemaker* (678): 66-68, 70-71; 2020.

2174 Roach, M.J., Borneman, A.R., Schmidt, S.A. Origin of Chardonnay clones with historical significance in Australia and California. *Aust. J. Grape Wine Res.* 26(4): 358-362; 2020.

2175 Wu, Q., Habili, N., Constable, F., Al Rwahnih, M., Goszczynski, D.E., Wang, Y., Pagay, V. Virus pathogens in Australian vineyards with an emphasis on Shiraz disease. *Viruses* 12: 818; 2020.

2176 Coulter, A. Ask the AWRI: DMDC – an insurance policy. *Aust. N.Z. Grapegrower Winemaker* (679): 52-53; 2020.

2177 Moate, P.J., Jacobs, J.L., Hixson, J.L., Deighton, M.H., Hannah, M.C., Morris, G.L., Ribaux, B.E., Wales, W.J., Williams, S.R.O. Effects of feeding either red or white grape marc on milk production and methane emissions from early-lactation dairy cows. *Animals* 10(6): 976; 2020.

2178 Szeto, C., Ristic, R., Capone, D., Puglisi, C., Pagay, V., Culbert, J., Jiang, W., Herderich, M., Tuke, J., Wilkinson, K. Uptake and glycosylation of smoke-derived volatile phenols by Cabernet Sauvignon grapes and their subsequent fate during winemaking. *Molecules* 25(16): 3720; 2020.

2179 Longo, R., Pearson, W., Merry, A., Solomon, M., Nicolotti, L., Westmore, H., Dambergs, R., Kerslake, F. Preliminary study of Australian Pinot noir wines by colour and volatile analyses, and the Pivot© Profile method using wine professionals. *Foods* 9(9): 1142; 2020.

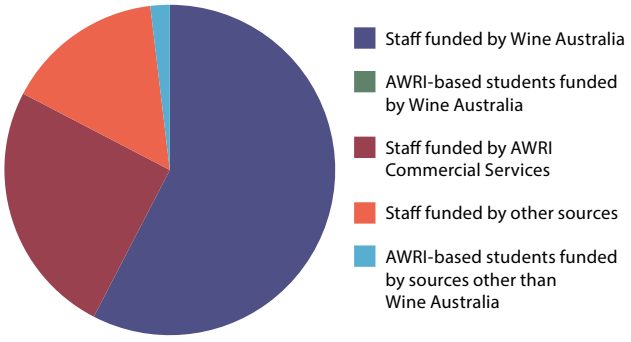
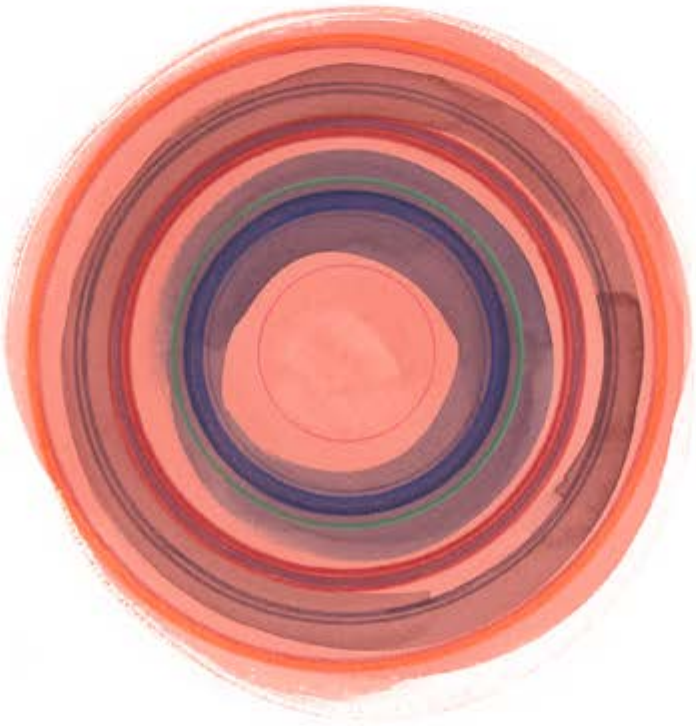


Figure 29. Funding of AWRI staff and students, excluding visiting researchers and visiting students


AWRI
STAFF
2020



awri.com.au