

The Australian Wine
Research Institute
Annual Report 2007



Board Members

Mr R.E. Day, BAgSc, BAppSc(Wine Science)
Chairman–Elected a member under Clause 25.2(d) of the Constitution

Mr J.F. Brayne, BAppSc(Wine Science)
Elected a member under Clause 25.2(d) of the Constitution

Mr P.D. Conroy, LLB(Hons), BCom
Elected a member under Clause 25.2(c) of the Constitution

Mr P.J. Dawson, BSc, BAppSc(Wine Science)
Elected a member under Clause 25.2(d) of the Constitution

Mr T.W.B. James, AssDip(Wine Prod)
Elected a member under Clause 25.2(d) of the Constitution

Mr G.R. Linton, BAppSc(AppChem),
GradDip(SysAnal)
Elected a member under Clause 25.2(d) of the Constitution

Mr S.B. Millar, CPA, DipMgmt
Elected a member under Clause 25.2(d) of the Constitution

Ms J.S. O'Connor, BEd (PE.)
Elected a member under Clause 25.2(c) of the Constitution (from 8 May 2007)

Professor I.S. Pretorius, BSc(Hons), MSc, PhD
Ex officio under Clause 25.2(b) of the Constitution as Managing Director of the AWRI

Professor S.D. Tyerman, BSc(Hons), PhD
The University of Adelaide Representative under Clause 25.2(a) of the Constitution (until 15 January 2007)

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. In 2006, the AWRI implemented its ten-year business plan *Towards 2015*, and stated its purpose, vision, mission and values:

Purpose

To contribute substantially in a measurable way to the ongoing success of the Australian grape and wine sector

Vision

To deliver high value to the Australian grape and wine sector through world-class research and integrated solutions and to provide thought leadership to the research activities of the Australian wine sector

Mission

To underpin our world-class research and integrated solutions with:

- a tenacious pursuit of understanding;
- the development of a unique, extensive and usable knowledge base; and
- a focus on contributing substantially to stakeholders achieving their needs

AWRI's values provide guidance in how it will deliver on its mission. These values are:

- scientific integrity and excellence;
- a culture of delivering results;
- internally and externally collaborative;
- accountability and transparency; and
- focused on the Australian wine sector and industry driven

The AWRI's laboratories and offices are located within an internationally renowned research cluster on the Waite Precinct at Urrbrae in the Adelaide foothills, on land leased from The University of Adelaide. Architectural plans are well underway for AWRI's new home to be completed in 2008, within the Wine Innovation Cluster (WIC) central building, which will also be based on the Waite Precinct. In this new building, AWRI will be collocated with The University of Adelaide and the South Australian Research and Development Institute. The Wine Innovation Cluster includes three buildings which houses the other members of the WIC concept: CSIRO Plant Industry and Provisor.

Along with the WIC parties mentioned, the AWRI is clustered with the following research and teaching organisations: Australian Centre for Plant Functional Genomics (APFG), Australian Genome Research Facility (AGFR), Australian Grain Technologies (AGT), Australian Wheat Management, BiometricsSA, two different Cooperative Research Centres (CRC), three divisions of CSIRO, Department of Water, Land and Biodiversity Conservation, Primary Industries and Resources South Australia (PIRSA), and The University of Adelaide's *School of Science* (which includes the Schools of Agriculture and Wine, and Earth and Environmental Sciences).

Registered office

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Presented to
the Australian grape
and wine sector

Chairman's report



The first priority in the 2006/2007 year was the completion of two of the most important initiatives commenced the previous year. The 7-year Research, Development and Extension Plan for the AWRI was presented to key stakeholders and local wine association meetings around Australia and the 7-year investment agreement between the AWRI and the GWRDC was executed. The agreement backs the plan, providing for about \$65 million over the seven years which will be directed towards industry designated outcomes for the benefit of the grape and wine sector of Australia. This agreement means that AWRI is funded by about 30% of GWRDC's levy generated budget and this funding represented 76% of the AWRI's operating budget in 2006/2007.

Consistent with the identified strategy of moving to diversify the AWRI's funding sources the AWRI was successful in obtaining two significant additional tranches of funding during the year. The AWRI successfully applied and lobbied for a \$2.0 million grant under the National Collaborative Research Infrastructure Scheme (NCRIS). A total of \$1.2 million of Australian Government and \$800,000 of South Australian Government funding will be directed towards establishing the South Australian node of Metabolomics Australia at the AWRI. The AWRI was also successful in gaining a grant of \$533,745 from the South Australian Premiers Science and Research Council Fund which will permit fast tracking of yeast strain development. Together these two funding sources will be important contributions to non-levy based funding of the AWRI's operations. For the 2007/2008 year 34% of our funding is expected to be derived from sources other than those emanating from industry levies (and associated matching funding from the Australian Government).

Two key scientific breakthroughs which stand above other important work occurred during the year. Our scientists have identified the sesquiterpene primarily responsible for the spicy aroma of Shiraz grapes and wines, and peppercorns. Discovering the identity of this key aroma compound was somewhat of a coup given the importance of pepper flavour in the food industry. Its implications for wine and

particularly Shiraz are significant in the current environment of climate change, given that its impact is generally more significant in cool climate grapes. The second very important development was the discovery that the unknown compound, Factor X, which is required for protein haze formation in white wines, is the sulfate anion. This knowledge enables a better understanding of the mechanisms and participants in protein haze formation with potential implications for both wine quality and production economy.

Other important discoveries during the year include:

- A prototype wine yeast was developed that is able to substantially increase fruitiness levels in wine.
- Two new natural oak lactone precursors were identified for the first time in oak wood extracts.
- It was confirmed that the malolactic bacterium *Oenococcus oeni* is able to liberate *cis*-oak lactone from its glucoside precursor, supporting anecdotal evidence that malolactic fermentation contributes to wine oak character.
- The development of a method for in-bottle oxygen measure which allows the calculation of not only the oxygen ingress rate but also the initial amount of oxygen in the head-space of a wine bottle and the amount of oxygen entrapped in the closure.
- A better understanding of fullness and body of Riesling wines. Increasing ethanol has a surprisingly small impact on perceived body and fullness of Riesling wines.
- It was found that *Brettanomyces* flavour in red wine, even at a surprisingly low level, strongly decreased consumer acceptance.

Apart from the ongoing research work of the AWRI the highlights of which are listed above, a large amount of effort was channeled towards industry problem solving. Investigations into the nature and source of 'plastic' and 'chemical-like' taints in wines from the 2005 and 2006 vintages were successfully concluded. A range of chlorophenol compounds were found to be contributing to the taints, some at concentrations well below those previously considered a problem in wine.

Following on from problem solving efforts in previous years, almost 1000 samples were analysed for the smoke taint indicators guaiacol and 4-methylguaiacol during the 2007 vintage.

Other industry support and information dissemination activities included:

- Responding to more than 1,700 calls for technical advice and information.
- Publishing 40 papers on AWRI activities in refereed and non-refereed publications.

- Staff members gave 159 oral presentations, conducted 15 workshops, presented 9 posters papers and 49 lectures.
- In total AWRI staff members recorded and responded to 5,277 requests for information during the 2006/2007 year.

During the year, the development of the Wine Innovation Cluster has proceeded rapidly as planned. The building arrangements, the fruits of which are eagerly awaited by our staff whose working conditions have come to include a new degree of intimacy, are finalised and construction has begun. The bigger challenge, that of ensuring workable collaborating relationships between very diverse partners is still work in progress but the will to achieve scientific outcomes for the benefit of Australian wine is the driving force for the future of the cluster.

We welcomed grapegrower nomination, Jan O'Connor, to our board as the second of our special qualification directors during the year. Jan's inputs from the perspective of business and grapegrowing are insightful and valuable as are those of Foster's Legal Affairs Director, Paul Conroy, who took up the first of these positions last year. Our other board members have continued to deliver carefully considered guidance from their diversity of perspectives. Our Managing Director, Sakkie Pretorius, has again shown that he is capable of pushing the rate of change, backed by his personal energy, to new limits and the AWRI benefits enormously from his energy and professionalism. As previously mentioned, our staff have endured increasingly challenging tasks and conditions, but the output of the AWRI is testament to their positive spirit and willingness to rise to challenges.

There is little doubt that the future challenges facing the AWRI will redefine its identity and its contribution to the grape and wine sector. Its new situation as a pivotal partner in the Wine Innovation Cluster will enable it to take an important place in delivering key research outcomes to counter drought, effects of climate change and difficult economic conditions. The past record will suggest optimism in dealing with these issues but success will surely be dependent on embracing new and more effective ways of finding and communicating the technical information needed by a sector with a proven history of embracing change.

Robin Day
Chairman

Board notes

Chairman

At the Board Meeting held on 14 November 2006, Mr R.E. Day was elected Chairman of the Board.

Members of the Executive Committee

Mr R.E. Day
Professor I.S. Pretorius
Mr T.W.B. James
Mr G.R. Linton
Mr P.J. Dawson

Deputy Members of the Board

Mr N.P. Blieschke
Mr L.P. Deans
Mr A. Kennett
Mr J. Northey
Mr A.N. Sas

Audit Sub-Committee

Mr P.D. Conroy
Mr P.J. Dawson
Mr S.B. Millar

Meetings

Ordinary General Meeting

The 52nd Ordinary (Annual) General Meeting was held on 14 November 2006.

Special General Meeting

A Special General Meeting was held on 8 May 2006.

Board

The Board of the AWRI met on the following dates: 22 August 2006, 14 November 2006, 27 February 2007, 8 May 2007.

Funding

The Board of the AWRI acknowledges the continuing financial support of the Grape and Wine Research and Development Corporation.

Appreciation

The AWRI acknowledges the assistance and cooperation of the following organisations throughout the year:

Australian Society of Viticulture and Oenology

Australian Wine and Brandy Corporation

Charles Sturt University / National Grape and Wine Industry Centre

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Cooperative Research Centre for Viticulture

Department of Agriculture, Fisheries and Forestry

NSW Wine Industry Association Inc.

Queensland Wine Industry Association Inc.

South Australian Wine Industry Association Inc.

State Departments of Agriculture

State Government of South Australia

The University of Adelaide

Victorian Wine Industry Association Inc.

Wine Grape Growers Australia

Wine Industry Association of Western Australia Inc.

Wine Industry Suppliers Australia

Wine Industry Tasmania Inc.

Winemakers' Federation of Australia Inc.



Managing Director's report



Dan Johnson

Shiralee Dodd

Sakkie Pretorius

It would be easy to think that the only major events in the Australian wine sector over the past 12 months have been the impacts of drought and frost. However, while these challenges have rightly dominated media reporting and public discussion, this 12 month period will also be remembered, in my view, for breakthrough thinking among wine producers, grape growers and wine scientists – and the organisations that support them.

This breakthrough thinking has come at a pivotal time in our industry's history as the phenomenal rise in our international sales and recognition over the past two decades has been overshadowed in more recent times by a challenging global trading environment. Hurdles to be tackled include intensifying competition and retail consolidation in our domestic and key export markets, declining profitability among local producers, a global wine oversupply and the rising popularity of alternative beverages among younger consumers.

Indeed, the past 12 months has seen the Australian wine sector at its most vulnerable and most visionary.

Vulnerable in the sense that severe climate conditions have reduced the size of the harvest by about one-third (but thankfully not affecting wine quality which remains superior) and visionary with 2007 seeing the release of key national industry strategies that have been very well received. From the team at AWRI, the past year featured announcements on a number of exciting scientific achievements.

Relentless innovation

I would argue strongly that the Australian wine sector has evolved into a successful export-oriented and consumer-driven industry, underpinned by relentless innovation, through the cooperative efforts of three powerful forces: wine producers, grapegrowers and wine scientists.

While the roles of wine producers and grape growers in the sector's spectacular growth are generally well understood by the Australian community, the often unheralded work of our nation's wine scientists is worthy of increased attention and recognition.

Welcome, then, to the 'third force' in Australian wine: the scientific and research community of which the AWRI is proud to take a leading role.

As an industry-owned scientific organisation, the AWRI is focused on practical and ready-to-use improvements, technical analysis and, increasingly, consumer insights to benefit grape-growers and winemakers. At the same time, we have achieved an international reputation for world-class research into longer range 'over the horizon' opportunities in areas such as fermentation management, grape and wine phenolics and biopolymers, wine flavour and aroma compounds, wine taints and off-flavours, bottle closures and other packaging materials.

Harnessing science and strategy

The importance of wine science that delivers results is recognised in the three key industry strategies released during the year: the *Directions to 2025* document produced by the AWBC and WFA; the *Taking Stock and Setting Direction* report released by WGGA and the GWRDC's *Five Year R&D Plan: 2007-2012*. These three strategies complement the AWRI's own ten-year business plan and seven-year research, development and extension plan, both released in 2006.

What, then, are the linkages between these high level strategies and the AWRI's ongoing work that support our claim to be part of the 'third force' in delivering industry success?

In essence, each strategy can be distilled into three core areas that, if achieved, will ensure the Australian wine sector has a profitable and sustainable long term future:

1. Better understanding of trends in global wine markets and the early identification of profitable market segments by price point, varietal and wine style.
2. Developing and implementing strategies that will help anticipate and even influence consumer demand.
3. Returning value to winemaking and grapegrowing businesses by encouraging sustainable financial, social and environmental practices.

A higher level objective is to move away from the industry's historic volume-driven approach (which has seen exports surpass \$3 billion a year but with a worrying long term trend of a declining price per litre) and, instead, shift to a value-driven approach. Focusing on value over volume requires greater market and consumer understanding – and a vigorous and visionary approach to wine science – to ultimately deliver these much-needed higher profit margins.

Consistent with its role as the 'third force' in the Australian wine sector, the AWRI works hard to ensure that as well as delivering innovative science, our activities are closely aligned with the Australian wine sector's overall strategic direction. As a scientific organisation, we strive to maintain our relevance to market-driven imperatives such as matching consumer expectations about wine price, quality and availability.

Leadership in research, development and extension

The industry strategies released over the past 12 months share another common approach: in discussing the necessary action plans, they highlight the important contribution that can only come from wine scientists. This involves leadership in research and development from vine to consumer encompassing, in broad terms: understanding what consumers want to buy; continued innovation to ensure winemaking excellence; producing grapes that meet specification; and continuous improvement in environmental performance (including practical responses to climate change). In the

past 12 months, the AWRI has made a number of breakthroughs that clearly support these industry strategies. Below are just three examples, and I commend the reports on these and the other activities published elsewhere in this document for readers' interest:

Breakthrough 1: We have identified the single aroma compound that produces the spicy, 'black pepper' smell so popular with many Shiraz drinkers. This breakthrough could enable winemakers in the near future to manage this aroma compound to more effectively suit the tastes of Shiraz drinkers. It had been thought that the spicy pepper aroma might be the combined effect of many aroma compounds. However, the AWRI identified a sesquiterpene, which we have called 'Sympep', as the single aroma compound responsible for the spicy pepper character in Shiraz. Another important aspect of the discovery is that the pepper aroma compound can be found in Shiraz grapes and Shiraz wine – that is, at least some, if not all, of this compound survives fermentation and the subsequent winemaking process. This key finding could enable grapegrowers and winemakers to select, in advance, particular clones of Shiraz grapes or particular parcels of land that either minimise or maximise the pepper aroma characteristic to suit consumer tastes.

Breakthrough 2: Our scientists are working on a deeper understanding of the diverse role that yeast plays in wine production, beyond yeast's well-understood role of simply fermenting sugar in grape juice into alcohol. In fact, yeast is responsible for other chemical interactions that influence the aroma, flavour and colour of wine. Using this knowledge, the AWRI has gone a step further and developed a large number of unique yeast strains (some commercially available) and combination 'blends' of yeast strains which target specific characters and flavours of wine – an exciting new tool for winemakers.

Breakthrough 3: During the year, the AWRI further refined its wine analysis techniques to more effectively identify wine taints and off-flavours at extremely low concentrations. This is an important breakthrough because the reputation (and therefore export sales) of Australian wine could suffer if wine in sub-optimal condition reaches consumers in key overseas markets. The chemicals responsible for off-flavours and taints are frequently very potent and only need to be present in wine at extremely low concentrations, making detection difficult and time consuming. An investigation during the year into a number of taints further honed the AWRI's already astonishing detection skills. This capability will have an ongoing benefit in protecting the global reputation of Australian wine and will provide consumers with an unparalleled assurance of wine quality.

It is appropriate here to acknowledge the dedication and hard work of "Team AWRI" in achieving these breakthroughs and their continued work and quiet determination on what I am certain will be more breakthroughs in the future. In reviewing the past 12 months,

I would also like to recognise further successes including: initiatives to diversify the AWRI's funding base enabling the AWRI to expand its offering to the Australian grape and wine sector beyond that funded by industry levies; the ongoing development of a strong and streamlined Analytical Service division; and the increasing focus on information and knowledge management and delivery.

I would also like to thank the AWRI Board of Directors, under the chairmanship of Robin Day, for their guidance and support during a challenging and difficult period in the history of the Australian wine sector.

The AWRI's projects are funded by levies paid by Australia's winemakers and grapegrowers (with matching funding from the Australian Government) and my sincere thanks also goes to the GWRDC which collects and strategically invests these levies. We also appreciate ongoing support from Australian and State Governments, from organisations such as WFA, WGGA, AWBC, ASVO, WISA, and from many other domestic and international individuals and organisations that collaborated with us during the year.

By the very nature of our funding and our continued and close collaboration with industry partners, the AWRI is not immune to the challenges faced by wine producers and grapegrowers. We are proud of a record of responding to, and even anticipating, the needs of a market-driven sector.

Let me close with my earlier observation about the less publicised story of the Australian wine sector over the past 12 months. While the succession of natural calamities has caused hardship for many grapegrowers and winemakers, the good news is how our industry has successfully articulated a roadmap to support industry sustainability in three distinct but complementary areas of endeavour: winemaking, grapegrowing and the science that supports them.

The unity of purpose evident in the Australian wine sector is the envy of other wine producing nations and I am pleased that the importance and impact of scientific research – the so-called 'third force' – is receiving increasing recognition as a key contributor to our industry's success in the past and, significantly, into the future.



Sakkie Pretorius
Managing Director

Staff

Office of the Managing Director

Isak Stephanus Pretorius, BSc(Agric)(Hons), MSc(Agric), PhD, *Orange Free State*, Managing Director

Shiralee Joy Dodd, BA, LLB (Hons) *UAdel.*, Executive Officer

Daniel Luke Johnson, BSc(Hons), PhD, *Flinders*, General Manager – Business Development

Roxanne Portolesi, BSc *Western Australia*, BSc (Hons) *UAdel.*, PhD, *Flinders*, Business Development Officer (commenced 23 April 2007)

Corporate Services

Hans Engelbert Muhlack, BEc *UAdel.*, CPA Aust., Group Manager – Corporate Services

Linda Joy Halse, BA, PG Dip Ind. Relations *UNatal*, Human Resource Manager

Jeffrey Mark Eglinton, BSc (Hons) *UAdel.*, IT Manager

Rachel Lee Edwards, Accountant

Holger Gockowiak, BSc (Hons) *UAdel.*, OHS&W Coordinator (concluded 18 June 2007)

Rhonda Irene Milde, Finance Officer

Mark Raymond Braybrook, Operations Coordinator

Susan Louise Rock, Help Desk Officer (commenced 26 September 2006)

Pauline Jorgensen, Administration Officer

Janice Margaret O'Donnell, Receptionist (commenced 1 August 2006)

Deborah Joy Thornton-Wakeford, Receptionist (commenced 19 February 2007)

Pamela Joan Harrison, Receptionist (from 22 August 2006 to 12 January 2007)

June Robinson, Administration Support

Jeanette Fay Tooley, Administration Support

Communication and Information Resources

Raelene Joan Blair, CertAppMgt(Marketing) AIM, GAICD, Group Manager — Communication and Information Services

Linda Maree Bevin, BBus(InfoMgt), GradDip(Lib&InfoStud) *QUT*, Information and Knowledge Manager (commenced 19 February 2007)

Sean Matthew Boden, BA *UAdel.*, GradDip(InfoStud) *UniSA* (TBC Nov 2007), Librarian (commenced 13 November 2007)

Catherine Grace Daniel, BA *ANU*, GradDip(Lib) *RMIT*, Librarian (concluded 6 September 2007)

Ingrid Betty-Maud Oats, Dip(LibInfo) *Adel. Tafe*, Library Technician

Melissa Elizabeth Francis, BA *UMelb.*, DipEd *Melb. State Col.*, Library Assistant (concluded 30 August 2006)

Claire St George, Library Assistant

Kathryn Sarah Beames, Conference Secretariat

Pauline Thornton, Conference Assistant (from 12 February 2007 to 29 July 2007)

Research

Markus Johannes Herderich, PhD *UWuerzburg*, Group Manager – Research

Heather Margaret Donnell, Administrator – Research

Paul Joseph Chambers, BSc(Hons), PhD *Hertfordshire*, Research Manager – Biosciences

Ian Leigh Francis, BSc(Hons) *Monash*, PhD *UAdel.*, Research Manager – Sensory

Paul Anthony Henschke, BSc(Hons), PhD *UAdel.*, Principal Research Microbiologist

Mark Aidan Sefton, BSc(Hons), PhD *UWA*, Principal Research Chemist

Elizabeth Joy Waters, BSc, PhD *UAdel.*, Research Manager – Biochemistry

Yoji Hayasaka, DipEng(IndChem) *Tokyo I.T.*, MPharm Vic. Col. Pharm., CertIntBusMgt *Monash*, Manager — Mass Spectrometry Facility

Eveline Jutta Charlotte Bartowsky, BSc(Hons), PhD *UAdel.*, Senior Research Microbiologist

Paul Alexander Smith, BSc(Hons), PhD *Flinders*, Senior Research Scientist

Jan Hendrik Swiegers, MSc, PhD *Stellenbosch*, Senior Research Scientist

Anthony Richard Borneman, BSc(Hons), PhD, *UMelb.*, Research Scientist

Christopher Daniel Curtin, BSc(Hons) *Flinders*, Research Microbiologist

Gordon Michael Elsey, BSc(Hons), PhD, *Flinders*, Research Chemist

Richard Gawel, BSc *Adel.*, DipEd *Adelaide*, GradDipOenol *Roseworthy*, Research Scientist

Helen Elizabeth Holt, BAgSc(Hons), PhD *LaTrobe*, Research Scientist

David William Jeffery, BTech (For's & AnalytChem), BSc(Hons), PhD *Flinders*, Research Scientist

