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Translation of *Training Centre for Innovative Wine Production* Research into Industry Outcomes



FINAL REPORT TO WINE AUSTRALIA

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UA 1708: Translation of Training Centre for Innovative Wine Production Research into Industry Outcomes

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1. Abstract

The ARC TC-IWP 1 and 2 were established at UA with support from industry partners and Wine Australia. Project UA 1708, an extension of UA 1304 that supported TC-IWP 1, aimed to achieve synergistic collaborations between participants and projects, and to expedite translation of TC-IWP research into industry outcomes. It helped make better use across projects of scientific and industrial expertise and the contributions and facilities of UA, CSU, scientific organisations and industry partners. Outcomes of our suite of industry-relevant projects were widely shared with the broader industry stakeholder population, particularly via Centre seminars, technical workshops and myriad publications.

2. Executive summary

Through project UA 1708, our research outcomes have been disseminated to thousands of domestic and international, scientific and wine industry personnel, resulting in a greater awareness of the newest research at the University of Adelaide (UA), Charles Sturt University (CSU), and in particular, within the Australian Research Council (ARC) Training Centre for Innovative Wine Production (TC-IWP or TC) 1 and 2. Dr Ristic supported the TC-IWPs by creating strong links between UA, CSU and key grape and wine companies and R&D organisations, which provided a rich and unique, world-class training environment for students (HDRs) and post-docs (PDFs) with a strong end-user focus. The reach of Centre projects ranged from vineyards to wine consumers, with synergistic efficiencies and joint outputs being created by fostering collaboration between projects. Only with the support of UA 1304/1708, was it possible to coordinate ~30, often disparate, research projects in TC1 and TC2 and to dynamically communicate research highlights to the scientific and industry audience. Project UA 1304 collated, interpreted and summarised outcomes from 13 projects into an integrated strategy for flavour and alcohol modulation, available to the industry via the Wine Australia and TC-IWP websites. Findings and recommendations from individual projects were disseminated to industry via trade articles (11), technical notes (10), industry seminars (TAS, NSW, SA; over 100 participants), a workshop at the 16th AWITC, annual reports, various industry reports and presentations at domestic and international symposia. In addition, some 40+ peer-reviewed publications were produced, mostly in 2018 and 2019 as the HDRs completed their projects. In regard to TC2, the recruitment process has taken longer than anticipated, a common challenge for all current TCs. Despite a slowed start, UA 1708 organised industry seminars in Margaret River and the Barossa Valley and a workshop at the 17th AWITC, where findings from both TC1 and TC2 were shared with the wine industry. Additionally, Dr Ristic identified research gaps and completed two projects that led to a more comprehensive range of recommendations for the wine industry.

3. Background

Following the success of the first TC-IWP, the Australian Research Council granted a further $4,459,672 in funding over five years (2018-2022), with an additional $11.6 million in cash and in-kind from research and industry partners. The proposed 20 projects in TC2 focus on industry-related issues that can be grouped as i) Response to the challenges of climate extremes, diseases and spoilage, water limitations and quality losses, and ii) Increasing profitability through the production of sought-after, distinct wines that fetch higher prices and/or are made through more efficient processes. An outstanding multi-disciplinary team of researchers and industry partners (most participants were part of both Centres) has been assembled, with a strong emphasis on commercialisation of outputs from all projects. Wine Australia supported TC1 and 2 by funding a senior PDF (UA 1304 and UA 1708), whose role was to create synergies across projects and collate, translate and disseminate research outcomes to the wine industry.

In the first round of TC-IWP projects, UA 1304 facilitated collaboration between the UA, CSU and 12 key TC participants. Research outcomes from 17 projects have been collated, interpreted and summarised in an *integrated strategy for flavour and alcohol modulation*. These results were disseminated to the wine industry through various extension mechanisms, including articles in industry journals, reports, seminars, workshops, and domestic and international symposia. The final *integrated strategy* described the series of incremental modulations across a series of techniques applied to produce high quality, lower alcohol wines. It included physiological and molecular mechanisms of grape berry cell death and smoke compound uptake, early harvest blending regimes, the use of *Saccharomyces* and non-*Saccharomyces* yeast strains, individual or combined additions of commercially available additives, and the effects of reverse osmosis/evaporative perstraction treatment on reduced alcohol wine composition and sensory properties. The research into the alcohol 'sweet spot' and wine consumers' acceptance and liking of wines with lower alcohol content has also been conducted. Thus through a coordinated approach to research, collaborations and contributions to the integrated strategy, UA 1304 built a strong and compact team around wine and grape research at the TC-IWP. Importantly the impact of this extends beyond the first TC-IWP: much to the sector's benefit, all our excellent graduates have been employed by national and international industry and research providers (e.g. TWE, DPI-VIC, CSU, UTas/TIAR, the University of Bordeaux, AEB, Australian Institute of Business, etc).

In the same manner, Project UA 1708 was directly involved in the conduct of research activities that utilised expertise and facilities of UA, CSU, research organisations and industry partners. By coordinating and facilitating collaboration between TC-IWP projects and their participants, strong emphasis was given to the translation of TC-IWP research outputs into industry-ready applications and dissemination of their highlights and recommendations.

4. Research objectives

The main aim of the project was to oversee research projects in the TC-IWP to ensure they could be assembled into integrated strategies (where appropriate) and the research outcomes disseminated to the wine industry.

The primary objectives of UA 1708 were to:

1. Build a strong, compact and collaborative research team with coordinated research trials so that resources, facilities and expertise in UA, CSU and partner organisations were shared within TC2. The aim was to achieve synergies enabling outputs of greater scope or extended investigation.
2. Link projects with a similar focus, i.e. grapevine response as a result of exposure to the stress caused by drought, salinity and smoke or projects that define the unique chemical and sensory properties of distinct Australian wines made through more efficient processes that reduce waste and costs, and drive profitability.
3. Drive the collation, interpretation and dissemination of outcomes from IWP-TC projects by various extension mechanisms, including articles in wine industry journals, industry seminars and workshops, and presentation of the TC-IWP integrated research at domestic and international conferences. This objective was pursued subject to the IP protection processes operating within the Centre.

5. Method

A wide range of methods has been used in various TC-IWP projects. In some cases, small scale winemaking was conducted, and grapes and wines were analysed for chemical composition, flavour

and sensory profiles, while other projects required gene expression studies, therefore material and methods were only briefly described below. Many outcomes from the TC-IWP projects have been published in scientific, industry journals or conference proceedings, hence, they are under copyright restriction. In this report, wherever applicable, reference is made to the relevant publications.

6. Results and Discussion

6.1. Collation, interpretation and dissemination of outcomes from IWP-TC projects

The main focus of UA 1708 was to collate and disseminate research outputs to scientific and industry audiences via various mechanisms, including a range of publications and presentations.

Publications
In 2018/19 nine articles (8 authored or co-authored by Dr Ristic) describing benefits of different methods used for the production of lower alcohol wines were published in the trade journals. The final TC-IWP 1 report, written by Dr Ristic, described benefits of various methods and recommendations that arose from TC research activities from 2014 to 2018. This report and the TC2 Activity Update 2018/19 were distributed to the government and funding bodies, industry partners and various members of the wine industry. There was a range of technical notes produced, including a note that summarised an integrated strategy for decreasing alcohol levels in wines. In addition, Dr Ristic authored or co-authored 5 scientific publications. All these documents are available online and the full list of publications is given in Attachment 1.

Presentations
The intent of UA 1708 and TC-IWP was to run many knowledge-sharing events in order to facilitate the transfer of research knowledge and outcomes for 'end-user benefit'. Each of those events were attended by industry practitioners who actively elected to attend and were eager to adopt TC-IWP findings and recommendations. At the same time they freely provided feedback and suggestions for future directions. This underlined the strong interest in our work, its applications and potential benefits to the industry and society.

In 2019, TC-IWP 2 research highlights were disseminated as follows:

i) Industry seminar in Margaret River, WA, 15 May 2019
In collaboration with the Margaret River Wine Association, Dr Ristic organised an industry seminar for the local industry, which included viticulturists, winemakers and educators. Dr Ristic chaired the seminar and presented "An integrated approach to achieving lower alcohol levels in wine" highlighting the Centre's achievements from 2014 to 2018 and. Ten current students and early-mid career researchers spoke about their projects providing the audience with an idea of the breadth and quality of research being undertaken by the Centre.

ii) TC-IWP workshop at the 17th AWITC, 21 July 2019
TC research associate Dr Dimitra Capone convened a workshop titled "Exploring regional diversity in Cabernet Sauvignon" where she presented the highlights from her project that focus on commercial wines of different styles from four diverse wine regions (Coonawarra, Yarra Valley, Margaret River and Bordeaux). The workshop included a wine tasting and showcased important flavour and sensory attributes of the selected wines. The workshop also presented results from various projects on Cabernet Sauvignon related to berry shrivel