Alan Percy Pollnitz, BSc(Hons), PhD *UAdel.*, Research Chemist

Simon Anthony Schmidt, BSc(Hons), PhD *Flinders*, Research Scientist

George Kyriakos Skouroumounis, BSc(Hons) *Flinders*, PhD, GradDipOenol *UAdel.*, Research Chemist

Cristian Andres Varela Cabrera, BBiochem, MBiochem, PhD *Catholic Uni Chile*, Research Scientist

Maurizio Ugliano, PhD *Foggia*, Post Doctoral Research Fellow

Kenneth Frank Pocock, BAppSc *UAdel.*, FAIFST, Senior Chemist

Dimitra Capone, BAppSc, AssDip(Chem) *USthAust.*, Chemist

Peter James Costello, BSc(Hons) MSc *UNSW*, PhD *UAdel.*, Microbiologist

Kate Alexandra Lattey, BSc *Canterbury*, Sensory Scientist (concluded 1 September 2006)

Patricia Chaves Osidacz, BSc(FoodEng) *UEstadualde Campinas*, Sensory Scientist (commenced 4 June 2007)

Meagan Diane Mercurio, BSc(Hons), BTech *Flinders*, Chemist

Tangerine 'Mango' Parker, BSc *Flinders*, Chemist

Tracey Ellen Siebert, BSc *UAdel.*, Chemist

Brooke Travis, BAgSc(Oen) *UAdel.*, Sensory Scientist

Gayle Ann Baldock, BSc(Hons) *Guelph*, Technical Officer

Jennifer Rose Bellon, Technical Officer

Angus Henderson Forgan, BSc(Hons) *Flinders*, Technical Officer

Maria Jolanta Kwiatkowski, MSc *Gliwice*, Scientist

Belinda Ruth Bramley, ScTechCert(Biol), SAIT, Sensory Technician

Kevin Herbert Pardon, AssDip(AppChem) SAIT, Technical Officer

Oenone Jean Macintyre, BSc, BE(Chem) (Hons), *UAdel.*, Technical Assistant (commenced 2 January 2007) and PhD student

Jane Melissa McCarthy, AdCertMedLabSc *USthAust.*, CertVetNurs, CertAnimHand *TAFE*, Technical Officer

Katryna Agatha van Leeuwen, BSc(Hons) *Flinders*, Technical Officer

Robyn Louise Willmott, BSc *USthAust.*, Hons *UAdel.*, Technical Officer

Industry Development and Support

Peter William Godden, BAppSc(WineSc) *UAdel.*, Group Manager — Industry Development and Support

Narelle Elizabeth Cream, Administrator – Industry Development and Support (maternity leave from 1 November 2006)

Melinda Jane Vincent, Administrator – Industry Development and Support (from 28 August 2006 to 6 December 2006)

Teegan Jean Waples, BAgric. *UAdel.*, Customer Service and Marketing Manager (commenced 8 January 2007)

Con Arthur Simos, BAppSc(Oen) *Roseworthy*, Manager – Industry Services

Adrian Dermott Coulter, BSc *Flinders*, GradDipOenol *UAdel.*, Senior Oenologist

Geoffrey David Cowey, BSc(Hons) *UAdel.*, Oenologist

Matthew Grant Holdstock, BSc *Flinders*, GradDipOenol *UAdel.*, Oenologist

Emma Kennedy, BSc(Comput Modell) *Flinders*, Technical Officer

Mark Gishen, BE(Chem)(Hons), MEngSc(Chem) *UMelb.*, Quality Liaison Manager (concluded 8 January 2007)

Robert George Damberg, BSc(Hons) *UAdel.*, PhD *UQld*, Senior Research Scientist

Daniel Cozzolino, AgricEng *Uruguay*, PhD, *Aberdeen*, Research Chemist

Wiesława Cynkar, BSc, PhD *Wroclaw*, Research Scientist

Leslie Joseph Janik, AssDipIndChem, MAppSc *USthAust.*, Technical Research Officer

Sally-Jean Bell, BSc(Hons) *UWA*, GradDip(Wine) *Roseworthy*, PhD *UWA*, Manager - Viticulture

Creina Standish Stockley, BSc(Hons) *UAdel.*, MSc *Flinders*, MBA *USthAust.*, Health and Regulatory Information Manager

Marcel Essling, BBus *UVic.*, BSc(Agric) *UAdel.*, Viticulture Technical Officer (commenced 8 January 2007)

Sarah Louise Kobelt, BSc(Hons) *UAdel.*, Project Officer-Industry Development and Support (commenced 8 January 2007)

Ella Margaret Clare Robinson, BA, BSc(Hons) *UAdel.*, Project Manager – Industry Development and Support (commenced 2 April 2007)

Analytical Service

Mai Nygaard, MSc *UCopenhagen*, Group Manager – Analytical Service

Sandra Margaret Lloyd-Davies, BA *Flinders*, Customer Service Manager (concluded 25 January 2007)

Maria Concettina Mills, Customer Service Officer (concluded 14 February 2007)

Jelena Jovanovic, Customer Service Officer

Leanne Michele Craddock, BSc *UAdel.*, Analytical Laboratory Supervisor (commenced 8 January 2007)

James Matthew McIntyre, BSc; *Adelaide*, Dip BM, Analytical Laboratory Supervisor (concluded 20 October 2006)

Matthew James Cream, Project Manager (concluded 24 April 2007)

Stephen Peter Ormiston Smith, BSc(Hons) *UTas*, BAppSc(Wine Sc) *CSU*, Senior Laboratory Technician (concluded 22 December 2006)

Slavko Matthew Bekavac, BAppSc. (Chemistry) *USthAust.*, Laboratory Technician

Danielle Marie Butzbach, BTech (For's & Analyt Chem) *Flinders*, Laboratory Technician (concluded 31 January 2007)

Andrew John Ferrell, BSc(FoodTech) *USthAust.*, Laboratory Technician (commenced 26 February 2007)

Kate Marie Gerber, BSc(Vit) *UC Davis*, Laboratory Technician (commenced 8 January 2007)

Danielle Kylie Leedham, Dip. Applied Chemistry, Laboratory Technician

Carol Jean Sigston, BAgSc *UAdel.*, Laboratory Technician (concluded 1 September 2006)

Daniel Scott Tynan, Dip.AppSc, *USthAust.*, Laboratory Technician

Patrick August-Giesecke Dimanin, CertEnolVitic *Michigan State*, (commenced 31 July 2006) Laboratory Technician

Randell Leith Taylor, BSc(Hons) *UAdel.*, Trace Analysis Laboratory Supervisor

Caroline Jadvyga Sarneckis, BTech(For's & Analyt Chem), BSc(Hons) *Flinders*, Analytical Chemist (concluded 9 February 2007)

Heather Mandy Brooks, BSc *UAdel.*, Analytical Chemist

David Rolfe Boehm, BSc *UAdel.*, Analytical Chemist

Stella Kassara, BSc (Hons) *UAdel.*, Technical Officer

Yvonne Staeffler, AssDip(AppScLabSc) *CSU*, Technical Officer (commenced 12 February 2007)

Students and visitors

Maria Arevalo, PhD, *UCastilla-La Mancha*, Visiting Researcher (Spain)

Maria Josephine Birse, MSc *Nottingham*, BSc(Hons) *Brunel*, PhD Student

Inmaculada Blazquez Rojas, PhD, *UCastilla-La Mancha*, Visiting Researcher (Spain) (concluded 15 December 2006)

Rachel Christine Brown, BTech (For's & Analyt Chem), BSc(Hons), *Flinders*, PhD Student

Eric Denis, BSc(Hons) *Flinders*, PhD Student

Ellena Sophia Anne King, BAgSc(Oen), *UAdel.*, Casual Technical Assistant (commenced 14 November 2006) and PhD Student

Dariusz Roman Kutyna, MSc *Ag.UPoland*, PhD Student

Natoiya Dee Rayette Lloyd, BSc(MedChem), BSc(Hons), *Flinders*, PhD Student (commenced 7 May 2007)

Matteo Marangon, BAgSciTech, MAgScTech, *UPadua*, Visiting Postgraduate Student (Italy) (from 20 November 2006 to 30 May 2007)

Simon Nordestgaard, BE(Chem)(Hons) *UAdel.*, PhD student

Fernando Salazar, BEng UbioBio, DEAEng *URoviraVirgili*, Visiting Postgraduate Student (Spain) (commenced 7 May 2007)

Tina Tran, BSc(Hons) *Victoria*, PhD Student

Steven van Sluyter, BA, BSc *UNthCarolina*, PhD Student

Claudia Wood, *Pontificia U Católica de Chile*, Visiting Postgraduate Student (Chile) (hiatus period from 30 January to 1 July 2007)

See Appendix 3 for details of all students supervised by AWRI staff

In recognition of 40 years of service



In February 2007, Ken Pocock completed 40 years of service at the AWRI. When Ken commenced at the AWRI, in 1967, Dr John Fornachon was the Director and there were eight full-time and two part-time staff members. For the first 18 years, he worked mainly in the technical services area, which today is covered by the Analytical Service and Industry Development and Support groups. Initially, he worked with Dr Bryce Rankine, then after Dr Rankine left he was put in charge of this area, a position he held for five years before this area was expanded by the then Director, Dr Terry Lee. Ken then moved into research, working with Dr Chris Somers on phenolics in grapes and wines, then with Dr Pat Williams on oak extracts, bottle deposits from red wines, and bottle oxidation of white wines. For the past 12 years, as a Senior Chemist, he has worked with Dr Liz Waters contributing to the work on heat unstable proteins in grapes and white wines.

Obituary: Janet Currie (1945-2007)



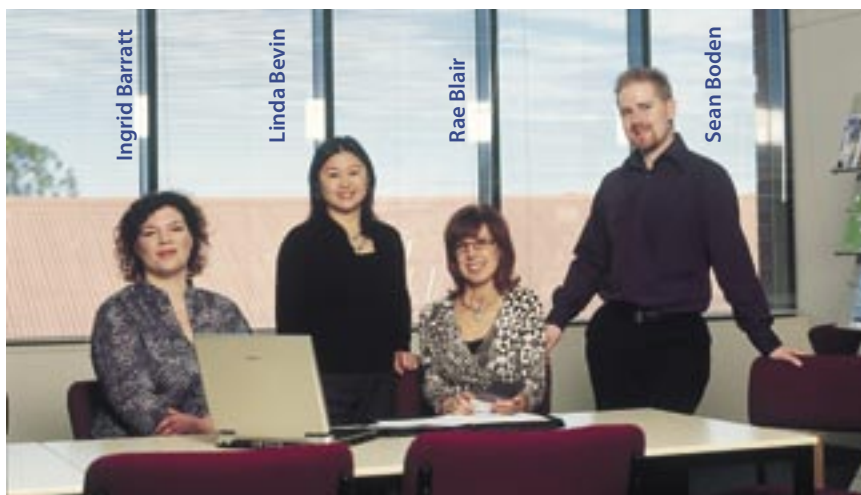
Janet was born in Scotland in 1945, and emigrated to Australia with her husband, daughter and two sons in 1977, after obtaining a BA from Glasgow University. She joined the AWRI in November in 1987 as Company Secretary and Public Officer. Over the next 14 years, Janet steered the financial activities of the AWRI without a flinch and allowed us to expand in a sustainable fashion through several phases. Her tight financial rein was also applied to the finances, in the early years, of the Australian Society of Viticulture and Oenology, and Janet worked as part of the bid team for the first Cooperative Research Centre for Viticulture, and was responsible for running the finances for the start-up organisation when the bid was successful. She also took a careful interest in the financial well-being of the Australian Wine Industry Technical Conference Inc. up to 1994, and was also its Public Officer. Janet's interest in and contribution to the corporate governance of the AWRI was enhanced with her Membership of the Australian Institute of Company Directors, and her contribution to the Board of the AWRI was valued by its members.

Janet's passing, after a long period of illness, is recorded with much sadness. The AWRI is truly indebted to Janet's contribution. Whilst her professional ethic is acknowledged, it was her personal connection to the AWRI 'family': its staff, students, visiting researchers and Board members, that was deeply valued. She continues to be an inspiration to those who knew her, and her singing in the AWRI's corridors, her humanity and her lovely Scottish sayings will be long remembered.

1. **Communication of the AWRI's 7-year Research, Development and Extension Plan.** The 7-year RD&E Plan was presented to key stakeholders on 10 August 2006 in Adelaide and subsequently presented at local wine association Annual General Meetings around Australia.
2. **Execution of a 7-year investment agreement** between the Grape and Wine Research and Development Corporation and AWRI. The agreement provides about \$65 million, over seven years, directed towards outcomes that will benefit the grape and wine sector in Australia.
3. **Successfully applied and lobbied for a \$2 million grant under the National Collaborative Research Infrastructure Scheme (NCRIS).** To establish the South Australian node of Metabolomics Australia at the AWRI with a specific focus on food and beverage metabolomics, the Australian Government awarded \$1.2 million and an additional \$0.8 million was awarded by the South Australian State Government.
4. **Successfully applied to the Premier's Science and Research Council Fund** for a grant of \$533,745 over three years for equipment, enabling AWRI to fast-track its yeast-strain development programs.
5. **Identification of a previously unrecognised 'pepper' aroma impact compound.** We have identified the sesquiterpene primarily responsible for the spicy aroma of Shiraz grapes and wines, and black and white peppercorns. This key aroma compound was also shown to be present in significant amounts in several other important herbs and spices. A sensitive method for quantifying the 'peppery' sesquiterpene in grape and wine samples was developed and validated and we are now able to study the factors affecting its accumulation in grapes, carry-over during winemaking, and longevity during maturation.
6. **Investigations into the nature and source of 'plastic' and 'chemical-like' taints** in wines from the 2005 and 2006 vintages were successfully concluded. A range of chlorophenol compounds were found to be contributing to the taints, some at concentrations well below those previously considered a problem in wine. The source of the taint in some wines was found to be tartaric acid, and it was discovered that more of the taint compounds were released from the acid when it was added before, rather than after yeast fermentation.
7. **A prototype wine yeast was developed** that is able to substantially increase fruitiness levels in wine. This prototype yeast possesses enhanced carbon-sulfur lyase activity and released up to 25 times more 4-mercapto-4-methylpentan-2-one (4MMP) and 3-mercaptohexan-1-ol (3MH) in model ferments than any other commercial wine yeast. This knowledge will be used to develop

- further yeast strains and inoculation strategies to enhance the varietal aromas of wines to predetermined market specifications including an expression of regionality.
8. **Two new natural oak lactone precursors were identified for the first time** in oak wood extracts. Several additional precursors have also been identified tentatively. These observations will enable us to better understand and monitor the oak flavour potential of oakwood products used in wine production.
 9. **It was confirmed that the malolactic bacterium *Oenococcus oeni* is able to liberate cis-oak lactone from its glucoside precursor**, whereas there was negligible release by yeast and other lactic acid bacterial species. This observation supports anecdotal evidence that malolactic fermentation contributes to wine oak character.
 10. **The unknown compound, Factor X, that is required for protein haze formation** in white wines was identified as the sulfate anion. This knowledge enables a better understanding of the mechanisms and participants in protein haze formation and might lead to new technologies to control this potential quality defect in wine and to more efficient predictive tools based on rapid compositional analysis.
 11. **The development of a method for in-bottle oxygen measurement** which allows the calculation of not only the oxygen ingress rate but also the initial amount of oxygen in the headspace of a wine bottle and the amount of oxygen entrapped in the closure. The method can be undertaken in synthetic wine solutions and measured in a wine bottle sealed with closures inserted and stored under normal commercial conditions. The ability to quantify the oxygen ingress through closures is an integral tool required to understand wine development in bottle.
 12. **Understanding the contribution of phenolics to wine composition has progressed**, with methods being developed to isolate and/or characterise anthocyanin oligomers, red wine tannins, and white grape and wine phenolics. The MCP tannin assay continues to feature predominantly and a survey of tannin levels in Australian grape and wine samples from different vintages, varieties and regions was completed. In addition, the MCP tannin assay was used as a reference method to develop a predictive model for red wine tannin based on UV spectroscopy.
 13. **A better understanding of fullness and body of Riesling wines.** Increasing ethanol has a surprisingly small impact on perceived body and fullness of Riesling wines. Fullness was most commonly associated with greater flavour and higher perceived viscosity. Neither glycerol nor wine polysaccharides appeared to be a major contributor to perceived viscosity.
 14. **As part of our increased attention on understanding consumer preferences**, it was found that *Brettanomyces* flavour in red wine, even at a surprisingly low level, strongly decreased consumer acceptance.
 15. **Initial survey data indicate that the concentration of 4-ethylphenol from *Brettanomyces* contamination has fallen** by over 90% in Australian Cabernet Sauvignon wines produced in the 2005 vintage, compared to those produced in the 1996 to 1998 vintages when the survey commenced. In 39% of the 2005 vintage wines tested, no 4-ethylphenol was detected.
 16. **A novel selection approach has yielded candidate yeast strains with higher tolerance to ethanol** and improved wine fermentation properties, providing a new resource for developing better wine fermentation yeasts.
 17. **Construction of the Wine Yeast Gene Deletion Library initiated.** This project will systematically produce a library of over 5000 yeast strains, which collectively represent variation in every gene in the yeast genome, providing a rich resource for future studies into improving wine yeast function.
 18. **Demonstrated that infrared and UV-Vis spectra can effectively represent a 'fingerprint' of the grape or wine sample** being analysed. Such spectra can be used to simplify traditional methods of analysis and reduce analytical times for many grape and wine analytes.
 19. **An Applied Biosystems 4000 Q Trap tandem mass spectrometer combined with an Agilent 1200 HPLC system (LC-MS/MS) was installed** in July 2006 and has immediately contributed to AWRI activities. In particular, the new instrument has made significant impact on progress in our tannin and flavour precursor research and was essential for critical problem solving work such as the investigation into the source of chlorophenol taint found in wines.
 20. **The AWRI Online Image Collection was launched in March 2007** and holds in excess of 2,000 images. The collection of images, some of which are nearly sixty years old, range from wine microorganisms to grape harvesting technology, and will be a useful resource for industry members, researchers, academics and students.
 21. **The Analytical Service provided smoke taint analysis** support to the grape and wine sector during the 2007 vintage. Close to 1,000 samples were analysed for the smoke taint indicators: guaiacol and 4-methylguaiacol.
 22. **The second AWRI Commercial Closure Trial was initiated by the Analytical Service** in May 2007. This independent evaluation of the performance of different closures is carried out for suppliers 'in confidence' over a two-year period.
 23. **Roadshow seminars and/or workshops**, were staged in ten grapegrowing regions in four states.
 24. **For the second year in succession**, the Industry Services team responded to more than 1,700 calls for technical advice and information.
 25. **The Viticulture team responded to 339 enquiries.**
 26. **Eleven thousand copies of the AWRI annual publication, *Agrochemicals registered for use in Australian viticulture 2006/2007*** were produced and the booklet was made available from the AWRI website. The booklet was distributed with the *Australian and New Zealand Grapegrower and Winemaker*, AWRI's *Technical Review* and the tables were featured in *Australian Viticulture* and *The Grapevine Management Guide 2006/2007*. The 2006/2007 maximum residue limits for Australia's major export markets were updated for the AWRI website. Three agrochemical updates were prepared for industry email subscribers.
 27. **Communication and Information Services group members** responded to more than 3,000 requests for information during 2006/2007.
 28. **Over 17,000 records** were added to the web-accessible database of the Library (available only to Australian winemakers and grapegrowers) during the year, making a total of over 50,000 records available for searching, 24 hours per day, 7 days per week.
 29. **AWRI published** 40 papers on AWRI activities in refereed and non-refereed publications.
 30. **AWR staff members gave** 159 oral presentations, conducted 15 workshops and presented 9 posters.
 31. **AWRI staff members presented** 49 lectures and coordinated the Grape Industry Practices, Policy and Communication six week subject to undergraduate students.
 32. **AWRI staff members supervised/co-supervised** 22 postgraduate students.
 33. **AWRI staff members recorded** and responded to 5,277 requests for information during the 2006/2007 year, or to put the statistics into perspective, 21 people contacted AWRI seeking information on every working day of the year. This figure does not include the amount of problem samples investigated (2,000) or the number of Analytical Service analyses undertaken (> 100,000) during 2006/2007.

Staff activities



In addition to undertaking research and other projects described in this report, the AWRI performs a large number of external activities in support of the Australian wine industry.

Information on seminars, talks and poster papers given to outside organisations, academic lectures delivered, graduate students supervised, and the papers published is tabulated and can be found in Appendices 1–6 of the Annual Report. Activities in addition to those in the Appendices are described below.

Sakkie Pretorius is a member of the South Australian Wine Industry Council; the Wine Innovation Cluster Leadership Group; the Wine Industry Technical Advisory Committee (WFA); the AWBC's Compliance Advisory Committee; the Council of the Royal Agricultural and Horticultural Society of SA Inc; the Wine Committee of the Royal Agricultural and Horticultural Society of SA Inc; Editorial Board of the following journals: *American Journal of Enology and Viticulture*, *Annals of Microbiology*, *FEMS Yeast Research* and *Yeast*. He is the Chairman of the Conference Planning Committee of the Thirteenth Australian Wine Industry Technical Conference. He is a member of the International Commission of Yeasts, the Scientific Board of L'Institut des Sciences de la Vigne et du Vin (ISVV), Bordeaux, France, the Scientific Committee of Institut Català de Recerca en Enologia i Viticultura (ICREV) Tarragona, Spain. He is also a Professor Extraordinary of the University of Stellenbosch and an Affiliate Professor of The University of Adelaide.

Markus Herderich is Leader of Project 1.2 of the Cooperative Research Centre for Viticulture II (CRCV2), Affiliate Associate Professor at The University of Adelaide and is a member of the Advisory Board of the *Journal of Agricultural and Food Chemistry*. He supports the Wine Innovation Cluster development as a member of the Technical Reference Group and co-chair of the Science Integration Committee, and is a member of the Planning Committee and Program Committee for the 13th Australian Wine Industry Technical Conference (Adelaide 2007).

Eveline Bartowsky serves on the Joint Editorial Board of the following journals: *Journal of Applied Microbiology*; and *Letters in Applied Microbiology* and serves on the Editorial Review Board of the *Journal International des Sciences de la Vigne et du Vin*. She is a member of The Waite Campus Health and Safety Forum, a member of the organising committee for the Australian Society of Microbiology Conference to be held in Adelaide in 2007, Poster Coordinator for the 13th Australian Wine Industry Technical Conference and is an Affiliate Lecturer at The University of Adelaide.