(Vinay Pagay) and managing wine alcohol level under challenging conditions (Olaf Schelezki and Renata Ristic).

iii) Industry seminar in the Barossa Valley, 20 Nov 2019
TC-IWP visited the Barossa wine region and presented projects and outcomes from the Centre's research to Barossa grape growers and winemakers across two broad themes; *responding to environmental challenges* and *increasing profitability*. The seminar was organised by Dr Ristic in collaboration with the Barossa Grape & Wine Association and Regional Development Australia Barossa Gawler Light Adelaide Plains. Dr Ristic presented an 'Integrated approach to managing alcohol levels in wine while maintaining quality and style' and chaired the seminar. The presentations highly engaging and of benefit to industry participants as well as the research students who had an opportunity to receive industry feedback on their work.

iv) Centre-wide seminars
The Centre-wide seminars were held on 1 Dec 2018, 13 May 2019 and 18 Nov 2019. The Centre organises these seminars twice a year so that HDRs and PDFs may present the highlights of their research and receive feedback from a broader audience and the Advisory Committee. The role of UA 1708 role was to organise and chair thsse seminars and distribute project progress assessment notes collected from the Advisory Committee.

6.2. Building a collaborative research team

UA 1708 has been building a strong, compact and collaborative research team with coordinated research trials using resources, knowledge and experience from TC1. Even with our pre-emptive efforts, the recruiting process for TC2 has taken longer than anticipated and only nine HDRs (out of 16) were active in 2019, which made coordination and project linkage more challenging. All remaining students have been identified, with most commencing early 2020. Nevertheless, in the last two years, UA 1708 has provided significant support:

i) in coordination and supervision of all winemaking activities in 2018/19, including training in small-lot winemaking for Projects 9 and 11, followed by sensory evaluation of wines (including training in sensory evaluation), as well as statistical analysis of sensory data.

ii) to projects focusing on the characterisation of the distinctive flavours of Australian Cabernet Sauvignon wines from both a chemistry (Project 10a) and sensory (Project 10b) perspective, which was extended to another PhD project that assessed the use spectrofluorometric and multi-element analyses with multivariate statistical analysis to determine the geographical origin of Australian Cabernet Sauvignon wines using. This manuscript (Pham et al., see below) has been submitted for publication.

iii) in the 2019/20 vintage for Project 3 (breaking the sugar:flavour nexus) and Project 11 (managing berry heterogeneity) by examining the accumulation of sugars and flavours in relation to berry heterogeneity under various irrigation systems.

iv) in the 2020 vintage through supervision and coordination of all TC winemaking activities at least until the end of the UA 1708 project.

One of the roles of UA 1708 was to organise professional development workshops enabling post-docs and students to develop capabilities and tools to become versatile and independent wine

researchers. Centre-wide seminars also included a series of presentations/workshops by prominent academics, industry partners, viticulturists and winemakers on topics such as *Collaboration: Experiences and Expectations*, *Sell your science*, as well as masterclasses on viticultural and winemaking practises in the Adelaide Hills, Margaret River or Barossa Valley wine regions (3 seminars). These seminars were highly beneficial, especially for the largely international the student cohort who gained an insight into key Australian wine practices and composition/quality traits, as well as learning first-hand about industry issues and challenges, often being able to incorporate these into their project planning and decision-making. At the same time, these sessions provided a dissemination mechanism and networking opportunity – many students secured employment in this way.

UA 1708 also organised project-specific workshops such as *sensory evaluations of wines* (June 2019) and *statistical analysis* (Aug 2019). It coordinated a meeting with industry partner Availer that focused on engagement with the industry and identification of commercialisation opportunities.

The role of UA 1708 was not only to build a strong research team within the Centre, but also to support supervisory panels in the training of versatile researchers, able to interact effectively with the partner organisations by developing skills in promoting their work through various peer-reviewed and industry channels. Our high success in PhD completion and employment of TC-IWP students prompted the Centre and UA 1304/1708 to seek formal recognition of our achievement through the *SA Excellence in Research Collaboration 2019* award (finalist) and the *2020 ACGR Award for Excellence in Graduate Research Supervision*, the latter just being announced as successful (embargoed until April).