Paul Chambers is a member of the Editorial Review Board of the *Australian Journal of Grape and Wine Research*. He is also a member of the organising committees for the XXIII International Conference on Yeast Genetics and Molecular Biology to be held in Melbourne in 2007; the 11th International Symposium on the Genetics of Industrial Microorganisms, to be held in Sydney in 2010; and is coordinator of the Australian Yeast Group (through its homepage at <http://www.australianyeastgroup.org/>).

Leigh Francis is a member of the Editorial Board of the *Journal of the Science of Food and Agriculture*, and is also an Affiliate Lecturer at The University of Adelaide.

Paul Henschke serves on the Editorial Review Board of the following journals: *Australian Journal of Grape and Wine Research*; *Food Microbiology*; and *Mitteilungen Klosterneuburg*. He is a member of the organising committee for the XXIII International Conference on Yeast Genetics and Molecular Biology to be held in Melbourne in 2007 and served on the program organising committee of the 39th Annual Australian Institute of Food Science and Technology Convention held in Adelaide, 9 – 12 July 2006.

Mark Sefton is on the editorial review board of the *International Journal of Vine and Wine Sciences* and is the project leader of project 1.3 of the CRCV2. He is also an Affiliate Senior Lecturer with The University of Adelaide.

Elizabeth Waters is an Associate Editor for the *Journal of Agricultural and Food Chemistry*, a Program Manager of the Cooperative Research Centre for Viticulture II (CRCV2), an Affiliate Associate Professor, The University of Adelaide and an Adjunct Professor, National Grape and Wine Industry Centre, Charles Sturt University. She is a member of the Program Committee for the 13th Australian Wine Industry Technical Conference (Adelaide 2007), the Scientific Committee for In Vino Analytica Scientia (Melbourne 2007), a Director of Provisor Pty Ltd and an Expert member of Performance BIB.

Hentie Sweigers is an Affiliate Lecturer, School of Agriculture and Wine, The University of Adelaide.

Peter Godden is a member of the 13th AWITC Program sub-Committee and the Workshop Coordinator of a program of 56 workshops to be held at the Thirteenth Australian Wine Industry Technical Conference. He was the chair of a judging panel at the 2006 Australian Alternative Varieties Wine Show.

Creina Stockley is an Affiliate Senior Lecturer, School of Agriculture and Wine, The University of Adelaide. She is a member of the National Drug and Alcohol Research Centre's Young People and Alcohol Project Advisory Group on behalf of the Winemakers' Federation of Australia (WFA), and the Winemakers' Federation of Australia Wine and Health Committee. She is also the Department of Agriculture Fisheries and Food's nominated Australian delegate for Organisation International de la Vigne et du Vin (OIV) Health and Safety Commission (IV), and on 13/3/07 was elected President of the Food Safety Expert Group, AWBC/WFA Wine Industry Technical Advisory Committee (as Technical Liaison); the AWBC Legislation Review Committee; and the Wine Industry National Environment Committee.

Adrian Coulter is a member of The University of Adelaide's Wine Science Laboratory Management Committee.

Rae Blair is a member of the Conference Planning Committee for the 13th AWITC and is the Public Officer, Treasurer and Conference Manager of the Australian Wine Industry Technical Conference Inc.

Mai Nygaard is a member of the WISA innovation committee.

Leanne Craddock is a member of the IWAG (Inter Winery Analysis Group) committee.

Roxanne Portolesi is a member of the Ausbiotech Student Committee.

Acknowledgements

Design by Geoffrey Reed Communication

Photography by Richard Humphrys

Visitors to the AWRI

International

Denmark

Peter Sommer, Christian Hansen A/S,
14 July 2006

Slovenia

Peter Raspor, University of Ljubljana,
18-19 July 2006

Germany

C-D. Patz, Forschungsanstalt Geisenheim, July
2006

Ludger Triebus, Bayer Crop Sciences,
13 February 2007

Sibylle Krieger-Weber, Lallemand,
5-6 February 2007

USA

Clark Smith, Vinovation, Sonoma, California,
USA, August 2006

John Finley, Chief Technical Officer, A.M. Todd,
U.S.A., 29 August 2006

Grant Cramer, University of Nevada, Reno, 16
January 2007

Gail Davis, International Trade Division, and
William Foster, Headquarters Operations of
the US Department of Treasury Alcohol and
Tobacco Tax and Trade Bureau, 18 January 2007

Greg Hodson, E&J Gallo, 31 January 2007

Martin Mitchell, Iowa Department of Economic
Development, Frans de Ryk, Iowa/South Australia
Transnational Alliance, Mark Campbell,
Integrated DNA Technologies, 19 March 2007

Nigel Sneyd and Chris Proud, E&J Gallo,
29 March 2007

Italy

Andrea Dal Cin, Masi Agricola, Verona,
2 August 2006

Fulvio Bosano and Franco Cocchiara,
Guala Closures, 2 March 2007

Alberto Granata and Kim Lawless, Dal Cin,
18 May 2007

Ireland

Eoin Lalor and Antonio Occelli, Kerry Bio-Science,
Cork, Ireland, 18 August 2006

Barry McCleary, Megazyme, 30 January 2007

France

Nathalie Sieczkowski, Martin Vialette
Oenologie, Epervay, France, 20 July 2006

Christophe Gerland, Fordras SA, Chateuil,
France, 26 October 2006

Stephane Vidal and Olav Aagaard, Normacorc,
21 and 22 March 2007

South Africa

Karien Lourens, Anchor Yeast, South Africa,
10 October 2006

Chile

Jose Luis Balmaceda, Chilean Ambassador to
Australia, 24 October 2006

Chilean business delegation, 11 November 2006

Pablo Pasten Gonzalez, Universidad Catolica
de Chile, 16 February 2007

UK

John Corbet-Milward, Technical and
International Affairs, Wine and Spirits Trade
Association, 30 January 2007

Belgium

Pol Coppin, University of Leuven,
7 March 2007

Japan

Michikatsu Sato and Fujitoshi Yanagida,
Yamanashi University, Japan,
16 February 2007

Akiko Osaki, Shuhan News, 8 March 2007

Russia

Valery V. Loginov, President, Union of
Winegrowers and Winemakers (SVVR), Igor
Kandaurov, Director of Primorsky Farm
(Krasnodar Region), Gennady V. Olesko, Chief
of Winegrowing and Gardening Department,
Krasnodar region, Aliona (Elena) Klenyaeva
Brand Manager (Australia), RusImport, David
Travers, Agent General (Acting) for South
Australia (London), 6 March 2007

New Zealand

Andrew Granger and Bruce Campbell,
HortResearch, 16 March 2007

Bruce Campbell, Michelle Williams and Dan
Ryan, HortResearch, New Zealand, 28 May 2007

China

Delegation from the General Administration
of Quality Supervision, Inspection and
Quarantine of the People's Republic of China
(Han Yi, Chen Gencun, Zhang Ribin and Guo
Xiaodong) 29 May 2007

Domestic

Frank Vriesekoop, and Dr Aldred, University of
Ballarat, Victoria, 13 July 2006

Henry Martin, Crawford Loss Adjustors,
21 July 2006

Ian Jones, Fosters Group, 18 August 2006

Grant Harrison, Coriole Wines, 24 August 2006

Miguel de Barros Lopes, University of South
Australia, 29 August 2006

Lance Schlipalius, Technovate Management
and Consultants Pty Ltd, 31 August 2006

Grant Stanley, Victoria University,
28 September 2006 and 27 November 2006

Michael Perkins, Flinders University and 6
students undertaking a Medicinal Chemistry
degree, 28 September 2006

Nick Tyden and Richard Branson, Sipcam,
September 2006

Andrew Ward, Becker Underwood,
September 2006

Eric Wilkes, Fosters Wine Estates, September 2006

Chris Bevin, Hardy Wine Company, September
2006, February, March, April and May 2007

Alan Newton and Mark McKenzie, Wine Grape
Grower's Australia, 4 October 2006

Anthony Saliba, Charles Sturt University,
Wagga Wagga, 11 October 2006

Dorota Clausen, Pernod Ricard Pacific,
19 October 2006

Olga Kostic, Fleurieu Winery Supplies, Yankalilla,
26 October 2006

Grant Harrison, Coriole Wines, 1 November 2006

Tom McMeekin, University of Tasmania,
2 November 2006

Michael Harding, Angove's Wines,
14 November 2006

Peter Anderson, Flinders University,
17 November 2006

Ian Macreadie, CSIRO, 24 November 2006

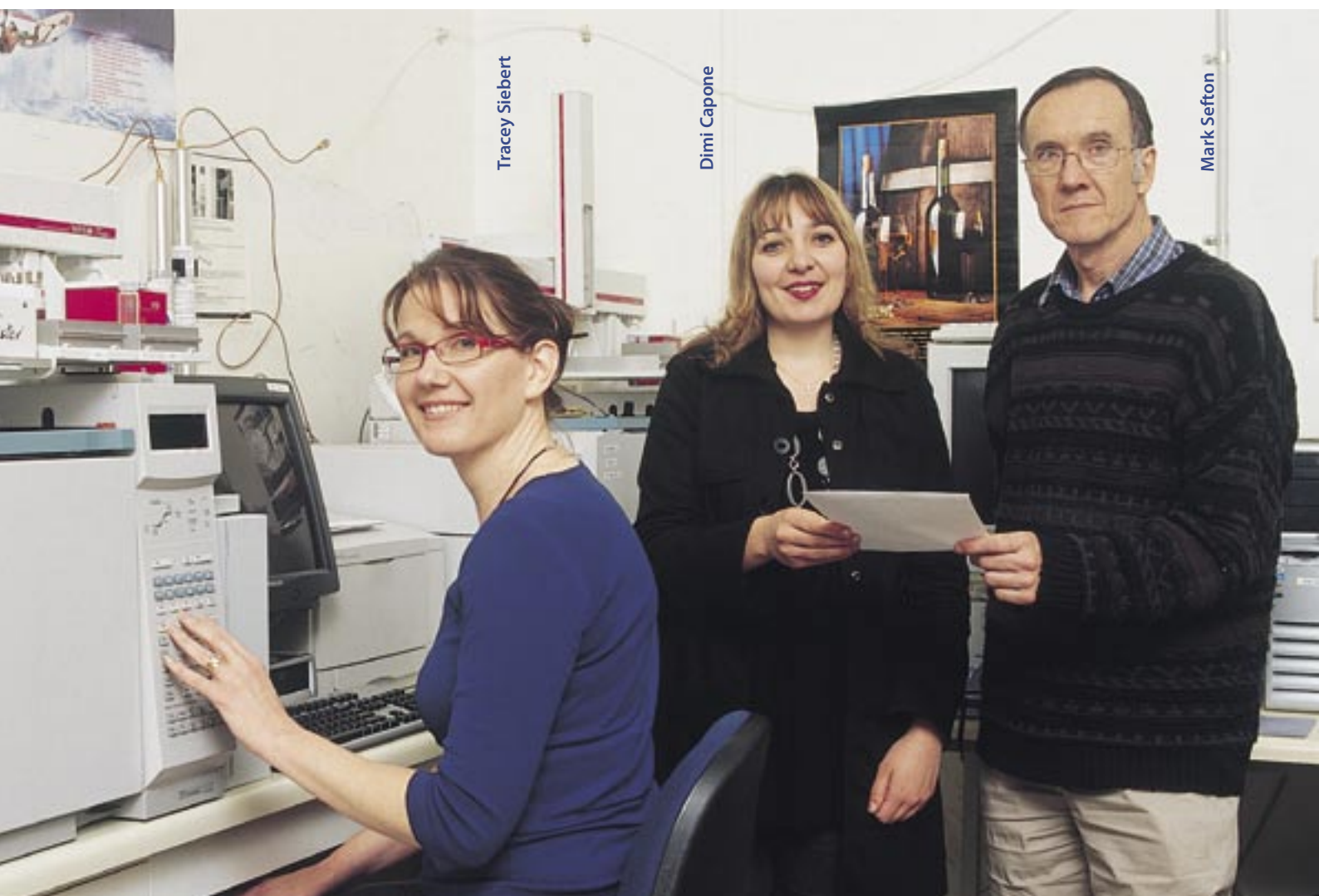
Lars Keld-Nielsen, University of Queensland,
28 November 2006

Sergeant Paul Friend, Traffic Training & Promotion
Section, SA Police, made presentation at the
Advanced Wine Assessment Course held 5-8
December 2006.

Brian Croser, 8 December 2006

Ciaran Forde and Conor Delahunty,
Food Science Australia, 18 December 2006

Visitors to the AWRI



Tracey Siebert

Dimi Capone

Mark Sefton

Domestic (continued)

Sarah Fraser, Victoria University, Melbourne, 19 December 2006

Stephen Strachan, Winemakers' Federation of Australia, 29 January 2007

Hugh Armstrong, Bayer Crop Sciences – Australia, 13 February 2007

Peter McCarthy and Billie Atanasova, Drinkwise Australia Ltd, 13 February 2007

Michael Milligan and Ken Murrell, Department of Further Education, Employment, Science and Technology, 26 February 2007

Bruce Stevenson and Simon Yudelevich, Auscap, 2 March 2007

James Fisher, Muresk Institute, Curtin University of Technology, 6 March 2007

Kym Lowell, CRC for Spatial Information, 7 March 2007

Andrew Markides, Lallemmand and Norman Phillips, Advanz Ltd, 7 March 2007 and Andrew Markides, Lallemmand, 25 June 2007

Mark Gishen, CRCV Technologies, 15 February and 7 March 2007

Steve Tyerman's group, School of Agriculture, Food and Wine, University of Adelaide, March and May 2007

Tamath Rainsford, Department of Chemical Engineering, University of Adelaide, 16 March 2007

Tom Geimer, Cettera Pty Ltd, 30 March 2007 and 21 June 2007

Greg Edwards and Rodney Bubner, Yalumba Wine Company, 19 April 2007

Peter Ridings, Vinpac International, 23 April 2007

Kate Lattey and Nick Warnock, Orlando Wines, May 2007

John Neville, Queensland College of Wine Tourism, 1 May 2007

Tony Bacic, University of Melbourne, Dick Wettenahll, Vladimir Likic, Mal McConville, Bio21 Institute of Molecular Science and Biotechnology, Lars Nielsen, University of Queensland, Ute Roessner, Australian Centre for Plant Functional Genomics, Robert Trengove, Peter Solomon, Murdoch University, Steven Smith, Wenxu Zhou, Plant Energy Biology ARC Centre University of WA, for a Metabolomics Australia meeting, 28 May 2007

Anupama Kumar, CSIRO Land and Water Adelaide, June 2007

Rob Hunt, Boars Rock Winery, 19 June 2007

Team reports

Theme 1: Grape and wine composition

Defining and controlling important volatile compounds and their impact on wine aroma and flavour

Staff and students

Dr Mark Sefton, Dr Elizabeth Waters, Dr Alan Pollnitz, Dr Gordon Elsey, Dr Sally-Jean Bell, Richard Gawel, Dimitra Capone, Tracey Siebert, Marcel Essling, Kevin Pardon, Katryna van Leeuwen (AWRI), Rachel Brown, Natoiya Lloyd, Carolyn Puglisi, Anthea Fudge, Joanne Giaccio, Heather Heading, Josh Hixson (students, Flinders University)

Visiting student

Claudia Wood (student, Pontificia Universidad Catolica de Chile).

An understanding of the relationship between wine composition and wine aroma and flavour is essential to being able to predict grape and wine quality. These aromas and flavours include many important varietal and bottle-age characters, characters associated with oak, wine microorganisms and oxidation, as well as taints, 'off-flavours', 'reduced', and 'green' characters. The objectives of this work are to determine the chemical nature of hitherto unrecognised important volatile wine components, to enhance our understanding of the relationship between wine composition and sensory properties, to develop analytical methods for important wine components and their precursors, and to determine the effect of viticultural and oenological techniques and wine storage conditions on the formation and fate of these compounds. The development of this knowledge will enable grapegrowers and winemakers to adjust their production practices to achieve wines of a pre-determined style.

Identification of a new, potent spicy aroma compound

Shiraz is a major red wine grape variety. Australian Shiraz is a medium to full-bodied wine, usually oaked, encompassing a flavour spectrum from blackberry, plum and mulberry to spicy, liquorice, cigar-box and eucalyptus. It is grown in a range of climates from hot sunny regions, which tend to produce full-flavoured plum, spice, blackberry and chocolate flavours, to cooler wetter regions which sometimes produce more of a distinctive black pepper aroma, depending on the year of vintage. Some of Australia's most famous 'icon' wines are made from Shiraz grapes. Various studies on the compositional and sensory analysis of Shiraz have been undertaken. However, as is the case for pepper itself, the compound (or group of compounds) responsible for the distinctive 'black pepper' aroma in Shiraz grapes and wine has remained unidentified.

Analysis of fractions from Shiraz grapes, and of extracts of Shiraz wines indicated that they contained a single component that gave a strong spicy/peppery aroma when assessed by gas chromatography/mass spectrometry/olfactometry (GC/MS/O). However, attempts to concentrate and purify this component sufficiently to be able to identify it were unsuccessful.

It was clear from the GC/MS/O work that the aroma associated with the peppery character in the grape fractions bore a striking resemblance to the aroma of commercial white pepper. Therefore, a crude extract of ground white pepper was analysed by GC/MS/O and this showed that, not only was the compound responsible for the peppery character in the grapes also apparently present in the white pepper extract, but that it was also one of the most potent, if not the most potent odorant in the latter sample. It was clear from searching the literature that, despite numerous high quality

compound it was possible to prove that 'Sympep' was indeed the peppery odorant in both the peppercorn and grape extracts.

An aroma detection threshold study for 'Sympep' was then conducted. Approximately 25% of panellists could only detect this compound at very high concentration or not at all, even in water. The sub-group detection threshold for red wine and water for the remaining panellists was 16 and 8 ng/L respectively. This makes 'Sympep' one of the most potent wine aroma compounds known. The significant proportion of the sensory panel that was insensitive to this compound indicates that the same sample of a peppery wine could appear completely different to two different consumers or wine judges.

With the identity and aroma detection threshold of the Shiraz peppery compound established, a GC-MS method for quantifying this compound in grapes and wine was then developed, using

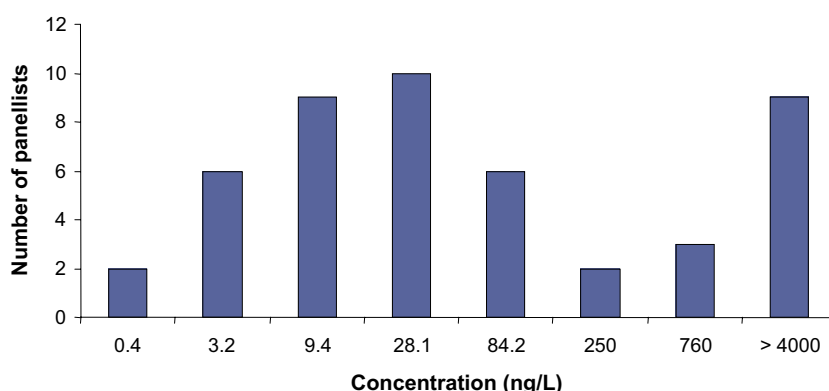


Figure 1. Distribution of best estimate threshold concentration (ng/L) for 'Sympep' in a red wine. About 20% of panellists could not smell the compound at 4,000 ng/L (the highest level tested)

publications on the composition of black and white peppercorns, this compound had not been identified in those products, nor had its importance even been recognised. This was probably because most of these studies had focussed on compounds that eluted earlier in the chromatograms of pepper extracts and/or on known compounds. Analysis, by GC/MS/O, also demonstrated the presence of this peppery compound in a variety of many additional herbs, spices and plant products. However, from the various GC/MS/O assessments, the concentration was obviously highest in the peppercorn extracts.

Because the compound responsible for much of the aroma of black and white peppercorns and for the peppery aroma in Shiraz grapes appeared to be one and the same, we endeavoured to isolate this compound from peppercorn extracts. Eventually, a fraction from this source was obtained that gave a chromatogram with one major homogeneous peak that had a clean mass spectrum on three different columns and also had a powerful pepper odour, even when diluted more than a thousand-fold. The mass spectrum and retention indices matched those of a reference sample of a sesquiterpene, 'Sympep', that had been synthesised by a European flavour company, with whom a collaboration had been established. With this authentic reference

a deuterium-labelled analogue synthesised in our laboratory. The method is accurate, precise and shows good linearity across the calibration range with low limit of quantitation (< 1 ng/L). This GC-MS technique allowed us to identify and quantify 'Sympep' in a range of natural products and spices as well as grapes and wine. The analyses showed that 'Sympep' is wide-spread in nature and is a key aroma component of many herbs and spices. In this preliminary survey, its concentration was highest in a white peppercorn extract (more than 10,000 times the concentration of the most peppery wine). However, some other plant samples, e.g. marjoram and rosemary contained surprisingly high amounts of 'Sympep'.

Various grape homogenate and wine samples on which sensory studies had previously been conducted were analysed for 'Sympep'. Grape homogenates with the highest 'pepper' score were shown to contain the highest concentration of 'Sympep'. The wine made from the same vineyard as the most peppery grape samples had the highest 'Sympep' concentrations. Similarly, the red wine survey and sensory data demonstrated the wide-spread presence of 'Sympep' in red wine and established, as observed for grapes, a close relationship between the concentration of this compound and the intensity of the 'peppery' aroma in red wine.

Team reports

With the nature of the compound responsible for the peppery aroma in wines established and methods for measuring this compound in grapes and wine developed, we will now be able to study how this compound behaves during fermentation and bottle ageing, and what factors are responsible for effecting the levels of 'Sympep' in grapes. This knowledge will enable viticulturists and winemakers to more effectively control pepperiness in grapes and wines.

Identification of new oak lactone precursors

A screening method for detecting oak lactone (OL) derivatives in extracts of oak using liquid chromatography/mass spectrometry (LC/MS) and authentic samples previously synthesised in our laboratory, has been conducted. The screening method, which uses LC-MS/MS, determined that the ring-opened *cis*-OL gallate; ring-opened *cis*- and *trans*-OL glucosides; and ring-opened *cis*-OL galloylglucoside, together with three other isomers of this last compound, were present as components of American and French oak wood extracts. Earlier experiments in our laboratory had shown that these compounds can be converted to oak lactone during barrel toasting or during malolactic fermentation. In addition, a ring-opened OL rutinoside was tentatively identified.