In summary, the Centre provided a unique environment for building a compact and collaborative research team with strong social interaction and a support network of HDRs and PDFs that will endure into the future as the cohort become leaders in the wine industry. UA 1304/1708 provided training and support, organised events and encouraged researchers to share their findings with end-users as well as tailor their research so they can provide recommendations and/or solutions for burning issues in the wine industry, but also in plant and wine science. Much of this would not have been possible with the limited resources of the Training Centre and without the support of Wine Australia.

6.3. Research activities

i) Enhancing quality parameters of earlier harvested grapes using non-*Saccharomyces* yeasts.

In 2018, Dr Ristic completed a follow-up study that aimed to assess the potential of selected non-*Saccharomyces* yeasts to boost the aroma/flavour of wines made from sub-optimally ripe Cabernet Sauvignon and Shiraz. The previous study (in TC1) evaluated the performance of multiple commercial non-*Saccharomyces* yeast in Shiraz wines with lower alcohol content (Hranilovic, Li et al. 2018). In that trial, the existing (and thus readily implementable) non-*Saccharomyces* starter cultures were compared in sequential fermentations of Shiraz at two maturity levels; with sub-optimal flavour ripeness in earlier-harvested fruit (24 °Brix) and at technical ripeness (29 °Brix). The wines underwent detailed chemical and sensory profiling revealing that at the earlier harvest stage the *S. cerevisiae* monoculture was perceived as 'vegetal', 'acidic', and 'bitter', while certain non-*Saccharomyces* treatments, in particular, *Torulaspora delbrueckii*, were related to more favourable sensory attributes (i.e. 'floral', 'red fruit', 'aroma intensity', 'spice'). Based on these results, the follow up study aimed to test the potential of the best-performing yeast treatment (sequential inoculation with *T. delbrueckii* strain Alpha) to boost the aroma/flavour of wines harvested at a potential ~11 % (v/v) alcohol.

The controls were an *S. cerevisiae* PDM monoculture, and an initially un-inoculated control (to confirm that the potential differences were attributable to *T. delbrueckii* rather than any other indigenous strain present). The 2016 Cabernet Sauvignon and Shiraz wines were produced at a pilot-scale (17 kg), with uniform cap and fermentation management across the treatments. Fermentation kinetics were monitored throughout fermentation, and upon alcoholic and malolactic fermentation completion, the wines were stabilised, bottled and subjected to chemical and sensory descriptive analysis. Wine volatile profiles were determined by gas chromatography-mass spectroscopy (GC-MS), following the procedure described previously (Hranilovic et al. 2018), and sensory properties by descriptive sensory analysis (DA) using a trained sensory panel.

The superior performance of the selected best-performing yeast treatment (sequentially inoculated *T. delbrueckii* strain Alpha) in comparison to the PDM monoculture or an initially un-inoculated control, was observed in both varieties. Both Shiraz and Cabernet Sauvignon wines fermented with Alpha yeast had a higher intensity of overall fruit aroma, 'red fruit',' jammy', and 'confectionary' aromas and flavour. In addition, Shiraz wines rated higher for wine body, and Cabernet Sauvignon wines for acidity, but lower for astringency.

The manuscript is to be submitted to a special issue of AJGWR (1: 2021) that features the work of TC1 and TC2.

ii) Changes in the chemical and sensory composition of wines made with the substitution of juice with water or 'green harvest' wines after 4 years of bottle ageing.

In warmer-climate viticulture regions, such as Australia, an amplified frequency of over-ripeness caused by increasing growing season temperature and extreme weather events (e.g. heatwaves and droughts), influences the desired quality of harvested grapes and raises wine alcohol content. To address this issue, one project in TC-IWP 1 assessed an approach that involved the addition of 'green harvest' wine (GHW) or water to dilute must sugar concentrations prior to fermentation. Cabernet Sauvignon and Shiraz wines were made in 2015 and 2016 using different proportions of substitution (10-40%). The research showed that the substitution of grape must with water, at rates not exceeding those in recently introduced regulations allowing water to adjust must to >13.5 °Baumé, only marginally altered wine qualities of Cabernet Sauvignon and, with some added limitations, Shiraz wines. Thus must dilution with water was confirmed to be a valid and easily applicable approach to manage wine alcohol levels under Australian conditions. It was also shown that the pre-fermentative incorporation of GHW is an interesting alternative and sustainable end-use for discarded grapes from bunch thinning (Schelezki, Smith et al. 2018, Schelezki, Suklje et al. 2018, Schelezki et al. 2020).

A selection of Cabernet Sauvignon 2016 wines was presented at the TC workshop at the 17th AWITC. Based on the feedback from winemakers that attended the workshop, a follow-up study was conducted in 2019/20 by Dr Ristic to evaluate the stability and ageing potential of Shiraz and Cabernet Sauvignon wines made by substitution of grape juice with water or green harvest wines.

Accordingly, wines that were bottle-aged for 3-4 years were re-analysed for wine colour density, hue, anthocyanins, total phenolics, polymeric pigments and tannins according to Mercurio et al. (2007). A selection of wines (<26% substitution with water or <20% with water) was analysed for their volatile profile by GC-MS, following the procedure described previously (Hranilovic et al. 2018). During sensory evaluation, each wine was assessed by 50 wine consumers using the 'Rate–All–That–Apply' (RATA) approach (Danner et al. 2018).

Preliminary data analysis showed that the chemical composition of selected wines (excluding treatments with >30% substitution) was not significantly affected in Cabernet Sauvignon wines, which confirmed results obtained after bottling. Furthermore, sensory evaluations supported chemical results. Perception of hotness (due to alcohol level) was always higher in wines from the latest harvest, which probably resulted in increased wine sweetness of Cabernet Sauvignon wines 2015 and 2016. Interestingly, no differences in hotness and sweetness were noted for Shiraz 2016 wines. Differences in aroma and flavour attributes were small (least significant difference <0.5 on the 7-point scale, $p<0.05$), albeit some statistically significant. 'Red fruit' flavour was rated the highest in Cabernet Sauvignon 2015 control wines and overall fruit flavour in Cabernet Sauvignon 2016 control wines. In regards to Shiraz 2016 wines, a 'confectionary' attribute was the most intense in wines made with 6% water substitution, but the difference was significant only for confectionary flavour (not aroma).

It can be concluded that water or GHW (up to 30%) can be used as pre-fermentative approaches to producing lower alcohol wines without detrimental effects on chemical composition and sensory properties of the wines. This was previously shown on ~1.5 year old wines and now after 3-4 years of bottle ageing. However, consequential changes in sensory attributes, such as hotness and sweetness, due to lower alcohol levels, were not considered unfavourable. The manuscript detailing this work is in preparation for the special issue of the AJGWR.

7. Outcome/Conclusion

Project UA 1708 was directly involved in the conduct of TC-IWP research activities by coordinating and facilitating collaboration between TC-IWP projects on the one hand, and translating and disseminating research outcomes to industry via various mechanisms on the other. As the majority of TC1 students finished their studies in 2018/19, one of the main aims of UA 1708 was to distribute outcomes and recommendations obtained from those projects. In those two years, UA authored or co-authored 10 articles in trade journals, 4 peer-review publications and presented TC-IWP highlights at three industry seminars and an AWITC workshop. Technical notes produced from TC research outcomes, available online and disseminated at industry seminars, have proven to be a very effective way of dissemination of the newest research at the participating universities. Furthermore, Dr Ristic wrote the Final ARC TC-IWP 1 report and ARC TC-IWP 2 Activity Update; both available online with hard copies distributed to the government and funding bodies, industry partners and wide wine industry.

Additional UA 1708 activities included:

1. The PDF has been building a strong and compact team around wine and grape research within the TC-IWP. Dr Ristic linked several projects that sourced grape material from the same vineyard and maximised benefits of shared resources. However, several TC2 projects haven't been activated yet because the recruitment process is ongoing.
2. The PDF provided training and support to HRDs for wine chemical analysis and sensory studies, interpretation of collated data and provided support in manuscript preparation.
3. Based on external recommendations, the PDF completed or conducted research trials focusing on the production of lower alcohol wines.

Besides numerous benefits to the Centre, the impact of this project on the Australian wine industry was substantial. Grapegrowers and winemakers were able to find out about the newest tools, viticultural and winemaking applications and techniques as well as a range of recommendations that they could trial in their vineyards and wineries. Producers learnt about the drivers of grape and wine

quality, as well as consumers' preferences for different wines styles. At the same time, the scientific community established greater awareness about current research, which provided opportunities for creating synergies between projects and more efficient use of resources and expertise.