A synthetic sample of a methylated gallate, proposed more than 20 years ago by researchers in the whiskey industry as an oak lactone precursor, could be easily detected by the screening method in spiked oak extracts. However, this compound was not observed in any of the unspiked extracts. This last observation is in keeping with our earlier research which showed that the precursor isolated 20 years ago had been incorrectly identified.

With the identity of several actual or potential oak lactone precursors established, we are now able to develop methods for determining the amount of these compounds in oak with a view to being able to predict the flavour potential of oak samples.

Wine flavour perception 'in-mouth'

Ethyl alcohol and glycerol are major products of yeast fermentation. In their pure forms, glycerol is sweet and viscous, and ethyl alcohol is both bitter-sweet and produces palate hotness. In the present study, the contribution of these important substances to wine fullness, hotness, sweetness, aroma and flavour were assessed by a formal sensory study, whereby a number of dry Riesling wines were fortified with wine realistic levels of both ethanol and glycerol and tasted by a trained panel.

Generally, alcohol and to a lesser extent glycerol had a positive effect on both white wine body and perceived viscosity. However, the effects were surprisingly small and were wine dependent. In a follow-up study, whereby the natural sweetness of glycerol was first blocked by a prior mouth rinse with an extract of the anti-saccharine herb *Gymnema sylvestre*, tasters could not detect any change in palate viscosity resulting from a large increase in glycerol concentration. This result further suggests that glycerol does not significantly affect perceived viscosity in

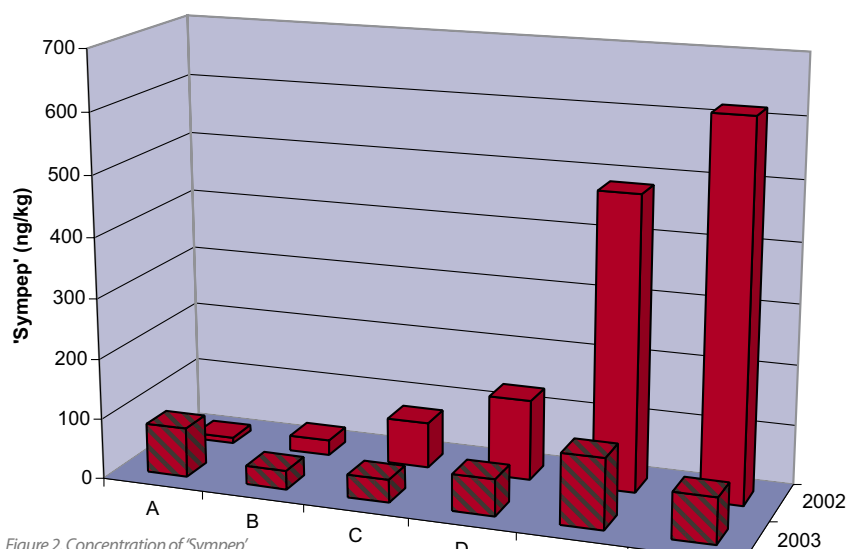


Figure 2. Concentration of 'Sympep' (ng/kg) in Shiraz grapes from six vineyards (A-F) over two vintages (2002 and 2003). 2002 was widely regarded as being a more 'peppery' year than 2003 for Shiraz grapes in several wine regions in Australia

dry white wines. Furthermore, elevated levels of ethanol or glycerol did not consistently affect aroma, flavour or sweetness perception.

The interpretation of what sensory attributes contribute to 'white wine body' was found to be idiosyncratic. Half of the tasters associated increased flavour and perceived viscosity with body. Perceived hotness was not viewed as an important component of body by any taster while the role of acidity in defining body was taster dependent.

Future work will involve further investigations into the interactions between wine polysaccharides and other white wine components and their effect on white wine body and palate hotness. We have been successful in extracting polysaccharides from white wine using multilayer counter current chromatography using food grade methods for use in future studies.

Phenolics and their contribution to wine composition and sensory properties

Staff and students

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Collaborators

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Chris Bevin, Kerri Thompson, Warren Birchmore, Sue Bell (Hardy Wine Company); Jai O'Toole (Orlando Wines); Dr Eric Wilkes (Foster's Group); Bruce Kambouris (McGuigan Simeon Wines).

The Phenolics Research Team at the AWRI has the objective of evaluating the roles of phenolic compounds present in grapes and wines. One critical aspect of this project includes developing the ability to measure phenolic grape and wine components relevant for wine colour, mouth-feel, astringency and taste on a molecular level. Focus is also directed toward development of a more detailed insight into the winemaking-related transformations of phenolic compounds, particularly the consequences of these reactions for wine composition, quality or style, which relate to preserving and enhancing quality, consumer expectations and profitability. The project also develops knowledge of grape and wine phenolic attributes of relevance for consumer wine preferences and looks to improve grape harvesting and delivery processes. Finally, targeted optimisation of viticultural and winemaking practices, and the verification of potential and risks associated with novel practices and new technology are considered critical aspects to the projects success.

Structure and function of phenolic compounds in grapes and wine

One of the keys to driving applied phenolics research forward is to increase the fundamental knowledge of how the chemical 'structures' of grape and wine phenolics affect their 'function'. Whether the function of interest is mouth-feel, colour or perhaps bitterness, it is crucial to understand the molecular structures of the relevant phenolics. David Jeffery leads the charge in this area with particular focus on characterisation of tannin structure, reactivity and function; one of the last frontiers in natural product chemistry. As tannins in wine constitute a hugely heterogenic mixture, and reference substances are largely unavailable from commercial sources, separation, isolation and characterisation of compounds are a significant challenge. Progress in characterisation of red

wine tannins requires new technologies for separating this complex class and the project has progressed significantly in this area in the last year. New analytical HPLC techniques using novel solid phases now allow characterisation of several tannin sub-fractions. A solid phase extraction (SPE) method, using a novel solid phase, has been finalised in our laboratory for rapidly isolating pure wine tannins with minimal handling, using just one cartridge. This allows total wine tannin to be isolated; or two wine tannin sub-fractions (which together constitute the total wine tannin fraction), one of which is significantly more polar than the other. Gaining access to these two tannin sub-fractions is a major step forward as the relationship of each of the two sub-fractions may now be investigated with respect to wine age, variety, sensory properties or other parameters.

Yoji Hayasaka continues to contribute his significant skills to determining phenolic structures. A study demonstrating the presence of anthocyanin oligomers in a grape skin extract for the first time (AWRI publication #808) has been expanded upon and a project is under way to isolate anthocyanin oligomers using multilayer counter current chromatography.

In addition, a method for the characterisation of tannin subunits by acid-catalysed hydrolysis in the presence of cysteamine was optimised and evaluated using commercial seed and skin tannins as well as insoluble materials of red wine. This method is a more sensitive (by mass spectrometer) and user-friendly substitute for other methods for the characterisation of subunits of tannins. Together with the new SPE fractionation method, these two new methods now form essential parts of the 'tannin toolkit' available to the AWRI.

The PhD research of Eric Dennis on the organic synthesis of condensed tannins continues to make good progress through our collaboration with the Natural Products Chemistry research group at Flinders University led by Michael Perkins. The coupling of monomeric units together into larger, structurally-defined tannin polymers remains the focal point of this research project; such molecules are critical to understanding the influence structure has on function. The use of reactive 'handles' within the molecules now allows for extension of the tannin molecules in a high yielding and controllable manner.

Grape phenolics and their contribution to wine composition and sensory properties

To improve our understanding of the relationships between viticultural practices, grape composition, red wine composition and sensory properties, Helen Holt has continued her study into pruning, irrigation and maturity effects on berry size. Berry composition was compared for three pruning treatments (Machine, Spur and Rod and spur [Rod]); two irrigation treatments (irrigated and regulated deficit irrigation [RDI]) and three maturity stages (determined by °Brix not by [relative] harvest date). The preliminary findings are summarised as follows:

- Differences between pruning treatments were evident for berry size (measured as berry weight) and for anthocyanin concentration, although changes in concentration (mg/g) were generally directly related to berry size (smaller berries had higher anthocyanin concentrations). Berry anthocyanin content (mg/berry) was also generally related to berry size – larger berries had higher anthocyanin content. Results for total phenolics and tannin broadly followed the patterns observed for anthocyanin levels.

- Machine pruning generally resulted in smaller berries, higher concentration and lower content of anthocyanins, total phenolics and tannin than Rod or Spur.

- Irrigated berries were generally larger than RDI berries. In two of three years assessed, anthocyanin concentration was related to berry size. Total phenolic and tannin concentration levels in berries did not show strong relationships to berry size and irrigation treatment. In two of three years assessed, berry content measurements for anthocyanins, total phenolic and tannin levels were directly related to berry size.

- The trial was conducted over three vintages and as noted berry composition was largely influenced by berry size. However, one year was hotter and drier than the other two and in that year total anthocyanin and tannin concentration (mg/g) did not reflect berry size differences due to irrigation treatments, suggesting that berry anthocyanin and tannin biosynthesis were directly altered by irrigation in this vintage. One year was cooler and wetter than the other two and in that vintage total anthocyanin and tannin content (mg/b) did not reflect berry size differences due to irrigation treatments, suggesting that in a year when rainfall was adequate, RDI was compromised and any effects of RDI on berry composition seen in other years did not occur.

- Maturity effects were also seen with a general decrease in berry size in later stages, which was reflected by changes in berry anthocyanin concentration. Again changes in berry total phenolic and tannin concentration levels were less consistently linked with maturity and berry size differences. There were differences between maturity stages in berry content measures, but there was no distinct pattern in the differences which were observed. The results of this trial not only provide useful data concerning the effects of vineyard management strategies, but the variability between vintages also demonstrates the importance of conducting such trials over a number of vintages to obtain accurate information.

In addition, our 2007 vintage experimental work focussing on the relative contributions of seed and skin tannin to wine tannin has been successfully completed. This work was conducted using seven parcels of Cabernet Sauvignon grapes from five regions and a wide range of berry tannin concentration. Over 9,000 berries were de-seeded or de-skinned in order to investigate the composition of the berries and the wines resulting from micro-fermentations of 100 berries. These data will be used to determine the direction of future work in this project, particularly with respect to developing more rapid methods to examine the influences of skin and seed extraction into wine during fermentation and markers of phenolic maturity in berries.



Team reports

Method development and optimisation for measurement of white grape and wine phenolics has continued. Mango Parker remains responsible for the identification of the compositional basis for style and quality parameters associated with phenolics in white grapes and wines, and the positive and negative roles these compounds might play in defining taste and colour. This work has a strong collaborative focus through interaction with research groups at AWRI, The University of Adelaide and wine sector partners. A white wine phenolics review was published (AWRI publication #969) which summarised the chemistry of the phenolic compounds in white grapes, juice and wine, their typical concentrations, knowledge about the effect of processing on the phenolics, and their relevance to attributes such as colour, mouth-feel, taste and quality.

Analysis of phenolic compounds – developing innovative phenolic analysis techniques

We have continued to provide the wine sector with practical and informative material to help them measure the tannin concentration in their grapes and wines and to help improve the understanding of the implications of tannin. Meagan Mercurio continues to drive the development, adoption and application of new, industry-applicable methods for tannin measurement in response to the wine sector's need for objective indicators of grape and wine quality. The AWRI's standardised methodology for quantifying tannins in grape and wine samples has now been fully developed and is based on precipitation of tannin with methyl cellulose. This assay, known as the methyl cellulose precipitable (MCP) tannin assay is now fully optimised, validated and available to the wine sector and researchers alike in 1 mL, 10 mL and high throughput (HTP) formats. The 1 mL format uses small sample volumes which reduces reagent costs and allows laboratories equipped with small bench-top centrifuges and a UV-Vis spectrophotometer to easily adopt the assay. The HTP format can be performed in 1.1 mL 96 well deep-well plates and read on a microplate reader spectrophotometer. A very rapid UV-based predictive model for red wine tannin has also been developed in collaboration with the AWRI spectroscopy and chemometrics team. This allows prediction of tannin levels using several simple, single wavelength measurements. A web-accessible standard operating protocol (SOP) is available for the MCP tannin assay (crcv.com.au/resources/) and hard copy liftouts of the AWRI SOPs for measuring tannin and colour were distributed with the 2007 *Australian and New Zealand Grapegrower and Winemaker Annual Technical Issue* mailout to over 5,000 subscribers. The primary peer-reviewed publication for the MCP tannin assay (AWRI publication #975) appeared in *The Journal of Agricultural and Food Chemistry* while our article in the *Australian and New Zealand Wine Industry Journal* (AWRI publication #971) highlights the roles and relevance of tannin in understanding quality and consumer preferences. Our article in the *Australian New Zealand Grapegrower and Winemaker Annual Technical Issue* demonstrates the ease with which any laboratory in the wine sector can apply such an assay to assessments of grape composition.

Development of rapid spectral grape and wine tannin measurement using the MCP tannin assay as a reference method continued in collaboration with the AWRI's spectroscopy and chemometrics team, who recently developed a UV-based method to predict tannin in red wines using several individual UV wavelengths, thus allowing very rapid determination of tannin by the wine sector on Australian samples. This wine model complements existing models developed by the team which allow very rapid tannin measurement in grape homogenate extracts.

In addition to assisting the grape and wine sector with the measurement of tannin, we can now also provide information on what that number 'means' within Australia. This significant opportunity stems from completion of our Australian grape and wine tannin survey and the development of a database that now allows investigation of tannin concentration variations among regions, varieties and vintages. Furthermore, using allocation grading data from major wine sector partners, we have shown consistent positive correlations between red wine quality and tannin concentration which might have significant implications for quality assessment in the future.

Microbial modulation of wine composition to increase wine value

Staff and students

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Collaborators

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Research conducted by the Wine Biosciences group at the AWRI focuses on the microbial physiology, genetics, molecular biology and biochemistry of wine yeast and bacteria, with the aims of: generating yeasts and bacteria that confer improved wine sensory properties; improving robustness of wine yeasts and malolactic bacteria; generating novel wine yeasts using non-GM approaches such as interspecies hybridisations; developing 'low-alcohol' yeasts; and developing and commercialising wine microorganisms.

Flavour-enhancing yeast

The metabolism of wine yeast results in the production of a large quantity of flavour compounds. This year we have significantly increased our knowledge on yeast-mediated production of valuable flavour compounds from grape-derived precursors.

We have developed a prototype wine yeast able to significantly enhance the passion-fruit aroma in white and red wines (Figure 3). In this work, a gene cassette containing a bacterial carbon-sulfur lyase gene was integrated into

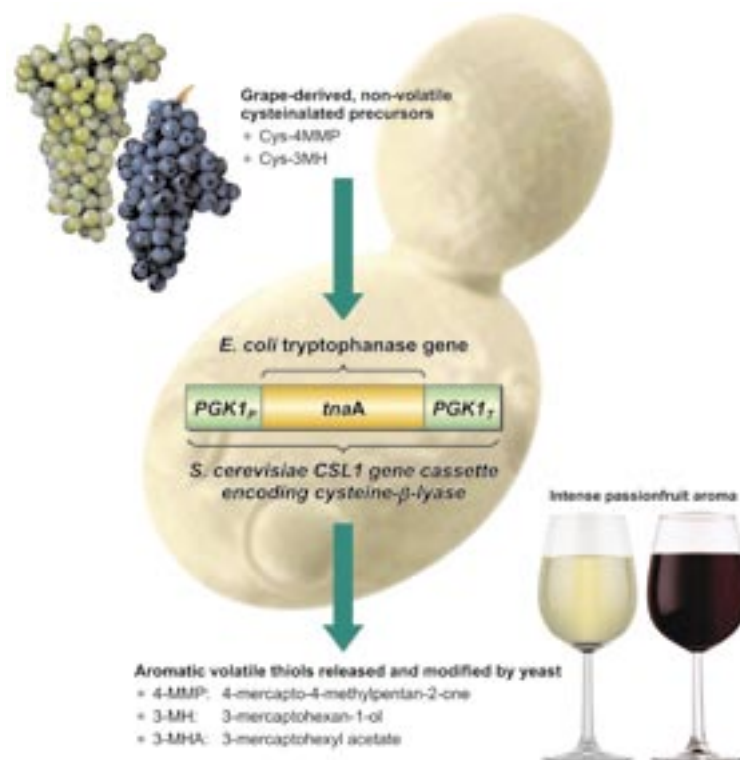


Figure 3. Prototype wine yeast which enhances the passion-fruit aroma in wine

the genome of a wine yeast resulting in the release of elevated levels of the volatile thiols 4-mercapto-4-methylpentan-2-one (4MMP) and 3-mercaptohexanol (3MH), from the corresponding cysteine conjugate precursors. This work indicates that it is possible to enhance significantly the aroma of wine, even from grapes where the flavour precursors are limited. This prototype (proof-of-concept) aroma-enhancing yeast is useful as a scientific benchmark model only; information generated with this prototype yeast will be used to develop non-GM flavour-enhancing wine yeast and practices.

We are continuing to characterise and identify novel yeast genes encoding enzymes involved in wine flavour. Microarrays covering the entire yeast genome have been used to characterise gene expression in two flavour-modulating wine yeasts, and a number of flavour-enhancing candidate genes have been identified. These genes will be investigated in more detail to determine their impact on wine flavour. Other, previously identified, 'flavour genes', such as the ester forming *ATF1* and *EHT* genes, are currently being characterised.

A number of experimental and winery trials have been conducted using co-inoculation of wine yeast as a tool to modulate wine flavour. Chemical analysis indicated that co-fermented wines were more complex in terms of yeast-derived flavour compounds and that the concentration levels of volatile thiols were elevated in the co-ferments compared to the single strains ferments. Sensory analysis indicated that some of the co-ferments resulted in wines with the highest level of passion-fruit aroma. This knowledge will enable winemakers to more effectively control 'fruitiness' levels in wines and to achieve wines of pre-determined style.

Nutrient effects on red wine fermentation and wine composition

Nutrients are essential for proper yeast growth and fermentation activity but also play a primary role in determining wine composition at the end of fermentation. Yeast Assimilable Nitrogen (YAN) is a key nutrient in musts. YAN levels vary widely among varieties and vintages, and consequently, can greatly affect fermentation. Suboptimal levels of YAN are associated with slow fermentation rates and increased risk of stuck and sluggish fermentations. Diammonium phosphate (DAP) is widely used to supplement low nitrogen grape musts, particularly before or during alcoholic fermentation, as it is considered the most useful tool for readily optimising yeast fermentation performance. In previous studies, a relationship between the nitrogen composition of grape juice and the volatile composition of wine has also been observed, although the biochemical implications of this connection are still poorly understood (AWRI publication #875). However, the effect of YAN supplementation of red grape musts that contain grape solids, on wine volatile composition, has not been investigated. For the same reasons, the influence of nitrogen supplementation of grape must on the chemical compounds responsible for red wine colour and mouth-feel has not been determined.

The first of a series of red wine fermentation experiments, carried out by maceration on grape skins, has studied the impact of DAP supplementation of a low YAN must on the volatile and non-volatile composition of Shiraz wines. The initial YAN concentrations of musts were chosen to bracket the range of YAN values (100 – 400 mg/L) typically encountered under Australian conditions.

Supplementing the musts with DAP increased the fermentation rate and consequently shortened the time taken to complete fermentation. So as to determine the impact of DAP supplementation on the colour and phenolics content of the final wines, maceration was continued for 14 days, by which time fermentation of all treatments had completed. An effect on the polyphenolic constituents and colour parameters was observed. DAP supplementation affected the content of anthocyanins in the young wines. CIE Lab analysis of the wines (Figure 4) indicated that DAP supplementation increased colour intensity with a stronger contribution of red and blue colour components.

As observed previously with model and white wine fermentations (AWRI publication #875), DAP supplementation of the musts before fermentation had a strong impact on the volatile composition of Shiraz wines. Variations in the concentration of different classes of compounds, such as medium-chain fatty acids and their corresponding ester, acetates, higher alcohols, iso-acids and their ethyl esters, were found. Of special note was an increase in the level of concentration of several esters potentially contributing to the fruity characters of red wine in response to DAP addition. The concentrations of grape-derived volatile compounds such as monoterpenes, which are derived mostly from glycosides, showed little response to DAP supplementation of musts.

DAP supplementation has long been used to optimise fermentation kinetics but this is the first study to provide an evaluation of the potential of DAP supplementation of a red wine must to modulate the colour, aroma and flavour of Shiraz wines made from low YAN grapes fermented by maceration on skins. Further work with different musts and yeast strains is in progress to confirm the general nature of observations.

Non-conventional wine yeasts: interspecific yeast hybrids

Interspecific hybrids are being generated between commercial wine yeasts and non-*Saccharomyces cerevisiae* species that have winemaking potential, to produce novel wine yeasts which impart unique flavour characteristics. Hybrids generated to date typically share properties of both parents, including the robustness of the wine yeast, with, for example, improved low temperature growth characteristics of the non-*S. cerevisiae* parent. Chemical analysis confirms that the composition of the wine made using hybrid yeasts is different to what is achieved when using *S. cerevisiae* wine yeasts. For example, there are differences in the concentration of aromatic compounds, such as ethyl propanoate

('fruity'), 2-methyl butyl acetate ('banana'), hexyl acetate ('lolly') and 3-methyl butanoic acid ('cheesy').

A number of wineries participated in trials using some of these non-conventional wine yeast strains during the 2007 vintage. Hybrid strains

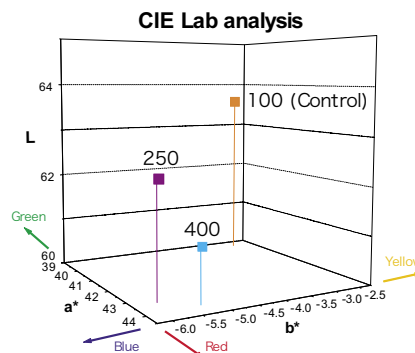


Figure 4. CIE Lab analysis of young wines made by fermentation of Shiraz musts of different initial nitrogen content (100, 250 and 400 mg/L YAN), produced by supplementation with DAP, with maceration for 14 days

of *Saccharomyces cariocanus*/*S. cerevisiae* (AWRI 1502), *Saccharomyces kudriavzevii*/*S. cerevisiae* (AWRI 1503) and *Saccharomyces bayanus*/*S. cerevisiae* AWRI 1505 were included in this trial. Wines were made from Chardonnay, Semillon, Viognier, Merlot and Cabernet Sauvignon grapes. Sensorial and chemical analysis will be undertaken later in 2007. Some of the wines are to be showcased in workshops at the 13th Australian Wine Industry Technical Conference to be held in Adelaide in July 2007.