8. Recommendations

Extension and adoption of research outcomes are a continuing challenge, at times greater than the questions of the research themselves. UA 1708 integrated outcomes and enhanced dissemination of findings in the first ARC Training Centre for Innovative Wine Production. The implementations of TC-IWP 1 findings by the industry were significant, particularly in 2018 and 2019. For example:

1. An early harvest blending regime for managing wine alcohol content was implemented in collaboration with the industry partner, Lowe Wines, to produce two commercially available wines (TINJA – 2015 Mudgee Verdelho low alcohol and TINJA – 2016 Mudgee Petit Verdot low alcohol).
2. DPI NSW has begun exploring with growers and winemakers the potential implications of potassium concentration for grapevines, which can be manipulated at both the soil and foliar levels.
3. The antitranspirant, di-1-p-menthene, helped to decrease both water loss and photosynthesis, leading to bigger berries (with diluted sugar) and also less sugar accumulating in berries due to less photosynthesis. Since less sugar = less wine alcohol, industry is evaluating the method for sensory effects on 'real' wines.
4. In a first for the Australian industry, water addition to high sugar juices was shown to be a convenient way to decrease wine alcohol content without adverse quality impacts. It was identified as perhaps the best technique for dealing with shrivelled grapes (i.e. very high in sugar) that arise due to hot weather.
5. Yeast species other than the usual 'wine yeast' (*Saccharomyces*) have shown great potential for enhancing wines made from earlier harvest grapes (whilst low in sugar, also low in flavour), decreasing alcohol levels in over-ripe harvest wines, or being able to complete high sugar (hence high alcohol) fermentations *per se*. A *Lachancea* strain underwent further evaluation at the University of Bordeaux during an HDR placement there and is now being trialled by a partner, Laffort Oenologie, before commercialisation.
6. Partner TWE Ltd has overhauled its approach to determining what level of alcohol they should reduce their wines to, based on the sweetspotting trials our HDRs conducted in collaboration with their winemakers.
7. Several research higher degree graduates have been employed in industry or industry-embedded positions and in the long term, these employees will create a greater awareness of the value of well-credentialed science personnel in the industry.

Although it is too early for TC-IWP 2 projects to make industry recommendations, drivers of the distinctive flavours of Australian Cabernet Sauvignon wines are being identified and those findings were communicated to the wine industry, particularly in the Coonawarra and Margaret River wine regions. More findings in relation to mitigation of smoke taint, berry heterogeneity, flavour development in berries and protein stability in wines are expected this year when mentioned projects complete the second vintage.

9. Appendix 1: Communication

9.1. Industry publications

- Ristic, R., Schelezki, O. and Jeffery, D. (2018) Water into wine: pre-fermentation strategies for producing lower alcohol wines. Wine & Viticulture Journal 33 (1) 26-29
- Ristic, R., van der Hulst, L. and Wilkinson, K. (2018) Development of smoke taint in wine during bottle ageing. Wine & Viticulture Journal 33 (2) 15-18
- Li, S., Wilkinson, K., Bindon, K., Bastian, S. and Ristic, R. (2018) Winemaking supplements: what is inside? Wine & Viticulture Journal 33 (3), 30-33
- Xiao, Z., Liao, S., Rogiers, S., Sadras, V. and Tyerman, S. (2019) Are berries suffocating to death under high temperature and water stress? Wine & Viticulture Journal 34 (1) 42-45
- Longo, R., Ristic, R. and Schimdtke, L. (2019) Low alcohol wines: blending with an early harvest or dealcoholisation of a later harvest? Wine & Viticulture Journal 43 (1) 32-35
- Ristic, R. and Wilkinson, K. (2019) Smoke taint in the bottle: How long will it last? Grapegrower & Winemaker, 660, 46-49
- Wilkinson, K. and Ristic, R. (2019) Understanding the effect of smoke taint on fruit and wine Grapegrower & Winemaker. 2019, 660, 42-44
- Deloire, A., Pellegrino, A and Ristic, R. (2019). Spatial distribution of berry fresh mass, seed number and sugar concentration on grapevine clusters of Shiraz: Discussion of potential consequences for sampling to monitor vineyard ripening. Wine & Viticulture Journal 34, 42-47
- Liang, C., Ristic, R., Stevenson, R., Jiranek, V. and Jeffery, D. (2019) ARC TC-IWP uses magnetic polymers to remove overpowering green capsicum flavour from Cabernet Sauvignon wine. (2019) Wine & Viticulture Journal 34 (4), 24-26