AB Mauri Yeast produced AWRI 1502 in active dried yeast form for the first time for the 2007 vintage and in sufficient quantity to carry out evaluations under winery conditions. AWRI 1503 has undergone winery trials in a dried yeast format for the past three vintages and is now being actively promoted by AB Mauri Yeast in Europe and South Africa, with emphasis on fermenting red grape varieties.

Non-conventional wine yeasts: *Saccharomyces bayanus*

On the basis of promising laboratory-scale and winery trials with freshly prepared cultures of *Saccharomyces bayanus* AWRI 1375 and AWRI 1176 over recent vintages (AWRI publication #914), Lallemand have produced AWRI 1176 in active dried form to permit larger-scale evaluation during the 2007 vintage. Some ten wineries have carried out trials in red and white varieties. Winemaker feedback is showing that the yeast is generally performing well, and enhances fruit character and mouth-feel. The non-conventional yeast provide winemakers with additional options for improving the flavour diversity of wine and to develop new wine styles.

Team reports

Generating wine yeasts that produce reduced levels of ethanol

Wines which are typically full-bodied, rich and with ripe-fruit flavour, have undoubtedly contributed to the success of the Australian wine industry. This 'big wine' style is essentially the product of relatively dry climatic conditions, which facilitate lengthy maturation of grapes. These conditions, however, can lead to grapes with high sugar levels, and this, in turn, leads to wines with high levels of alcohol. High alcohol content can be problematic because it potentially compromises wine flavour, increases export costs in countries where taxes are levied according to ethanol content, and raises health concerns associated with excessive alcohol consumption. Therefore, the wine sector is pursuing strategies to lower the ethanol content of wine without compromising quality or increasing input costs.

this sounds simple, finding a selective pressure that favours low ethanol production, while not disrupting important winemaking properties, is not straightforward. Nonetheless, there are ways of doing this and data from recent experiments have shown that yeast cultures can be generated that deliver a range of low-ethanol phenotypes. Although the decrease in ethanol levels is still small, we are confident that the selection is going in the right direction, and to improve on what has been achieved so far.

This work is being done in collaboration with Associate/Professor Grant Stanley (Victoria University), and Dariusz Kutyna, a PhD student from the same university.

This work addresses the problems of suboptimal ethanolic and malolactic fermentations, focusing on the microbiology of fermentation.

The efficiency of wine fermentations depends on grape must quality and composition, and on the robustness and handling of microorganisms used in vinification; suboptimal fermentations are likely to result if any of these are wanting. Costs that arise as a result of suboptimal fermentations can be considerable, thereby compromising the international competitiveness of Australian wines in the world market. Thus, it is critical to develop strategies, protocols and microbial strains that will reduce the incidence of suboptimal wine fermentations.

Increasing the robustness of wine yeasts

In recent times, the wine sector has witnessed improvements in the performance and consistency of commercial fermentations. This has, at least in part, stemmed from an increased understanding of the nutritional requirements of yeast and an improved understanding of the composition of must. However, fermentation performance continues to be a topic of significant interest to the sector, with requests for literature on stuck and sluggish fermentations constituting one of the AWRI Information Services' top five enquiries.

Yeast stress, due to changing conditions in grape must during vinification, is likely to be one of the main contributors to poor fermentation performance. Of the many factors that cause this stress, ethanol accumulation is thought to be one of the most important; as can be seen from Figure 5, ethanol has a drastic impact on sugar utilisation in wine yeast.

In an attempt to generate more robust wine yeasts, we have isolated strains from populations that have been subjected to long-term selective pressure. Screening these populations identified individuals with improved ethanol tolerance, defined as improved biomass formation during ethanol stress compared to the parent strain (an example of the performance of one of the isolates can be seen in Figure 6). Some individuals isolated from these populations exhibited moderate improvements in their time to dryness and variations to their basic metabolite profile in both synthetic must and demanding grape juice fermentations. A small number of isolates have been selected for further detailed chemical and sensory evaluation in small-scale grape juice fermentations. We are also continuing with the adaptive evolutionary program to generate more novel strains with improved robustness.

In a collaborative project between the AWRI, A/Prof. Grant Stanley (Victoria University) and Dr Miguel de Barros-Lopes (University of South Australia) we are also attempting to understand the genetic basis of ethanol tolerance by comparing evolved ethanol-tolerant laboratory strains to parental strains. Tina Tran, a PhD student with a scholarship from Victoria University, is applying microarray technology to identify genetic polymorphisms between the parental and evolved strains.



One strategy we are exploring utilises gene technologies for proof-of-concept to obtain genetically modified (GM) yeasts that divert some of their sugar metabolism away from ethanol production. One of the GM approaches we are using involves over-expression of the yeast's GPD genes, encoding glyceraldehyde-3-phosphate dehydrogenase, which leads to increased glycerol production at the expense of ethanol. The resultant GM yeasts will not be made commercially available to winemakers (no genetically modified organisms are used in the production of Australian wines) but they will provide us with information to enable the development of improved strategies for generating suitable wine yeasts using traditional, non-GM approaches.

A more difficult approach is to make 'low-alcohol yeasts' using traditional breeding and selection techniques. Yeasts obtained by such means can be adopted immediately by the wine sector; 'traditional' methods are not controversial and are routinely used in food and beverage sectors. Selection strategies require a selective pressure that favours enrichment of the desired characteristic within the population, and are performed over many generations. Although

Theme 2: Grape and wine production

Optimising fermentation performance to maximise wine production efficiency

Staff and students

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Collaborators

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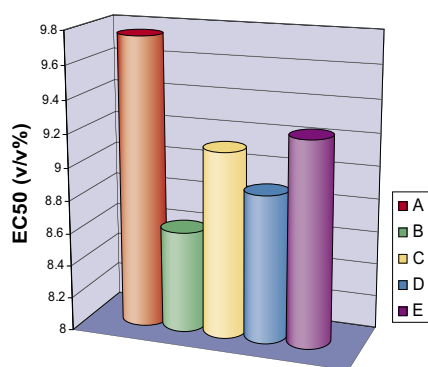


Figure 5. Effect of ethanol on the ability of five strains of wine yeast to utilise sugar. The coloured columns indicate the estimated ethanol concentration required to reduce by half the amount of sugar consumed by five commercial wine yeasts in a 24 h period

Wine yeast gene deletion library

Understanding the genetics of wine yeasts is crucial for the strategic development of strains with improved winemaking properties. The study of yeast genetics requires the isolation of variant strains which are screened for new and interesting properties. In the past, the generation of these variants has been accomplished using random mutagenesis approaches. While these techniques produce large numbers of novel strains, the genetic variation that produces the desirable traits are generally difficult to identify. Additionally, the nature of random mutagenesis does not guarantee that every gene in the genome will be tested. To overcome these limitations, the wine yeast deletion library (WYDL) project is creating a collection of wine yeast strains, each strain carrying a unique gene variant. By systematically assembling this library, the collection will contain approximately six thousand strains where each individual variant has lost one of the six thousand genes from the yeast genome.

Prior to generation of the WYDL, it was necessary to choose a parent wine yeast strain in which the deletion collection would be constructed. The strain AWRI1631 has been developed for this role. This yeast is a stable haploid derived from standard diploid wine yeast. Despite being haploid (i.e. having only one set of chromosomes; most wine yeasts have at least two), the fermentation performance of AWRI1631 was shown by both chemical and sensorial analysis to be comparable to the wine yeast parent strain from which it was derived.

To begin construction of the WYDL, a collaboration was established with Prof. Charles Boone from the University of Toronto, whose laboratory is currently building a similar deletion library in a laboratory strain. We have obtained DNA cassettes from Prof. Boone's laboratory which will enable the construction of the library in the AWRI1631 background. Protocols for the high-throughput construction of the library have now been established and the first strains are being produced and characterised.

Malolactic fermentation

Malolactic fermentation (MLF) is an important step in grape vinification for virtually all red wines, as well as numerous white and sparkling wines. From a winemaking perspective, the main purpose of this secondary fermentation is to deacidify wine and to improve its microbial stability by removing L-malic acid, which can act as a potential carbon source for various spoilage microorganisms. However, MLF is notoriously capricious, therefore, a major objective of MLF research at the AWRI is to improve its reliability.

A second objective of this project is to characterise the factors involved in MLF-mediated changes to wine aroma and flavour; in addition to malic acid metabolism, the action of MLF bacteria (particularly *Oenococcus oeni*) also influences the appearance, aroma and palate of red and white wines. Grape glycosides represent a pool of non-volatile aroma and flavour precursor compounds that can be hydrolysed by different species of lactic acid bacteria (LAB) to liberate flavour-active compounds that potentially contribute to the varietal character of wine. Much of the recent AWRI-based LAB glycoside research work has been presented in the 2005 and 2006 Annual Reports and AWRI publications (#762, #770, #869 and #872). An additional source of aroma and flavour compounds can arise during wine maturation in oak barrels. A glucoside of oak lactone, recently synthesised by the AWRI Volatile Flavour Team (led by Dr Mark Sefton), was used in a model wine system to screen different LAB species and typical wine associated yeast species for their ability to liberate the oak-lactone. The five yeast strains tested: species from *Saccharomyces*, *Hanseniaspora* and *Dekkera*, were unable to liberate the oak-lactone from the glucoside. The *Oenococcus oeni* strain was able to liberate almost 80% of the *cis*-oak lactone from the glucoside during MLF and the *Lactobacillus plantarum* strain exhibited some glucosidase activity (11%) (Figure 7). This observation supports anecdotal evidence that MLF contributes to wine oak character and is even more exciting with the Volatile Flavour and Mass Spectroscopy Teams recently confirming the presence of the oak lactone glucoside in oak wood (see separate report).

With increased knowledge of MLF and *O. oeni*, winemakers will be better placed to run reliable MLFs and deliver more interesting and targeted flavours and aromas to their wines.

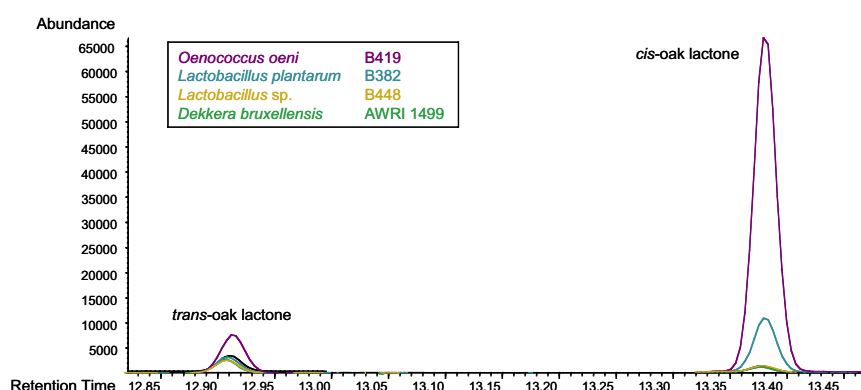


Figure 7. GC/MS chromatogram showing the different levels of oak lactone released by various lactic acid bacteria and a strain of *Dekkera bruxellensis*

AWRI Culture Collection

The AWRI Culture Collection is an important and significant resource for the AWRI and the Australian wine sector as it contains over 1,800 bacterial and yeast strains. Included in this collection are type strains, reference strains, winery isolates, research and experimental strains.

Numerous yeast strains recently developed by the Biosciences Team are available as experimental trial strains to the Australian wine sector. Information received from wineries on commercial-scale fermentations with the experimental strains augments the AWRI knowledge base and helps to develop a detailed overview on performance and potential of these yeast strains. Several of these experimental yeast strains are now commercially available. Molecular biology-based identification techniques are being used to confirm the identity of strains to the genus and species level, and to differentiate strains within a species.

Comparison of Biomass Yield During Growth Under Ethanol Stress

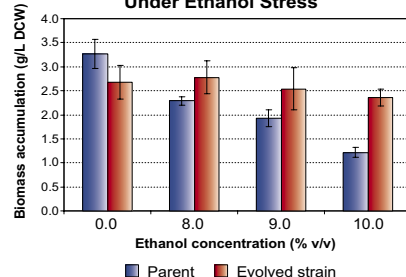


Figure 6. Comparison of biomass accumulation between parental and a more robust, evolved strain derived from this parent. Micro-cultures of synthetic must with increasing concentrations of ethanol were inoculated with either the parent or the evolved strain and grown for 72 h. Biomass accumulation was estimated after 72 h

Yeast and bacterial strains are provided upon request to Australian wineries, research institutions world-wide, Australian teaching institutions and commercial companies. Provision of all cultures, except experimental strains, incur a modest cost-recovery fee.

Team reports

Novel winemaking processes to stabilise and package wine and deliver it to the consumer in optimum condition whilst maintaining or improving quality, value and sustainability

Staff and students

Dr George Skouroumounis, Mariola Kwiatkowski, Ken Pocock, Dr Simon Schmidt, Dr Paul Chambers (AWRI); Oenone (Jean) Macintyre (student, The University of Adelaide), Steven Van Sluyter (student, University of Melbourne), Matteo Marangon (student, University of Padova)

Collaborators

Simon Nordestgaard, Dr Chris Colby, A/Prof. Brian O'Neill (The University of Adelaide); Chris Day (Provisor); Dr Peter Anderson (Flinders University); Nigel Krollig, Dr Vanessa Stockdale, Dr Eric Wilkes (Foster's Wine Estates); Audrey Lim (The Hardy Wine Company); Leon Deans (Pernod Richard Pacific); Dr Filomena Pettolino, Prof. Tony Bacic (University of Melbourne)

This activity focuses on two key winemaking processes: protein stabilisation and packaging.

Protein stabilisation

Protein haze remains as one of the key potential instabilities in white wine production that requires costly treatment with losses in overall quality. The majority of these costs are associated with the quality downgrading of wine recovered from the bentonite lees. The first suite of projects in this stream addresses the need to develop alternatives to bentonite fining by discovering novel proteolytic enzymes, developing new heat treatment regimes and through a thorough understanding of the phenomenon of haze formation.

We have made good progress in understanding the mechanism of protein haze formation this year. It is likely a two step process with the first step being protein denaturation, aided by 'Factor X'. Sulfate is one potential Factor X and probably aids in protein denaturation by structuring and binding water, thus increasing the effective concentration of protein in solution and stripping off some of the surface water surrounding the protein molecules. The denatured protein then aggregates (the second step of the process). Whilst sulfate appears to be fundamental to haze formation, other wine components such as phenolic compounds remain as candidate haze modulators. One possibility is that white wine phenolic compounds affect the particle size of denatured aggregated proteins, possibly through crosslinking.

It is clear that protein haze formation in white wine is a multifactorial process. This study elucidated one new factor that is involved, in addition to protein itself, and it is possible that other wine components also participate in protein haze formation. Identification of essential factors might ultimately yield new methods to tackle protein haze formation that either reduce or abolish the need for bentonite. In addition, a more thorough understanding of the mechanisms

and participants in protein haze formation might also lead to more efficient predictive tools based on rapid compositional analysis.

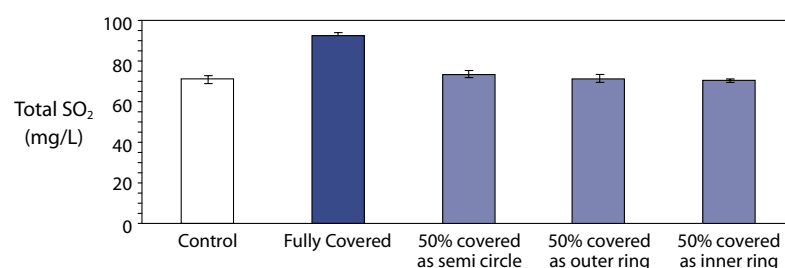
Packaging

In addition to protein haze formation after bottling, wines can also be placed at risk of oxidative spoilage and premature development through packaging, transport and storage decisions. At present the wine sector has little in the way of tools to predict shelf life because the factors likely to impact on it are poorly understood or difficult to measure. The second suite of projects in this stream aims to develop the tools and collect the data required to assess the relative importance of winemaking practices, packaging choices and transport and storage conditions on oxygen ingress into wines and to link this to wine development in bottles and oxidative spoilage.

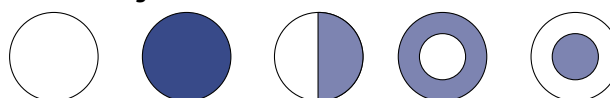
conditions. The determination of oxygen permeation rates is calculated from measurements made over an eight week period under controlled storage conditions.

We have also undertaken studies to elucidate the route of oxygen ingress through a synthetic closure, Nomacorc, and a natural bark closure, into bottled wine. These studies have used araldite, an epoxy resin which is highly impermeable to oxygen, to cover different parts of the exposed surface of the closures in bottles. For the Nomacorc closures, the control wines and those sealed with 20% or 50% araldite coverage in all different shapes, did not differ significantly in SO_2 concentration. An example of the final SO_2 values for the closures with araldite coverage of 0%, 50% and 100% is shown in Figure 8a and a schematic to illustrate the areas covered by the different treatments is

a) Nomacorc



b) Schematic of araldite coverage



c) Natural bark cork

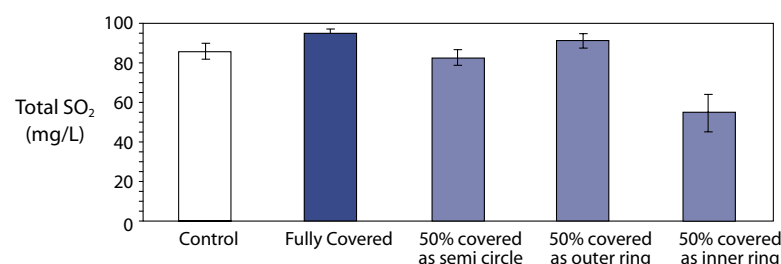


Figure 8. The effect of araldite coverage of a) Nomacorc and c) natural bark cork closure surfaces in positions on the cork as shown in b) on the concentration of total SO_2 in bottled wines after 33 months' storage upright at 25°C. The values shown are the average of eight replicates

We have developed a method which allows the calculation of not only the oxygen ingress rate through closures but also the initial amount of oxygen in the headspace of a wine bottle and the amount of oxygen entrapped in the closure. The developed assay uses methylene blue and light to convert dissolved oxygen into singlet oxygen, the reactive form of oxygen, and a water-soluble compound (BPAA) to trap singlet oxygen. The reaction product formed when BPAA reacts with singlet oxygen has a different absorption spectrum than BPAA. The change in absorbance after the reaction can then be related to the quantity of oxygen present. By using a modified spectrophotometer, these reactions can be undertaken in synthetic wine solutions and measured in a wine bottle sealed with closures inserted under normal commercial

given in Figure 8b. The data indicate that oxygen permeates through the Nomacorc closures similarly at all positions. A possible explanation for the 20% and 50% coverage treatments resulting in similar SO_2 losses as did the controls is that the rate through the exposed regions of the closure increases when part of the closure surface is covered by araldite, so that the overall rate is seemingly unaffected by the araldite.

The data from the natural bark closures, however, were more difficult to interpret, primarily because the control (not covered with araldite) treatment did not have the greatest loss of SO_2 , nor the highest colour, and variation within all treatments was relatively high. We suspect that at least part of the problem was that the variation in this batch of natural bark closures



Bob Dambergs

Wies Cynkar

was too great, even though eight replicates were used. An example of the total SO_2 data is shown in Figure 8c. The trend was for all treatments with outer coverage (20%, 50% or 80% of the area) to have higher SO_2 levels than their respective inner circle treatment. This trend suggested that the closure–glass interface is a major route for oxygen permeation but given the lack of robustness in the data this cannot be conclusively deduced.

We are now in a position to use the BPAA method to more rapidly evaluate the route of oxygen ingress into bottled wines and validate the data we have already obtained. This information will add to a growing body of data that we plan to collect during the next few years in order to assess the relative importance of winemaking practices, packaging choices and transport and storage conditions on wine development and oxidative spoilage. Our ultimate aim is to be able to develop models to allow predictions of shelf life to be made at various stage of a bottled wine's 'life'.

Environment, engineering and analytical techniques

Staff

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Collaborators

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Following the completion of the Cooperative Research Centre for Viticulture (CRCV), the former 'Rapid Analytical Methods' team at the AWRI commenced a new Project under the current seven-year plan, where the main objective was to combine existing spectroscopy knowledge into Process Engineering and Environmental Monitoring. As a part of the previous CRCV, we initiated investigations into the application of promising rapid analytical techniques such as ultraviolet (UV), visible (Vis), near infrared (NIR), mid-infrared (MIR) spectroscopy and electronic noses. Collaborations with other AWRI teams, wine sector partners and academic institutions have enabled us to develop and understand the different viticultural and winemaking practices through the use of spectroscopy.

The team collaborates extensively within the AWRI and externally as noted above. The team also maintains a strong commitment to the training and teaching of the principles and uses of multivariate analysis techniques (chemometrics) and spectroscopy to the Australian wine sector, and have developed materials for a workshop for winemakers, viticulturists and laboratory staff that have been presented at wineries in South Australia.

A characteristic of our work is the determination of a strong commitment on applied research orientated towards a development of spectroscopic methods that could provide the Australian wine sector with tools to ensure its high international competitiveness.

White grapes and white juice

The project has previously had a primary focus on developing or improving Vis-NIR methods for rapid analysis of red grapes including total anthocyanins, total soluble solids (TSS, °Brix) and pH. This analytical approach has been shown from earlier work to be capable of providing very fast, low cost routine analyses of a range of parameters important to commercial wine production. The Vis-NIR method calibration is being expanded annually with new samples and is currently being used in some large wineries as an analytical tool for the routine analysis or monitoring of red grape samples. In 2006 we commenced developing rapid methods to analyse white grape and white grape juice samples, including a determination of the effect of different storage conditions on grape juice composition.

Authentication, discrimination and geographical origin

The authenticity of wine is regulated by strict guidelines as laid down by the responsible national authorities. In Australia, this is monitored by examination of records kept by the wine producers. Wine identification, or classification, mainly in terms of variety and geographical region of origin, has received increasing attention during the past 10 years using both multivariate statistical techniques and spectroscopic methods. Verification of authenticity of food in general, and wine in particular, has become a promising potential application of NIR spectroscopy. We have demonstrated that infrared and UV-Vis spectra can effectively represent a 'fingerprint' of the grape or wine sample being analysed (AWRI Publications #955, 940) (see Figure 9). Such spectra can be used to simplify traditional methods of analysis and reduce analytical times for many grape and wine analytes. Furthermore, compared to traditional laboratory methods, spectroscopic techniques often give new and better insight into the chemical complexities of a sample by measuring a great number of chemical compounds at once, thus enabling a full chemical 'fingerprint' of each sample. Spectroscopy can be used for the continuous and non-destructive process monitoring of grape and wine products and processes over time and, in many cases, give an understanding of the chemical properties of materials *in-situ* during the production of various wine products. Such methods are attractive due to their inherent

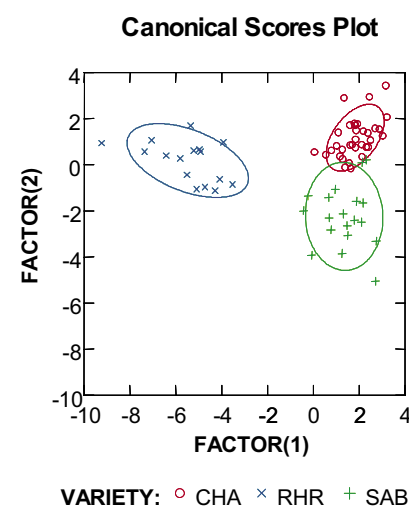


Figure 9. A canonical scores plot for linear discriminant analysis of grape variety using principal component analysis scores of the UV spectra (200–400 nm) of white wines (Chardonnay, CHA, red; Sauvignon Blanc, SAB, green; Riesling, RHR, blue). The ellipses show the 95% confidence intervals for the variety clusters. Riesling wines were clearly separated from the other two varieties, which showed some overlap

versatility, flexibility, effectiveness and richness of information. Recently, we have successfully applied Vis-NIR spectroscopy to the discrimination of Australian Riesling and unwooded Chardonnay white wine varieties; to classify the geographical origin of commercial Tempranillo wines from Australia and Spain, and to discriminate among Riesling wines produced in Australia, New Zealand, France and Germany (AWRI publication #942).

Team reports

Electronic noses/aroma sensors

Investigations into potential applications of an electronic nose (MS-based) instrument for rapid grape and wine analysis are continuing. Preliminary studies with both red and white wines have shown great promise for the MS-ENose to successfully classify the samples by varietal origin using multivariate methods. MS-based studies have been extended to investigate a range of other applications including the detection of taints, *Brettanomyces* contamination (AWRI publication #942), and wine development monitoring, as well as confirmation of varietal classification, and preliminary results are encouraging.

Environmental monitoring

A major challenge facing the Australian wine sector is the need to maintain its international competitiveness in the face of new environmental-footprint requirements for European and Japanese markets. This challenge places pressure on wine grape producers and winemakers to continue growing quality grapes within an internationally accepted environmental reporting framework (ABARE, 2002). Environmental auditing and monitoring, and ecological management and advisory services will become increasingly as much a part of our economy as are primary industries such as agriculture, food and energy. The recently

carbon pool chemistry (SOC), potassium content (K), organic matter content and type (OM), soil and plant water potential and to combine these predictions with geographic information systems (GIS) and meteorologic, social and economical modelling. Collaborative studies with CSIRO (Land and water), SARDI, University of Adelaide, and wineries across a wide array of systems must be undertaken to understand the effects of climate change and production processes on environmental carbon balance, soil properties, biodiversity, disease incidence and production output. As a first step, rapid methods for waste water monitoring will be an important target within the core studies to be undertaken by this project.



Grape and wine phenolics

One of the original applications for Vis-NIR analysis developed at AWRI was the analysis of total anthocyanins in grapes. A follow on from this was the application of this technology for fermentation monitoring of phenolic profiles of red wines. More recently, we have also applied similar methods to monitoring specific anthocyanin species (e.g. coumarylated derivatives) and total tannin, using the UV region of the electromagnetic spectrum. This might ultimately allow routine applications in winery laboratories where the appropriate instrumentation is more commonly available than an NIR capable device. This applies to both red and white wines – phenolic analysis of white wines is an area that is being developed further in collaboration with wine sector partners, the tannin group at AWRI and the University of Adelaide.

Fungus in grapes

The use of NIR methods to quantify fungal infection of grapes, in particular powdery mildew, has been an ongoing project in collaboration with The Fungal Pathology Laboratory of the University of Adelaide. The original work was performed with samples collected from trial plots and involved expert visual classification as well as DNA analysis to confirm infection status of samples scanned by NIR spectroscopy. That initial work showed very positive results, therefore, the next phase involved collection of samples from various commercial vineyards by industry field staff. This work was performed with samples from the 2006 vintage and highlighted problems with subjective evaluation by field staff. The DNA assay is, therefore, important as a reference method for any NIR calibration work and has been adapted to a high throughput PCR format by the University of Adelaide and the Australian Genome Research Facility, using samples collected from the 2007 vintage (see Table 1).

Table 1. Standard error of prediction for malvidin-3-glucoside (M3G), malvidin-coumaryl glucoside (MCG) and total tannin, using calibrations developed with ultraviolet (UV), mid-infrared (MIR) or a combined wavelength ranges. Results are expressed as a percentage of the mean reference value. The lowest standard errors were with UV wavelengths and combining UV with MIR gave no advantage

	UV	MIR	UV+MIR
M3G	8	28	12
MCG	7	16	10
Tannin	8	30	14

Process engineering

Process analytical chemistry (PAC) and process engineering (PE) capability has existed for several decades in many industries and is now gaining renewed popularity in the pharmaceutical industry. Both PAC and PE encompass a combination of analytical chemistry, process engineering, process chemistry, spectroscopy and multivariate data analysis. Process engineering is fundamentally a multidisciplinary field supported by a cross-functional team including members from manufacturing, analytical chemistry and plant maintenance and engineering. The use of process analytical chemistry enables one to gain a deeper understanding and control of the production process. This can, in turn, lead to a more consistent product with reduced waste and cost, improved manufacturing efficiencies, overall improvement in the use of resources, improved safety and better control over environmental impact. As part of the AWRI's seven-year plan PE and PAC will be applied to current know-how and new methods in order to monitor the winemaking process and the environmental impact. This will include the development and application of spectroscopic techniques to monitor wine fermentation (Cozzolino et al. 2007), in bottle analysis (Cozzolino et al. 2007), harvest analysis and environmental monitoring.

released Millennium Ecosystem Assessment report (MEA) remarks that business cannot continue to deliver food, fibre and other services if ecosystems, water, soil, biodiversity, and climate are degraded or unsustainable. Because the whole area of environmental reporting and auditing has been identified as crucial for implementing any environmental management strategy, the AWRI has identified and incorporated the environment in its current seven-year plan.

Undoubtedly, water is becoming the major concern of Australian wine grape producers. Other issues, however, such as disease, salinity, depletion of soil nutrients, acidity, erosion, and waterlogging as a consequence of climate change and production processes have also been reported as problems by many growers and viticulturists. In one of the main areas of priority in implementing environment studies at the AWRI is the development of tools to economically and effectively monitor water and soil properties resulting from winery and viticultural processes, with a view to using such methods to help to model the environmental impact and risk assessment.

The goals of this project will be to analyse and develop spectroscopy methods to estimate different soil and plant properties such as available soil nitrogen content (N), soil organic

Investigations into the relationship between *Dekkera/Brettanomyces* yeast and red wines in Australia

Staff

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Collaborators

Leigh Francis, Belinda Bramley, Brooke Travis, Yoji Hayasaka, Gayle Baldock (AWRI); Simone Mueller, Larry Lockshin (University of South Australia Ehrenberg-Bass Institute for Marketing Science); Mark Tamplin, Tom McMeekin and Tom Ross (University of Tasmania)

'Brett' research at the AWRI is focused upon providing the Australian wine sector with tools to guide their decisions regarding management and detection strategies. Broadly, through our activities we aim to deliver: the ability to benchmark against industry trends in 'Brett' spoilage; the ability to assess relative susceptibility of wines to 'Brett' spoilage; and the availability of knowledge linking wine composition and sensory data to individual thresholds and consumer preferences. The multidisciplinary nature of this approach necessitates internal and external collaborations, and a strong practical focus through the AWRI's Industry Development and Support Group.

Benchmarking – trends in 'Brett' spoilage

The ongoing targeted survey of Cabernet Sauvignon wines made in five major wine regions of Australia highlights the major success of Australia's winemakers with regard to improved 'Brett' management. Uptake of control strategies presented to ~6,000 winemakers at AWRI Roadshows and other forums since 2000, and greater practitioner awareness of 'Brett', has resulted in median concentrations of 4-ethylphenol in commercially available Cabernet Sauvignon in recent vintages (Figure 10) well below recently determined sensory perception thresholds. Across all five regions concentrations are lower, although some regions have progressed more rapidly than others. Furthermore, from multiple analyses of wines from individual wineries it is clear that while some are effectively managing 'Brett', others still have high concentrations of 4-ethylphenol in recent vintages of their wines.

The trend towards low 4-ethylphenol concentrations in Australian red wine was also evident in a survey of 103 commercially available wines spanning vintages from 1991–2006, encompassing the varieties Cabernet Sauvignon, Shiraz, Pinot Noir, Merlot and Durif. Mean 4-ethylphenol concentrations in 42 wines made prior to 2001 was 543 µg/L, whereas in wines made from 2001 onwards (n=61) the mean concentration was 232 µg/L.

Sensory perceptions of 'Brett' and relationship with consumer preferences

The sensory descriptors attributed to 'Brett'-related compounds such as 4-ethylphenol and 4-ethylguaiacol in wine are well established; likewise the negative impact of these upon

wine quality is generally accepted. There are, however, several poorly understood aspects of 'Brett' perception that are relevant under Australian conditions, and limited data concerning how 'Brett' affects consumer preferences.

A series of studies were undertaken during the past year in collaboration with Leigh Francis and the AWRI Sensory team to examine the effect of wine style and relative concentrations of volatile phenols (in combination) upon sensory perceptions of 'Brett', and the impact of 'Brett' character upon consumer preferences.

Perception thresholds for 4-ethylphenol, 4-ethylguaiacol, and 4-ethylcatechol were determined for 30 panelists at AWRI in three different Cabernet Sauvignon base wines. These were selected as examples of different wine styles – 'fruit'-driven, 'green' and 'oaky'. Group mean perception thresholds for 4-ethylphenol ranged from 368 µg/L in the 'fruity' base wine, to 425 µg/L in the 'green' wine, and 569 µg/L in the 'oaky' wine. Thresholds for 4-ethylguaiacol and 4-ethylcatechol were similarly affected, thus 'green' and 'oaky' wine styles were shown to mask 'Brett' compounds.

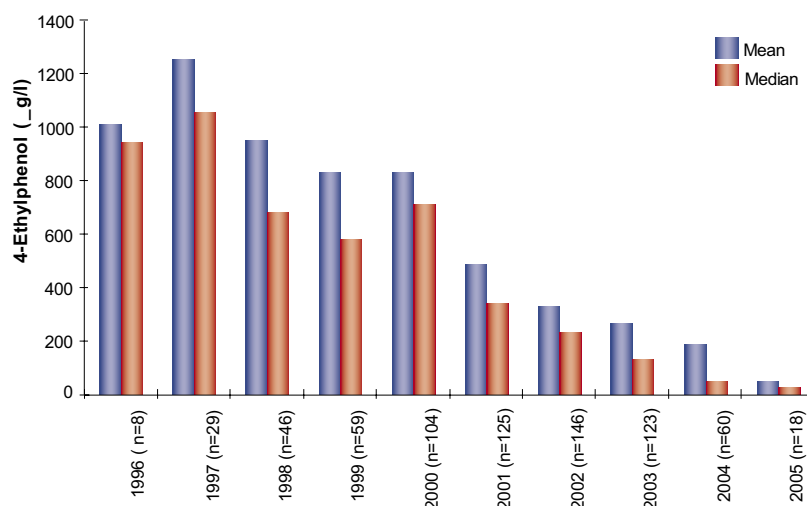


Figure 10: Mean and median concentrations of 4-ethylphenol in Cabernet Sauvignon and Cabernet Sauvignon/Merlot wines made in five regions of Australia (Barossa Valley, Coonawarra, Hunter Valley, Margaret River and Yarra Valley) from 1996–2005

This study was followed up with a sensory descriptive analysis of a single base wine ('fruity' style of Cabernet Sauvignon) into which various combinations of volatile phenols were spiked, alone or in conjunction with isobutyl-methoxypyrazine or oak compounds (vanillin, oak lactone, guaiacol, 4-methylguaiacol). Mean rating of medicinal/leather flavour by the trained panel (Figure 11) provided further evidence that 'green' and 'oak' characters effectively mask 'Brett' character.

Data from the Cabernet Sauvignon survey indicate that while the 'typical' ratio of 4-ethylphenol: 4-ethylguaiacol is 9:1, there is great variability with common ratios ranging from 3:1 to 23:1. The sensory descriptive study demonstrated that low ratios such as 3:1 exhibit intensified 'Brett' characters, while the addition of 4-ethylcatechol introduced 'smoky' characters at sub-threshold concentrations. Thus interactions

exist between the compounds, as well as between 'Brett' character and intrinsic wine sensory attributes.

The effect of 'Brett' aroma and flavour upon consumer preferences was examined for a subset of wines from the sensory descriptive analysis. Sydney consumers (n=104) recruited on the basis they are regular wine drinkers; purchase wine in the \$20–\$30 price bracket; and drink Cabernet Sauvignon, were presented with samples containing high and low 'Brett' compound concentrations at various ratios. All combinations of 'Brett' compounds were significantly disliked compared with the base wine, and strong correlations were observed between mean consumer liking scores and 'Brett' flavour ratings by the trained AWRI panel – this demonstrated that consumers were sensitive to 'Brett' character. A separate study of Adelaide wine consumers (n=112) examining the effect of various wine attributes on preferences provided further evidence for consumer dislike of 'Brett' character.

Physiological characterisation of *Dekkera bruxellensis* isolates from Australian wine

Genetic characterisation of industry isolates, as reported in the 2006 Annual Report, has enabled the distinction of eight different genotypes, three of which occur commonly across multiple winemaking regions of Australia. Ongoing research is focused on understanding the link between the different genotypes and their relative ability to grow in wine and produce volatile phenols.

The relationship between genotype and sulfite tolerance was strengthened during the past year through screening of more isolates, and experiments demonstrating that other variables (such as oxygen) did not impact upon observed 'tolerances'. Isolates varied in tolerance over a 4-fold range, suggesting that some strains will be more difficult to control than others using sulfite.

Team reports

Efforts to translate laboratory results into winery applicable knowledge are often hampered by the 'matrix-effect'. A reproducible trend in chemically defined media may not be evident when experiments are conducted in a wine, due to unforeseen interactions in the more complex wine matrix. Predictive microbiology is a framework for such 'translation' that has been successfully applied in the food industry. Broadly, this approach involves large-scale factorial experiments that are condensed using mathematical models, which can then be validated against 'real-world' observations – in this case, the ability of *Dekkera/Brettanomyces* yeasts to grow in wine.

Preliminary models have been developed during the past year, that will be refined through collaboration with Predictive Microbiologists at University of Tasmania.

The figure for the number of investigations conducted is 24% lower than the previous year and the total number of samples analysed as part of these investigations decreased by 11%. Completion of the major investigations into the nature of 'unknown' taints, described elsewhere, account for a large proportion of the observed decrease in number of investigations and samples submitted. However, the number of wines that are determined to be contaminated or tainted with substances that are not permitted additives to wine continues to be of concern. The issues related to taint and the minimisation of the risks of tainting wine are now being addressed in workshops presented during AWRI Roadshows. In order to increase awareness of these issues, a half-day workshop was prepared to present to suppliers of chemicals, winemaking consultants, transport companies and suppliers of winemaking and bottling services. This workshop was presented on two occasions in two states during the first half of 2007.

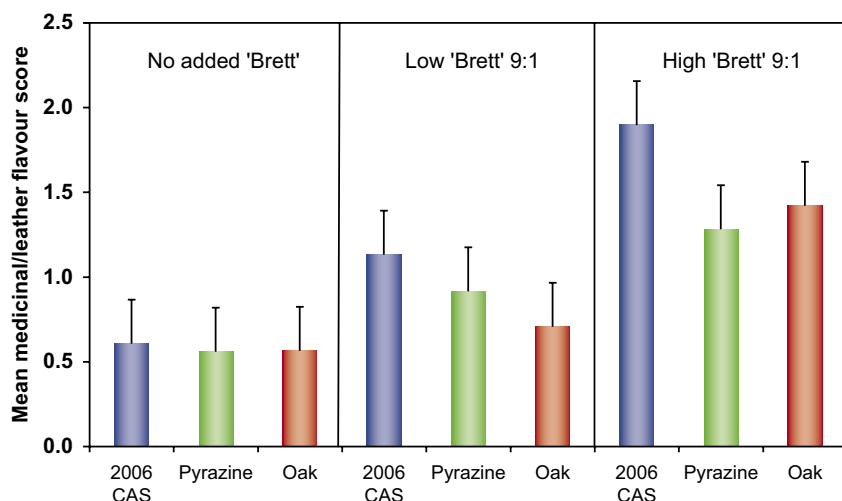


Figure 11: Effect of methoxypyrazine and oak compounds upon sensory rating of medicinal/leather flavour in a base wine (2006 CAS) spiked with 4-ethylphenol and 4-ethylguaiacol at high (1200 µg/L 4-ethylphenol) and low (600 µg/L 4-ethylphenol) 'Brett' levels

Technical problem solving

Staff

Peter Godden, Con Simos, Adrian Coulter, Mark Gishen, Geoff Cowey, Matt Holdstock, Narelle Cream, Emma Kennedy, Yoji Hayasaka, Gayle Baldock

In addition to its extension and information transfer activities, the Industry Services team provides a technical problem solving and analysis service to the Australian wine industry, which represents a significant proportion of the team's workload. This service is provided according to strict Terms and Conditions, and client confidentiality is an important aspect of the provision of the services. This facilitates a frank exchange of information between the AWRI and its clients, which in turn allows the maximisation of the knowledge gained from the provision of these services.

A summary of the number and type of investigations conducted by the Industry Services team over the past three financial years is presented in Table 2.

The percentage of investigations conducted during the current year related to the combined problems of hazes and deposits and microbiological instabilities (39%) decreased slightly from that of the previous year (42%). Whilst this decrease is welcome, the overall number of wines affected by these problems remains a concern. Issues related to such instability problems continue to be addressed in AWRI Roadshow workshops and the *Practical Solutions* website.

Many of the investigations recorded in Table 2 result in a full written report being prepared for the client. These reports contain a large amount of technical information relating to the problem being investigated and are written in a way which seeks to explain the underlying causes of the problems encountered, and provide advice on how to prevent their re-occurrence. The reports are often accompanied by a number of technical references relating to the area of investigation.

The types of investigations recorded in Table 2 are extremely varied, and some particularly interesting and unusual cases have been investigated during the year.

Contamination during bottling

The Team was contacted by a winemaker regarding a white wine exhibiting a possible pinking or oxidation problem shortly after bottling. The wine had been bottled from one tank in one bottling run and bottles of the wine from the later part of the run appeared pink/brown in colour, compared to bottles of the wine from the start of the run.

It was suspected that the problem was oxidation-related and 'good' samples of the wine from the start of the bottling run were analysed and the results compared to those of 'bad' samples of the wine from the end of the run. The samples were analysed for the concentration of free and total sulfur dioxide (SO₂) and the colour development was measured by means of optical density (absorbance) 420 nm (OD₄₂₀). The degree of pink colour was also measured by means of optical density at 520 nm (OD₅₂₀).

There were no differences between the means for the concentration of free and total SO₂ in the 'good' samples and the 'bad' samples, suggesting that there was no difference in the extent of oxidation between the 'good' and 'bad' samples. However, there were significant differences between the means of the OD₄₂₀ and OD₅₂₀ values for the 'good' samples and the 'bad' samples; the 'bad' samples displayed both higher OD₄₂₀ and OD₅₂₀ values than the 'good' samples. The results of previous investigations into oxidation and/or pinking of white wines, where 'good' and 'bad' samples have been analysed and the results compared, have shown that increases in OD₄₂₀ and OD₅₂₀ values for 'bad' samples have been associated with concomitant decreases in the concentration of SO₂ in those samples. Increased oxidation of the 'bad' samples compared to the 'good' samples has explained the differences observed in those previous investigations. The lack of any difference in the SO₂ concentrations in the recent case investigated suggested that the problem associated with the wine was unlikely to be due to oxidation or pinking.

Given that the problem did not appear to be one of oxidation, it was thought that contamination with red wine would explain the observed results. Consequently, a 'good' sample and a 'bad' sample were analysed for the presence of anthocyanins by High Performance Liquid Chromatography (HPLC) using a method based on that described by Cozzolino et al. (2004).

As expected for a white wine, no anthocyanins were detected in the 'good' sample. However, a range of anthocyanins and their acetates, typical of those detected in red wines, were detected in the 'bad' sample, including malvidin glucoside, delphinidin glucoside and petunidin glucoside (Boulton et al. 1996). It was, therefore, concluded that the wine somehow became contaminated with red wine during the bottling run at the time that the 'bad' bottles of the wine began to appear.

High extraction force problem

The Team was contacted regarding a high cork extraction force problem associated with a sweet, low alcohol wine. It was reported that some 'gushing' had been observed during the filling operation at the time of bottling the wine and that the corks were extremely difficult to remove from the bottles. The AWRI was requested to conduct an investigation in order to determine the nature of the problem and to identify its possible cause.

The observation that the corks were difficult to remove from the bottles of the wine was confirmed by tests conducted at the AWRI, which showed that the extraction force values ranged from approximately 700 Newtons (N) to greater than 1000 N. The extraction force values expected for the combination of bottles and corks used should have fallen in the range 250–450 N, suggesting that considerable difficulty would have been encountered during extraction of the corks from the bottles using a conventional corkscrew. Analysis of unused corks supplied for the quantity of surface treatment material indicated the amount present on the corks was consistent with the amount recommended by the cork supplier. This result suggested that a lack of sufficient cork treatment material on the corks was unlikely to be the cause of the high extraction force problem.