9.2. Scientific publications

- Liang, C., Ristic, R., Jiranek, V. and W. Jeffery, D.W. (2018) Chemical and sensory evaluation of magnetic molecularly imprinted polymers as a remedial treatment for elevated concentrations of 3-isobutyl-2-methoxypyrazine in Cabernet Sauvignon grape juice and wine. Journal of Agricultural and Food Chemistry 66, 7121-7130. DOI: 10.1021/acs.jafc.8b01397
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- Ristic, R., Danner, L., Hoek, A., Meiselman, H. L., Johnson, T.E. and Bastian, S.E.P. (2019) Wine- related aromas for different seasons and occasions: Hedonic and emotional responses of wine consumers from Australia, UK and USA. Food Quality and Preference 71, 250-260. https://doi.org/10.1016/j.foodqual.2018.07.011
- Pham, D.-T., Ristic, R. Stockdale, V.J., Jeffery, D.W., Tuke, J. and Wilkinson, K. Influence of partial dealcoholization on the composition and sensory properties of Cabernet Sauvignon wines. Food Chemistry (under review)

9.3. Presentations

- Industry seminar in Margaret River, WA
- Industry seminar in Barossa Valley, SA
- TC-IWP workshop at the 17th AWITC

9.4. TC-IWP Publications

- ARC TC-IWP 1 Final report (2014-2018) https://www.adelaide.edu.au/tc-iwp/publications/annual-report/arc-tc-iwp1-finalreport-20190730.pdf
- Technical note No 10: Strategies for decreasing alcohol levels in wine. https://www.adelaide.edu.au/tc-iwp/publications/technical/TN10-strategies-for-decreasing-alcohol-levels-in-wines.pdf
- ARC TC-IWP 2 Activity Updates (2018-19) https://www.arcwinecentre.org.au/activity-update-18-19/

10. Appendix 2: References

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Schelezki, O. J., et al. (2018). "Comparison of consecutive harvests versus blending treatments to produce lower alcohol wines from Cabernet Sauvignon grapes: Impact on polysaccharide and tannin content and composition." Food Chemistry **244**(Supplement C): 50-59.

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11. Appendix 3: Staff

Table 1. TC-IWP Key Centre Personnel

TC-IWP 2 Personnel		
Prof Vladimir Jiranek	University of Adelaide	Director
A/Prof David Jeffery	University of Adelaide	Chief Investigator
Prof Stephen Tyerman	University of Adelaide	Chief Investigator
Prof Kerry Wilkinson	University of Adelaide	Chief Investigator
A/Prof/Susan Bastian	University of Adelaide	Chief Investigator
A/Prof/Christopher Ford	University of Adelaide	Chief Investigator
A/Prof/Paul Grbin	University of Adelaide	Chief Investigator
A/Prof Casandra Collins	University of Adelaide	Chief Investigator
Dr Richard Muhlack	University of Adelaide	Chief Investigator
Dr Vinay Pagay	University of Adelaide	Chief Investigator
Prof Leigh Schmidtke	Charles Sturt University	Chief Investigator
Prof Markus Herderich	AWRI	Partner Investigator
A/Prof Paul Boss	CSIRO	Partner Investigator
A/Prof Suzy Rogiers	NSW DPI	Partner Investigator
Dr Jean Macintyre	Pernod Ricard Winemakers	Partner Investigator
David Wollan	VA Filtration	Partner Investigator
Cristopher Brodie	Coonawarra Grape & Wine	Partner Investigator
Dr Anthony Borneman	AWRI	Partner Investigator
Dr Nick Dokoozlian	E & J Gallo	Partner Investigator
Dr Liz Waters	Wine Australia	Other Investigator
Dr Eveline Bartowsky	Lallemand	Other Investigator
Andrew Grant	Availer	Other Investigator
Dr Jacqui McRae	University of Adelaide	Associated Investigator
Prof Dabing Zhang	University of Adelaide	Associated Investigator
Dr Alexander Donald	University of NSW	Associated Investigator
Andrew Clark	Charles Sturt University	Associated Investigator
Dr Renata Ristic	University of Adelaide	Research Coordinator

Table 2. Projects and researchers in TC-IWP 2

THE CENTRE PROJECTS	Start date
Project 1: Inter-vine signalling via plant volatiles Researcher: Joanah Midzi ICHDR o Supervisors: Vinay Pagay, Steve Tyerman, David Jeffery, Suzy Rogiers	16 Dec 2019
Project 2a: Vascular transport into the berry – impact on fruit size and composition Researcher: Zeyu Xiao ICPD o Supervisors: Suzy Rogiers, Leigh Schmidtke, Stephen Tyerman, Vinay Pagay	1 Mar 2018
Project 2b: Investigating the roles of potassium in berry ripening and cell vitality Researcher: Yin Liu ICHDR Supervisors: Suzy Rogiers, Leigh Schmidtke, Stephen Tyerman, Vinay Pagay	15 July 2019
Project 3: Breaking the sugar:flavour nexus – growing grapes with more flavour and less sugar Researcher: Pietro Previtali ICHDR o Supervisors: Chris Ford, Kerry Wilkinson, Nick Dokoozlian	30 Apr 2018
Project 4: Genetic basis of salt exclusion in grapevine Researcher: Andres Zhou Tsang o Supervisors: Matthew Gilliham, Cassandra Collins, Paul Gooding	17 Feb 2020
Project 5: Molecular control of grapevine bud fruitfulness Researcher: Xiaoyi Wang ICHDR o Supervisors: Matthew Gilliham, Cassandra Collins, Dabing Zhang	3 Dec 2018
Project 6a: Rapid assessment of grapes prior to harvest to quantify fungal off-flavours and product composition Researcher: Dr Morphy Dumlao ICPD; ICHDR (TBA) o Supervisors: Leigh Schmidtke, Alex Donald	18 Mar 2019
Project 6b: Rapid assessment of grapes prior to harvest to quantify fungal off-flavours and product composition Researcher: TBA o Supervisors: Leigh Schmidtke	TBA
Project 7: Alternatives to sulfur dioxide for controlling *Brettanomyces* spoilage in wine Researcher: TBA o Supervisors: Paul Grbin, Anthony Borneman, Jean Macintyre	TBA
Project 8: Wine stability in bottle - impact of light Researcher: TBA o Supervisors: Andrew Clark, Leigh Schmidtke, Kerry Wilkinson	TBA
Project 9: Overcoming taint from vineyard exposure to bushfire smoke Researcher: Colleen Szeto ICHDR o Supervisors: Kerry Wilkinson, Vinay Pagay, Nick Dokoozlian, Markus Herderich	28 May 2018
Project 10: Characterising the distinctive flavours of Australian Cabernet Sauvignon wines Researcher: Dr Dimitra Capone ICPD o Supervisors: David Jeffery	5 Mar 2018
Project 10: Characterising the distinctive flavours of Australian Cabernet Sauvignon wines Researcher: Lira Gonzaga ICHDR (MPhil) o Supervisors: David Jeffery, Dimitra Capone, Sue Bastian	2 July 2018
Project 11: Managing berry heterogeneity Researcher: Claire Armstrong ICHDR o Supervisors: David Jeffery, Vinay Pagay, Paul Boss	8 Oct 2018
Project 12a: Defining and exploiting the indigenous microflora of grapes Researcher: Dr Krista Sumby ICPD o Supervisors: Vladimir Jiranek, Cassandra Collins, Anthony Borneman, Kim Chalmers	19 Feb 2018
Project 12b: Defining and exploiting the indigenous microflora of grapes Researcher: TBA o Supervisors: Vladimir Jiranek, Krista Sumby	TBA
Project 13: Shaking up the microbiology of winemaking Researcher: Dr Krista Sumby ICPD o Supervisors: Vladimir Jiranek	19 Feb 2018
Project 14a: Efficient red winemaking by monitoring extraction and evolution of colour and polyphenols Researcher: Judith Unterkofler ICHDR o Supervisors: Richard Muhlack, David Jeffery, Jean Macintyre	5 Nov 2018

Project 14b: Mathematical modelling of red wine colour and polyphenols extraction and evolution to enhance winemaking efficiency Researcher: Rachael Anne Tindal ICHDR (MPhil) o Supervisors: Richard Muhlack, David Jeffery, Jean Macintyre	12 Aug 2019
Project 15a: Membrane filtration technologies for efficient wine processing and recovery of valuable extracts Researcher: Yihe (Eva) Sui ICHDR o Supervisors: Kerry Wilkinson, Richard Muhlack, Jacqui McRae	16 Apr 2018
Project 15b: Membrane filtration technologies for efficient wine processing and recovery of valuable extracts Researcher: Stephanie Angela ICHDR o Supervisor: Kerry Wilkinson	TBA
Project 16: Rootstock effects on grape rachis composition and the implications for red wine flavour and aroma Researcher: Ross Sanders o Supervisors: David Jeffery, Dimitra Capone, Paul Boss, Catherine Kidman	Addition to ARC TC-IWP
Project 17: Translation of 'whole of production chain' wine science research to industry outcomes Researcher: Renata Ristic (PDF) o Supervisors: Vladimir Jiranek	15 Jan 2018

ICHDR = postgraduate student; ICPDF= post-doctoral fellow