Considerable variation (6–28 mm) in the ullage distance values was observed for the samples of wine submitted, yet there was no evidence to suggest that the samples had leaked, such as the presence of a residue around the inner circumference of the bottle finish on the circumference of the cork exposed to the atmosphere. If not due to leakage, the variation in the ullage distance values could have been due to poor consistency of the bottling operation with respect to fill heights, one cause of which could have been 'gushing' during filling. The wine was determined to contain a relatively high concentration (3.2 g/L) of carbon dioxide (CO₂) for a still wine and considerable degassing of the wine was observed after the corks had been extracted. These observations were consistent with there having been 'gushing' during the filling operation at the time of bottling.

It was considered likely that 'gushing' of the wine during the filling process would have wet the inside surface of the bottle necks with wine,



and that there might have been wine 'foam' contained within the bottle necks, before the corks were inserted. Given that the wine had been determined to contain approximately 125 g/L of glucose plus fructose, it was suspected that a sticky wine 'foam residue' might have facilitated a 'bond' between the corks and the glass, resulting in the high extraction force problem.

As no residue could be observed in the necks of the bottles by visual examination after extraction of the corks, an experiment was devised to make any possible residue that might be present more easily observable. Using a length of plastic tubing, the wine was removed from the bottles by siphoning in such a way that no wine contacted the inner surface of the neck of the sample bottle from which the wine was removed. The empty bottles were then placed upright in an oven at approximately 100°C for two hours, after which time they were removed and allowed to cool to room temperature. Examination of the bottles after cooling revealed the presence of a thin film of material around the inside circumference of the necks of the bottles where the corks had been. The material was isolated from the bottle

necks by scraping with a spatula and was then analysed by infra-red (IR) spectroscopy. The IR spectrum of the material was almost identical to that of caramel, suggesting that wine was present on the inside surface of the bottle necks at the time of insertion of the corks. These results were again consistent with there having been foaming or 'gushing' of the wine during filling.

In order to investigate the 'sticky wine residue' theory further, an 'extraction trial' experiment was conducted using four unused wine bottles and corks that were the same type as those used to package the sweet, low alcohol wine being investigated. Two empty bottles were sealed with corks using a hand corking machine with a four-piece corker jaw assembly. The remaining two empty bottles were rinsed with some of the sweet, low alcohol wine in such a way as to ensure that the wine contacted the inner surface of the bottle neck. A cork was then inserted into each bottle that had been rinsed with the wine. The hand corking machine described above was used to insert the corks. All four empty bottles were placed in an incubator, set at a temperature of 27°C, for seven days, after which time they were removed and allowed to cool to room temperature (approximately 20°C). The extraction force required to withdraw the closures from the bottle necks was then measured.

The results of the 'extraction trial' showed that rinsing bottles with the sweet, low alcohol wine prior to insertion of the corks resulted in extraction force values that were statistically significantly higher than those for bottles which had not been rinsed with the wine prior to insertion of the corks. That is, it appeared that rinsing the bottles with wine before insertion of the corks increased the adherence of the corks to the glass of the bottle necks, after exposure to a temperature of 27°C for seven days.

Table 2. Summary of the number and type of problem solving investigations conducted, and numbers of samples analysed by the Industry Services team during the past three years

Type of investigation	Investigations conducted and samples analysed		
	2004/2005	2005/2006	2006/2007
Identification of hazes and deposits	86	107	74
Microbiological investigations	107	47	36
Sensory assessments	42	37	26
Taint problems	31	118	80
Other investigative analyses	66	48	36
Closure-related investigations	5	11	26
Total number of investigations	337	368	278
Total number of samples analysed	736	2255	2000

¹ The group aroma best estimate threshold of 2,6 DCP in the white wine was determined to be 32 ng/L (Travis et al. 2007)

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The results of analyses conducted and observations made at the AWRI were consistent with the theory that a 'bond' might have somehow been created between the cork and the bottle neck glass due to the presence of residual wine at the time the corks were inserted. A possible explanation is that a 'sticky' film might have been present between the corks and the glass of the bottle neck, due to the high concentration of sugar in the wine, which might have undergone some degree of caramelisation to form the 'bond'.



Eucalyptus flavour in wine

The Industry Services team occasionally receives queries regarding possible 'eucalyptus' flavours in wines, presumed to originate from Eucalyptus trees grown in the vicinity of vineyards. However, until recently, analytical methods to test for eucalyptol (1,8-cineole) were not available, which made the investigation of such queries difficult. However, both ETS Laboratories (St Helena, California, USA) and the AWRI have recently developed methods for measuring eucalyptol, and the AWRI has completed a survey of 147 commercial wines for eucalyptol, making it possible to conduct investigations into wines affected by 'eucalyptus' flavours. The team conducted two such investigations during the year.

The first winemaker contacted the team regarding a 'eucalyptus' flavour in a particular red wine. The winemaker had made two batches of wine using grapes from the affected vineyard: one batch was made from grapes that were within 50 m of the Eucalyptus trees, and one batch made from grapes that were between 50 to 175 m of the Eucalyptus trees. The batch that was made from grapes which were further away was determined to contain 0.1 µg/L of eucalyptol, whilst the batch of wine made from grapes that were in close proximity to the Eucalyptus trees was determined to contain 15.5 µg/L. ETS Laboratories determined the aroma detection and recognition thresholds of eucalyptol in a California Merlot wine as 1.1 µg/L and 3.2 µg/L, respectively. The concentration of 15.5 µg/L of eucalyptol found in the Australian wine made in close proximity to the Eucalyptus trees was approximately five times higher than the recognition threshold determined by ETS Laboratories, suggesting that the eucalyptol was likely to have a sensory impact on the wine. However, the results of sensory assessments

of the two wines were inconclusive, possibly due to the presence of other low-level, non-eucalyptol related faults.

The second winemaker also contacted the team regarding 'eucalyptus' flavour in a red wine. In this case, the winemaker had made six batches of wine using grapes sampled from the affected vineyard at various distances, ranging from approximately 11–18 m to approximately 230–430 m, from the Eucalyptus trees. The results were reasonably consistent: in general, the wines

that were made from grapes sampled from greater distances from the Eucalyptus trees were determined to contain lower levels of eucalyptol than those wines made from grapes situated close to the trees. The wine made from the grapes closest to the Eucalyptus trees contained eucalyptol at 9.5 µg/L, whilst the wine made from the grapes farthest from the Eucalyptus trees contained eucalyptol at 0.4 µg/L. The level of 9.5 µg/L is approximately three times higher than the aroma recognition threshold determined by ETS Laboratories, and approximately eight times higher than the aroma detection threshold. Like the first case investigated, the results suggested that the eucalyptol was likely to have a sensory impact on the wine made from the grapes harvested near the Eucalyptus trees. However, as with the first case investigated, the results of sensory assessments of the six batches of wine were inconclusive, due to the presence of other low-level, non-eucalyptol related faults.

Although a more detailed study of the relationship between grape composition and proximity to Eucalyptus trees is planned for 2008 (van Leeuwen et al. 2007), it would also be beneficial to study the sensory impact of eucalyptol on red wines.

Wine leakage

The manager of a winery contacted the AWRI regarding a leakage problem associated with a Chardonnay wine. The wine bottles, sealed with screw cap closures, were stored in a horizontal position in apple bins without any packaging material between the layers of bottles. The wine had been bottled by a mobile bottling company at a contract winery, packed into apple bins and transported to the owner's premises for storage. The manager had observed numerous

bottles of the wine with high ullage distances and, upon opening, mould growth under the caps and oxidised wine. Apart from the leakage issue, there were other problems associated with the caps, including cases where the caps came off without breaking the bridges, caps with cuts to the tuck under region and caps with insufficient thread depth.

Subsequently, the manager also observed similar problems with other wine varieties bottled on the same day as the Chardonnay wine, by the same mobile bottling company.

After considerable correspondence and examination of numerous samples of the Chardonnay wine, many of the problems associated with the caps, such as poor depth of redraw and tuck under, poorly formed threads and caps which come off completely without the bridges breaking, were concluded to be the result of an incorrectly adjusted capping machine. It was evident that a number of equipment checks that should have been performed before commencing the bottling process, such as checking the spring tension on the threading and the tucking rollers, and checking that the head pressures were within the recommended specifications for the bottle and the cap, were not performed.

However, other problems with the caps, that were not due to the bottling process, were observed during the investigation. For example, most of the screw caps examined as part of the investigations were found to have dents around the redraw area. It is suspected that these dents were most likely the result of the bottles having been transported, unprotected, for approximately 30 km in apple bins after bottling. If a bottle of wine sealed with a screw cap is knocked against another bottle or other hard surface, then there is the potential for the seal to be damaged, which can result in leakage. Whilst most of the wine bottles examined that had dented caps had also leaked, some bottles that had leaked had no dents, or only very minor denting, on the caps. In addition, two bottles examined which had dented caps had not leaked. These results suggested that dented caps do not necessarily lead to leakage and that there might have been another cause of the leakage problem.

Inspection of the liners from the caps of samples which had leaked revealed the presence of at least one 'scratch/cut' or 'channel' in each liner in the region where the bottle finish contacted the liner to form a seal. In many cases there were multiple parallel 'scratches/cuts' in the liners. 'Bubbles' were also observed in the liners, where it was assumed wine had leaked beneath the tin layer of the wadding. It is considered possible that the 'scratches/cuts' in the liners might have provided a channel through which wine was able to travel, by capillary action, and hence eventually cause leakage. In cases where leakage was observed but no 'scratches/cuts' in the liners were observed, it was suspected that denting, resulting in damage to the seal, was responsible for the leakage. It was suspected that the presence of the 'scratches/cuts' in the liners most likely lead to a greater amount of leakage than damage to the redraw area of the screw

caps, however, it was concluded that more leaking and non-leaking samples would need to be assessed to confirm this suspicion.

This is the first leakage problem associated with wine in bottles sealed with screw caps that the Industry Services team has investigated.

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Conclusion of investigations conducted into the nature of 'unknown' taints

In the 2006 Annual Report, investigations into 'plastic/chemical-like' taints observed in wines from the 2005 and 2006 vintages were described in detail. At that stage of the investigations, the compound 2-chloro-6-methylphenol, a chlorophenol compound commonly known as 6-chloro-o-cresol (6-chloro-ortho-cresol or 6CC), was found to be responsible for tainting batches of yeast hulls that were used during the 2005 vintage. Whilst 6CC was considered to be the major contributor to the taint observed in a small number of wines, the compound 2,6-dichlorophenol (2,6-DCP) was considered to be the major compound contributing to the taint observed in the majority of both the 2005 and 2006 wines. In addition to 6CC and 2,6-DCP, the compound indole was also found to be responsible for off-flavours in small number of wines from those vintages. At the time of the publication of the 2006 Annual Report, the origin of the 2,6-DCP taint had not been determined, therefore, a summary of the final investigations is provided below.

Further sensory analysis and chemical testing of wines affected by the 'plastic/chemical-like' using the 'halophenol' method developed by the AWRI continued to provide evidence that 2,6-DCP was the major compound contributing to the taint. Statistical analysis of the results showed that there were statistically significant relationships between the concentration of 2,6-DCP in the wines and the results of the sensory assessments for the taint attributes rated during the sessions. However, no statistically significant relationships could be established between the results of the sensory assessments and the concentrations of any of the other compounds targeted in the 'halophenol' method.

Source of the 2,6-DCP taint

Although it became clear during the investigations that 2,6-DCP was the compound responsible for the taint observed in the majority of the 2005 and 2006 vintage wines exhibiting the 'plastic/chemical-like' taint, the question of the origin of the taint remained. After ruling out yeast hulls as the source of the 2,6-DCP taint, a commercial-scale winemaking trial was conducted at one of the wineries affected by the 'plastic/chemical-like' taint. During this trial, all the additives and processing aids used to make the tainted batches of wine were used in different 'treatments' during the processing of the 'trial wine'.

The results of 2,6-DCP analysis of different treatments set up during the trial implicated a particular batch of tartaric acid (H₂T) as the possible source of the 2,6-DCP taint. However, the results were unusual in that 2,6-DCP was detected in the wines from treatments where the 'suspect' H₂T had been added to the juice before fermentation, but was not detected, or very little was detected, in the wines from treatments where the acid had been added after fermentation. The 'suspect' H₂T was analysed for the concentration of halophenol compounds and whilst 2,6-DCP was detected in the acid, the result was much lower than expected based on the results of analysis of the wines from treatments where the 'suspect' H₂T had been added to the juice before fermentation.

a) The 'addition trial'

Additions of the 'suspect' H₂T were made to a Sauvignon Blanc (SB) wine, which had been previously analysed and determined to contain no detectable concentration of 2,6-DCP. The 'suspect' H₂T was added to the SB at a rate (4 g/L) near the high end of that typically used during winemaking and also at a rate (100 g/L) far in excess of that typically used. The results of halophenol analysis, conducted 24 hours later, showed that the 'suspect' H₂T was capable of tainting wine with 2,6-DCP when an amount (100 g/L) far exceeding that typically used during wine making was added directly to wine. However, when added to wine at a rate (4 g/L) near the upper end of the range typically added during processing in the Australian wine industry, no 2,6-DCP was detected. These results were not consistent with those obtained for the tainted wines analysed during the investigations, the mean 2,6-DCP concentration for which was approximately 50 ng/L¹. The results of halophenol analysis also showed that the wine used in the trial contained a 'trace' of 2,4-DCP from a source other than the 'suspect' H₂T.

The results of the addition trial suggested that either there was another source of 2,6-DCP contributing to the taint problem, that the contamination was not homogeneous throughout the batch of 'suspect' H₂T, or that only a small portion of the 2,6-DCP present in the 'suspect' H₂T was 'released' by a simple addition of the acid to wine.

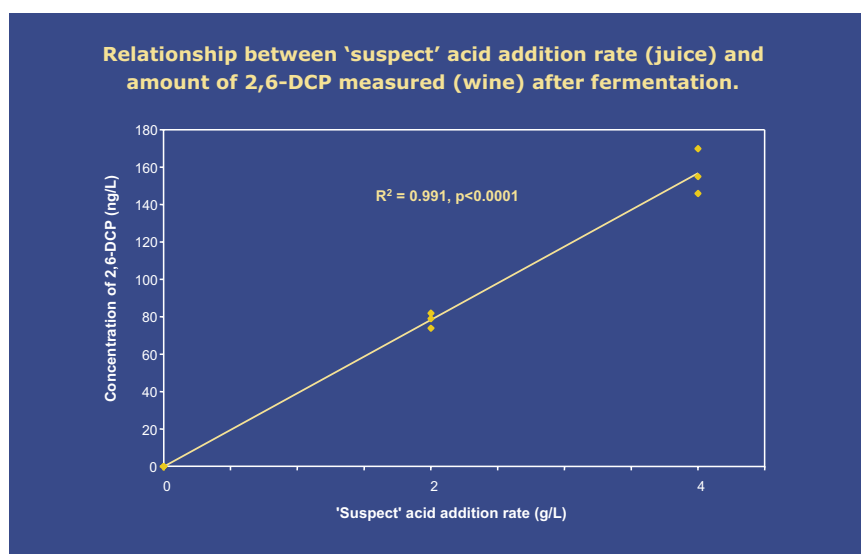


Figure 12. Relationship between the amount of 'suspect' H₂T added (three replicates for each addition rate) to a Chardonnay juice prior to fermentation and the concentration of 2,6-dichlorophenol (2,6-DCP) measured in the wine after fermentation. Addition rates were 0 g/L (T1), 2 g/L (T2) and 4 g/L (T3)

In order to investigate the batch of 'suspect' H₂T further, two trials were conducted at the AWRI: a) an 'addition trial', whereby additions of the 'suspect' H₂T were made to a wine, which was subsequently analysed for the concentration of chlorophenols; and b) a 'replicated fermentation trial', whereby multiple, replicate additions of the 'suspect' H₂T were made to portions of a 0.2 µm filtered Chardonnay grape juice, which were subsequently fermented to 'dryness'.

b) The 'replicated fermentation trial'

The 'replicated fermentation trial' consisted of three treatments, each comprised of three replicates. No 'suspect' H₂T was added to Treatment 1 (T1), however, 4 g/L of *Sigma* tartaric acid (cat#251380) was added to this treatment. Treatment 2 (T2) received an addition of 2 g/L of the 'suspect' H₂T, whilst Treatment 3 (T3) received an addition of 4 g/L of the 'suspect' H₂T. All the replicates from each treatment were subjected to halophenol analysis once they had fermented to dryness.

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Although 'trace' levels of 2,4-DCP and 2-CP were detected in all of the post-fermentation T1 replicate samples, no 2,6-DCP was detected in any of these samples. However, 2,6-DCP was detected in all of the post-fermentation T2 and T3 replicate samples, which also contained 'traces' of 2,4-DCP and 2-CP. The mean concentration of 2,6-DCP in the T2 replicate wine samples was 78 ng/L, whilst the mean concentration of 2,6-DCP in the T3 replicate wine samples was 157 ng/L, approximately twice the mean value obtained for the T2 replicate wine samples. These results were consistent with those obtained for the tainted wines analysed during the investigations, the mean and maximum 2,6-DCP concentrations for which were approximately 50 ng/L and 180 ng/L, respectively (leaving out an 'outlier' result of 236 ng/L).

There was a strong linear correlation ($R^2=0.991$) and highly statistically significant ($p<0.0001$) relationship between the amount of 'suspect' H₂T added before fermentation and the amount of 2,6-DCP detected in the resulting wine (Figure 12). The results of halophenol analysis also showed that the wine used in the trial contained 'trace' levels of both 2,4-DCP and 2-CP from a source other than the 'suspect' H₂T.

In summary, the combined results of the 'addition trial' and the 'replicated fermentation trial' showed that the 'suspect' H₂T was capable of tainting wine with 2,6-DCP. The trials also showed that 2,6-DCP, which was presumably bound to a minute fraction of tartaric acid molecules within the 'suspect' H₂T, was released during fermentation of grape juice to which the acid had been added, such that 2,6-DCP could be detected in the resulting wine after fermentation. It was also found that a small

amount of the 'bound' 2,6-DCP could be released, presumably by hydrolysis, after an addition of the 'suspect' H₂T to finished wine.

LC-MS/MS analysis of the 'suspect' H₂T

Given that the 2,6-DCP appeared to be present in a non-volatile, 'bound' form within the 'suspect' H₂T, the technique combining HPLC and electrospray-mass spectrometry, an ionisation and ion separation tool (together known as LC-MS/MS), was used to characterise the non-volatile, 'bound' form of 2,6-DCP.

The results of LC-MS/MS analysis of extracts of the 'suspect' H₂T and Analytical Grade (AR) H₂T showed that the 'suspect' H₂T contained a broad range of chlorinated compounds, consistent with di-, tri-, tetra- and penta-chlorophenol bound with H₂T. Based on these results, it was postulated that chlorophenol compounds (CP's) might have reacted with the H₂T to form CP-tartaric acid esters. If this was the case, then it might be possible that an enzyme(s) present in yeast could hydrolyse the ester and release 2,6-DCP during fermentation. This theory would explain the observations made during the 'addition trial' and the 'replicated fermentation trial'.

How did the H₂T become contaminated?

Contamination of food, food ingredients and processing aids with chlorophenol compounds can occur during production, during storage in containers, during transport in freight containers fitted with timber floors or during storage on wooden pallets. There have been several examples where food has become contaminated with chlorophenols during production, or where freight containers, jute sacks, fibreboard or wood pallets have been the source of chlorophenol contamination in

foodstuffs (Whitfield 1983, Whitfield et al. 1984, Whitfield and Last 1986, Whitfield et al. 1994, Mottram 1998).

If the bags of 'suspect' H₂T had become aurally contaminated during transport or storage on a wooden pallet after packaging, then it would be expected that the degree of contamination would be dependant on the position of each bag of tartaric acid on the pallet (Whitfield et al. 1994). It would be expected that bags in the central part of a stack would be less contaminated than bags on the outer part of the stack, if the bags of acid had been exposed to an atmosphere of chlorophenols.

In order to determine whether the 'suspect' H₂T might have become contaminated during production or during transport or storage, it was clear that the distribution of the contamination in 'suspect' bags of tartaric acid would need to be determined. Fortunately, one of the wineries affected by the taint had retained more than 30 bags of the 'suspect' batch of H₂T, which had been delivered to the winery on one pallet. A methodology and plan for sampling different positions within the remaining unopened bags of the 'suspect' H₂T stored at this winery, that enabled statistical evaluation of the results of analysis of the samples, was developed.

Statistical analysis of the results of LC-MS/MS analysis of 24 samples taken from various positions within the bags of the 'suspect' H₂T, indicated that the chlorinated compounds targeted during the analysis appeared to be fairly uniformly distributed throughout the bags. Given the fairly even distribution of CP-H₂T compounds throughout the bags of the 'suspect' H₂T, combined with the lack of detection of these compounds in non-'suspect' H₂T bags stored in the vicinity of the 'suspect' H₂T and

over the same time period, it was concluded that the results did not provide any evidence that the contamination occurred during transport or storage after the bags of 'suspect' H₂T were packaged.

Conclusion of the plastic/chemical-like taint investigations

Batches of yeast hulls used during the 2005 vintage were determined to be contaminated with 6CC and this contaminant could be transferred to wine. Although 6CC was identified in a small number of wine samples at such high concentrations that it was considered most likely to be the major contributor to the observed taint in those wines, 6CC did not appear to be the major compound responsible for the taint observed in most of the 2005 and 2006 vintage tainted wines. Similarly, whilst indole was considered to be the cause of the taint observed in a small number of the tainted 2005 and 2006 vintage wines, it was not responsible for the taint observed in most of the wines. The data obtained from chemical and sensory analyses showed that 2,6-DCP was the compound responsible for the majority of the tainted 2005 and 2006 vintage wines. The wines became tainted after the addition of a particular batch of H₂T which was contaminated with chlorophenols that were bound to the acid. Although chlorophenol compounds consistent with diCP, triCP, tetraCP and pentaCP were present in this 'suspect' batch of H₂T, the taint appeared to be caused by the release of 2,6-DCP, which has the lowest aroma and taste threshold of the mono-, di-, tri-, tetra- and penta-chlorophenols in wine (Travis et al. 2007). Statistical analysis of the results of numerous samples from different bags of the batch of 'suspect' H₂T did not provide any evidence to suggest that the contamination occurred during transport or storage after the bags of 'suspect' H₂T were packaged.

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Theme 3: Wine in society

Wine and consumer needs

Staff

Dr Leigh Francis, Kate Lattey (until August 2006), Belinda Bramley, Brooke Travis, Patricia Osidacz (since June 2007)

Reliable sensory data are of utmost importance to understand outcomes of many wine research projects, and the assessment of whether altered sensory properties might be desirable can only truly be determined by reference to consumer testing. Stemming from a previous consumer preference mapping study, efforts have been invested into understanding consumer tolerance for *Brettanomyces* flavour, working closely with the Industry Development and Support group at the AWRI. It was shown clearly that a set of wines with added, varied levels of the 'Brett' flavour compounds 4-ethylphenol and 4-ethylguaiacol were not liked by consumers, even when only low 'Brett' flavour was evident, and that the liking scores related closely to intensity of 'Brett' flavour. This sub-project was run as a component in a large aroma threshold testing and sensory descriptive study, reported elsewhere. The effect on consumer liking and sensory properties of 'Brett' flavour compounds in the presence of other wine components, namely oak flavour, herbaceous/green flavour, and ethanol was also investigated. This latter investigation was conducted together with Professor Larry Lockshin and Dr Simone Mueller of the University of South Australia's Ehrenberg-Bass Institute for Marketing Science, as part of a joint study to compare consumer preference testing methods.

Extensive aroma and taste thresholds of chlorophenol and bromophenol compounds have also been completed, together with a sensory study to determine if sub-threshold levels of halophenol compounds can give rise to taint. In addition, major sensory studies have been completed as part of the research programs, reported elsewhere, including a study assessing malolactic strain effect on Cabernet Sauvignon sensory properties, Pinot Noir sensory characterisation, yeast strain and inoculation strategies on Sauvignon Blanc aroma, and nitrogen addition on fermentation performance. This is additional to continuous sensory testing as part of wine sector problem solving investigations and other service and contract studies.

Human health, nutrition and food safety issues impacting on the Australian wine sector

Staff

Creina Stockley

One of the activities of the AWRI has been to provide health and nutritional advice and assistance to the Australian wine sector, through Creina Stockley, the Health and Regulatory Information Manager. From 1 July 2006 until 30 June 2007, 82 independent information health and nutrition requests were received by the Health and Regulatory Information Manager from the wine sector, the general public and government.

Wine sector committee membership

During the year, support to the wine sector has been derived from the Health and Regulatory Information Manager's membership of the following industry committees: the National Drug and Alcohol Research Centre's Young People and Alcohol Project Advisory Group on behalf of the Winemakers' Federation of Australia (WFA), and the Winemakers' Federation of Australia Wine and Health Committee. She is also the Department of Agriculture Fisheries and Food's nominated Australian delegate for Organisation Internationale de la Vigne et du Vin (OIV) Health and Safety Commission (IV), and on 13/3/07 was elected President of the Food Safety Expert Group, and eight media interviews were conducted including one with Singapore Radio 938-LIVE.

Health and nutrition issues

During the year, the database of research on the beneficial and detrimental health effects of alcohol and in particular, wine, has been added to and these records are available online for levypaying members of the Australian grape and wine sector. This is facilitated by the subscription to relevant medical and scientific journals, and by the formal and informal exchange of information between complementary organisations, both national and international. The journals have been regularly scanned, and articles have been prepared for inclusion in the AWRI's publication, *Technical Review*, and for other Australian wine sector and international alcohol industry newsletters. Articles and other material have also been prepared for the electronic and print media (see Appendix 5). For example, two articles have been prepared for the bimonthly international publication, *AIM—Alcohol in moderation*, two articles for the monthly *Australian and New Zealand Grapegrower and Winemaker* (AWRI publications #947, 972), and two articles for the bimonthly *Technical Review*, as well as four peer-reviewed papers were accepted for publication in *Nutrition*, the *South African Journal of Oenology and Viticulture*, the *Annals of Epidemiology* (AWRI publication #965) and *Contemporary Drug Problems*. The Health and Regulatory Information Manager also was guest editor of the *Proceedings of the Vindaba 2005 South African International Wine and Health Conference* published by the *South African Journal of Oenology and Viticulture* in December 2006.

Team reports

An invited oral presentation was made at the *Wine—flavour, fortitude and fizz* session at the 39th Annual AIFST Convention 2006 in Adelaide on 10/7/06, at the Kettil Bruun Society Thematic Symposium *Population studies on alcohol consumption and harm* in Toronto, Ontario, Canada on 1–6/10/06 and three were made at the Organisation de la Vigne et du Vin Commission IV Expert Group meeting in Paris, France on 13–15/03/07. Also, a public lecture was presented at The Cool Climate Oenology and Viticulture Institute, Brock University, Ontario, Canada on 26/9/06, and a poster was presented at the International Society for Biomedical Research into Alcohol (ISBRA) 2006 World Congress on Alcohol Research in Sydney, NSW on 10–13/9/06.

In addition, the Health and Regulatory Information Manager has continued her part-time external PhD program in the Faculty of Health Sciences at Flinders University entitled *It is not per capita alcohol consumption that matters but per occasion alcohol consumption*.

companies were mailed out and the updates were collated for the 2007/2008 agrochemical booklet. A concerted effort continues to be directed towards obtaining a list of Chinese MRLs. Based on value, China is now one of Australia's top ten wine export markets.

The Manager – Viticulture organised and ran the annual Agrochemical Industry Reference Group meeting to review changes to the agrochemical booklet and associated issues. Reviews of carbaryl and captan use, in response to the substantial reduction in the allowable residue concentrations in wines exported to the European Union and its member states, and sulfur use in the vineyard and its impact on wine quality, were investigated for the meeting. Updates of the AWRI agrochemical database and the AWRI MRL database for 2007/2008 were almost completed. The MRLs for an additional country, Belgium, were added to the MRL database. The Australian Pesticides and Veterinary Medicines Authority (APVMA) 'off-label' permits table was updated for the agrochemical website on a regular basis (a

In response to a request by the Wine Industry Association of Western Australia Inc. (WIAWA), the Manager – Viticulture reviewed and provided comment on the potential implications for the WA winegrape industry in regards to the revised 'Pesticide legislation and Policies in WA' document.

Agrochemical information was provided (information not provided in the agrochemical booklet) to Martina Bernard (University of Melbourne) for a comprehensive publication on Integrated Pest Management (IPM) in wine grapes.

Regulatory, technical and trade issues impacting on the Australian wine industry

Staff

Creina Stockley

One of the ongoing activities of the AWRI has been to provide regulatory and technical advice and assistance (including environmental information) to the Australian wine sector, through the Managing Director, the Health and Regulatory Information Manager and the Industry Development and Support Group of which the Health and Regulatory Information Manager is a member. From 1 July 2005 until 30 June 2006, 145 independent information science and technical-related requests were received by the Health and Regulatory Information Manager from industry, the general public and government.

Wine sector committee membership

During the year, support to the grape and wine sector has been derived from the Health and Regulatory Information Manager's membership of the following committees: AWBC/WFA Wine Industry Technical Advisory Committee (as Technical Liaison); the AWBC Legislation Review Committee; and the Wine Industry National Environment Committee; and was the Department of Agriculture, Forestry and Fisheries (DAFF) nominated Australian delegate for Organisation Internationale de la Vigne et du Vin (OIV) Expert Group meetings (as reported above).

Technical and regulatory issues

The technical and regulatory support to the Australian wine sector is ongoing as issues are regularly raised by the sector or government, both in Australia and internationally, and often span several years. During 2006/2007, technical and regulatory information and/or issues that have been reviewed, and material prepared includes: comments on the *Review of the National Standard on Wines* published by The People's Republic of China for the OIV/DAFF; a generic explanatory statement for wines regarding the usage of potentially allergenic proteinaceous processing aids in winemaking for the Australian wine sector; four 85-page dossiers for the European Food Safety Authority and European Commission as an *Application for permanent exemption from the mandatory declaration of allergen derivatives on food labels under Article 6, paragraph 11 of Directive 2000/13/EC of the European Parliament and of the Council*



Marcel Essling

Sally-Jean Bell

Compilation, interpretation and communication of agrochemical issues

Staff

Dr Sally-Jean Bell, Marcel Essling

Eleven thousand copies of the AWRI annual publication, *Agrochemicals registered for use in Australian viticulture 2006/2007* were produced and the booklet was made available from the AWRI website. The booklet was distributed with the *Australian New Zealand Grapegrower and Winemaker, Technical Review* and the tables were featured in *Australian Viticulture* and *The Grapevine Management Guide 2006/2007*. The AWRI agrochemical database was updated in addition to the 2006/2007 MRLs for Australia's major export markets, available on the AWRI website.

The MRL source data was updated in preparation for the 2007/2008 growing season. To achieve this, all product labels were checked, chemical company lists were updated, requests to chemical

new addition to the agrochemicals website). Four agrochemical updates were prepared and made available to the industry on the AWRI agrochemical website and via the AWRI email subscriber's service. The addition of a Technical Officer to the viticulture group has ensured that prompt delivery of up to date agrochemical information is available to the wine industry in line with spray diary preparation.

The Manager – Viticulture and the Supervisor of the Trace Analysis Laboratory liaised with chemical companies (Sipcam, Dow, Syngenta and Becker Underwood) during the year, to advise on trial designs in order to obtain information to set or change export withholding periods.

Stock feed/grazing restrictions for all 128 actives registered for use in viticulture were collated. This is in response to a number of enquiries in regards to the use of grape marc as stock feed. The presence of chemical residues in meat is tightly regulated.

on the approximation of the laws of the Member States relating to the labelling, presentation and advertising of foodstuffs, as amended by Directive 2003/89/EC for the processing aids casein and potassium caseinate, egg white, milk and milk products and isinglass used in the manufacture of wine on behalf of the WFA and the AWRI; and three 70-page petitions for the exemption from major food allergen labelling for wine produced with milk and milk products such as casein and potassium caseinate, wine produced with egg white and egg white products such as lysozyme, and wine produced with fish products such as isinglass for the US Alcohol and Tobacco Tax and Trade Bureau. In addition, the Health and Regulatory Information Manager attended the Regulator's forum of the World Wine Trade Group (WWTG) in Canberra on 22/1/07 as a member of the Australian government delegation and presented the Australian case study on allergen labelling and the analytical and clinical research undertaken in the GWRDC-funded project ADF 02/01 entitled *The identification and measurement of potential allergens in wine*.

Reports were also prepared on: the concentration of copper in Australian wines to support an amendment to *Proposal A463 copper citrate* on behalf of the WFA; the percentage of water addition during winemaking to support an amendment to FSANZ application A573 *Water use in winemaking* on behalf of the WFA; the use of technology in Australian red and white winemaking for the DAFF which was presented to a Turkish government delegation to the Department of Foreign Affairs and Trade on 1/2/07; a summary of the multi-country study on authenticity as it relates to Australia's wine grape growing geographical regions; and the cancer-causing potential of screwcaps and assisted in the preparation of an AWBC press release and other media material. The *Final Report on the Analysis of 2,4-D in grapes and wine* for the Grape and Wine Research and Development Corporation (GWRDC) was also prepared and submitted. A paper entitled *Analysis of protein-fined wines for detection of residual food proteins in wine* and one entitled *Consumer health and safety issues related to the dietary intake of sodium—wine consumption in perspective* was also prepared for and presented at the OIV Commission IV Safety and Health meeting on 15/3/07 as was a paper entitled *The content of minerals in Australian soils, water, grapes and wines* at the Methods of Analysis Sub-commission meeting on 22/3/07. Furthermore, a Grape and Wine Research and Development Corporation (GWRDC)/WFA Risk Management Desktop Exercise—Operations Orders Workshop, and a two-day Chifley Business School Risk Management Short Course were attended.

The Health and Regulatory Information Manager also coordinates Course 3005WT *Grape industry practice, policy and communication* for the School of Agriculture, Food and Wine at The University of Adelaide. In its thirteenth year, 37 students enrolled in the Course, which exposes students to organisational, commercial, environmental, political, societal and technical issues relating to the wine sector's operating environment.



Project coordination

Through Creina Stockley, the AWRI has played a coordinating and a participating role in a GWRDC-funded research project on a medical and technical aspect of wine consumption entitled ADF02/01 *The identification and measurement of potential allergens in wine* in conjunction with the Department of Allergy, Asthma and Clinical Immunology at The Alfred Hospital and Monash University. The final report was completed and submitted to the GWRDC.

Theme 4: Information and knowledge transfer

Transfer of knowledge relating to viticulture

Staff

Dr Sally-Jean Bell, Marcel Essling

During 2006/2007 the Manager – Viticulture responded to 339 enquiries, the majority were regarding the use of agrochemicals for pest and disease control, the persistence of residues through winemaking and their effects on fermentation, and issues related to maximum residue limits in overseas markets. The remaining calls were season specific issues investigated on behalf of growers and included drought, smoke taint, frost, saline irrigation water and a failure to meet WHP in light of the early harvest. The number of enquiries was down compared to the previous year due to a season exhibiting low disease pressure.

The Manager – Viticulture participated in the AWRI Roadshow visits to the Clare Valley (03/08/2006), Coonawarra (28/08/2006) and Armidale (16/01/2007), delivering presentations entitled – 'Agrochemicals – selling quality wine', 'Management of pesticide residues during winemaking', 'Salty Wine' and 'Manipulation of phenolic profiles in red grapes and wine by viticultural management'. The Technical Officer – Viticulture was appointed in January 2007 and participated in the Armidale AWRI Roadshow

delivering a presentation entitled 'Management of *Botrytis* in the vineyard'. The Manager – Viticulture gave invited presentations to the Yarra Valley Winegrowers Association ('Phosphorous acid in grapes and wine'), to a E.E. Muir and Sons Grower Meeting in Coonawarra ('The implications of off-label use of ethephon' and 'Agrochemicals – selling quality wine') and was the keynote speaker at the Tasmanian Vineyard of the Year Field Day ('Does grapevine nutrition have an impact on wine quality?'). The Technical Officer attended the 'Agricultural Forum and impacts on Climate Change' at Mildura. The Manager – Viticulture and the Technical Officer attended a 'Drought response' workshop in the Barossa Valley.

Information was sourced and a review of Dr Henschke's book chapter on agrochemicals and fermentation were undertaken. A review of the impact of drought on viticulture was prepared. Abstracts were contributed to *Technical Review*, and the organisation and interviews for the Technical Officer - Viticulture position were undertaken. Additionally, the Manager – Viticulture reviewed two manuscripts for *The American Journal of Enology and Viticulture* and the *Australian Journal of Grape and Wine Research*. The Manager – Viticulture reviewed 118 viticulture poster abstracts for the 13th Australian Wine Industry Technical Conference as well as developing a workshop entitled 'Nitrogen – Friend or foe – Nitrogen nutrition and wine quality'.

Transfer of knowledge relating to winemaking

Staff

Peter Godden, Con Simos, Adrian Coulter, Geoff Cowey, Matt Holdstock, Emma Kennedy, Narelle Cream, and Teegan Waples.

The Industry Services team provides a wine-making consultancy service principally through the Group Manager – Industry Development and Support, Peter Godden, a qualified and experienced winemaker, Con Simos, Manager – Industry Services, a Roseworthy Oenology Graduate with 21 years experience, and

Team reports

Adrian Coulter, a Graduate in the Diploma in Oenology from The University of Adelaide. Of the other members of the team, Geoff Cowey (BSc), who had gained five years of winemaking experience before joining the AWRI in 2001, completed his undergraduate studies in wine-making at Charles Sturt University during the year. Matthew Holdstock (BSc) is also a Graduate of the Diploma in Oenology from The University of Adelaide, has overseas winemaking experience and previously held the position of Laboratory Supervisor with the AWRI Analytical Service. As part of the ongoing development program, both Geoff Cowey and Matthew Holdstock completed overseas vintages in the northern hemisphere in 2006. Geoff Cowey spent seven weeks at Torres, in the Penedes, Spain, in a vintage winemaking position whilst Matt Holdstock gained experience at Château de Pez, in St Estephe, Bordeaux, France, for a similar period. This training program proved to be a unique learning experience for both Industry Services Oenologists.

Most queries received are technical in nature and arise predominantly from Australian winemakers; this trend continued in 2006/2007. Other queries were also received from wine industry suppliers and government bodies, as well as a relatively small number from the general public and students. The majority of queries were answered either by telephone or, increasingly, by email. Thus, Industry Services staff facilitated the distribution of more than 2,000 technical papers or other pieces of relevant literature to callers each year, via the John Fornachon Memorial Library. Increasingly, Industry Services staff members are also able to direct callers to web-based information, on the AWRI's own website, and the support facilities provided by other AWRI research and information services staff members are important in supplying a quality integrated response to callers. Furthermore, the analytical capacity of the Industry Services Laboratory played an important role in responding to many of these enquiries.

A summary of the enquiries received by Peter Godden, Adrian Coulter, Con Simos, Geoff Cowey and Matthew Holdstock for the year is shown in Table 3, with comparison figures for the previous two years.

Table 3. Enquiries received by IDS advisory staff in the period 2004/2005 to 2006/2007

	2004 /05	2005 /06	2006 /07
Wineries	1047	1127	1285
Government organisations	101	55	36
Other	326	534	369
Students	28	29	21
Total	1502	1745	1711

Compared with the previous year, the figures for 2006/2007 show a nominal decrease in the total number of enquiries received. The total number of 1,711 requests was recorded for the year. It is important to note the significant

increase (+14%), compared with the previous year in the number of calls made by winemakers. The high number of calls received from wineries indicates that a large number of personnel in the Australian wine industry continue to regard the AWRI as a trusted, reliable, and an important source for quality technical information and problem solving solutions.

The investigative and advisory services are supported by Roadshow seminar and workshop tours which are currently made on a rotating basis to 29 Australian winemaking regions. A Roadshow visit plan to 2009 has been posted onto the AWRI website, which provides advance notice to regions of AWRI's impending visit.

During the year, Roadshow seminars and or workshops were held in the Barossa Valley, Clare Valley, Coonawarra, Geelong, Bendigo and, for the first time, in Armidale. The inaugural New England seminar and workshops were both very well attended and underlines the AWRI's commitment to servicing new and emerging regions.

Roadshows are organised in conjunction with winemakers' and growers' regional associations, and for seminars, those associations are asked to select the presentations to be made from a list of over sixty topics of current AWRI activities so that the seminars are closely tailored to the interests and needs of the audience. Whilst Industry Services staff members are responsible for the organisation of Roadshow seminars and present a substantial amount of the content, they rely heavily on input from all of the AWRI's research teams with at least six senior AWRI staff members making twelve presentations in each full-day seminar.

Roadshow workshops are generally presented solely by Industry Services staff, and several half-day workshop 'modules' have now been developed. As with seminars, regional associations are asked to choose the modules that have the greatest relevance to their regions, and new workshop material is often prepared at the request of the associations in order to accommodate their particular needs.

In addition to the formal presentations, Roadshows are also considered an important vehicle for the delivery of informal advice, and it is considered that if this contact were formally recorded then it would account for a substantial increase in the number of enquiries recorded in Table 3.

The AWRI has responded to many cases relating to taints and contamination in wines in recent years. It is AWRI's position that the issue of taints can only be addressed by engaging key stakeholders at all levels of the supply and process chain. This pro-active programme supplements AWRI's existing strategies in taint management specifically targeting the winemakers of Australia. The supplementary approach was to produce a tailored presentation on taints, specific to the needs of the supply chain. Presentations have already been made in both Melbourne and Adelaide; the feedback from these presentations was extremely positive. More than 50 organi-

sations were represented, covering areas such as legal, insurance, chemical suppliers and wine sector consultants. Further presentations will be given beginning in Sydney later in 2007.

The 21st and 22nd Advanced Wine Assessment Courses were held in December 2006 and June 2007 respectively. Both courses provided a further total of 60 participants the opportunity to develop and test their sensory evaluation performance. Both of these courses were presented under a four-day format and, as part of the intensive program, potential judges have the opportunity to evaluate a diverse range of more than 310 wines under simulated wine show conditions. The course consists of more than 40 hours of content and also includes lectures presented by AWRI staff and the participation of 14 leading wine show judges, journalists and winemakers.

The Industry Services team continues to develop content for the IDS section of the AWRI website. Clear links have been added to improve ease of use and functionality across the website. A process of continuous improvement is underway and new password protected content will be progressively added after the new AWRI website is launched (July 2007). New content includes recognition of wine faults and taints, and screening tests for commonly used winemaking chemicals and processing aids. In conjunction with the AWRI's Sensory Team, a new section on sensory assessment and conducting sensory trials is close to completion. Further practical advancements also include the addition of a calculator section, the purpose of which is to provide winemakers and laboratory staff with a back-up method in carrying out fining trials and calculating additions of reagents and chemicals used in the winery environment.

Australian wine sector personnel can access the information via the AWRI Home Page by selecting 'Industry development and support' then 'Practical Solutions'. This section of the site is password protected. Australian grapegrowers and winemakers who pay the *Winegrapes* or *Grape Research* levies who require the password can apply for their own unique username and password via the site (or email: infoservices@awri.com.au for assistance). However, other sections of the AWRI's website also contain a great deal of other technical information, and are publicly accessible by all interested parties.

The planning process for the 13th Australian Wine Industry Technical Conference was a major focus of the Industry Services team towards the end of the reporting year. The members of the IDS Group planned the conduct of workshops relevant to their field of endeavour; the Manager - Industry Services served on the 13AWITC Planning Committee and was one of the Program Sub-committee Convenors; and the Group Manager - Industry Development and Support was responsible for the overall workshop program; expectations of success have been boosted by the high interest from attendees and workshop presenters, and a record number of places, approximately 2,400 have been made available through the 57 workshops offered.

Communication and Information Services

Staff

Rae Blair, Linda Bevin, Kate Beames, Sean Boden, Ingrid Barratt, Claire St George, Pauline Thornton

The composition of the Communication and Information Services (CIS) group, led by Rae Blair, Group Manager, changed during the year in response to the identification of an increased need for knowledge management, articulated in the strategic directions of the AWRI's Business Plan. The appointment of information and knowledge management specialist, Linda Bevin, will facilitate a more effective control and ultimate delivery of knowledge to the Australian grape and wine sector. A new librarian, Sean Boden, was also appointed during the year. Sean brings to the team modern information collection and retrieval techniques with an enthusiastic interest in maximising effective delivery via electronic methods. The team is complemented with Ingrid Barratt, Library Technician and our part-time Library Assistant, Claire St George. The conduct of the Australian Wine Industry Technical Conferences falls within our ambit and as such our team this year also included conference staff, Kate Beames, Conference Secretariat and Pauline Thornton, Conference Assistant.

The CIS group is a service unit within AWRI, and its stakeholders include AWRI staff; members of the Australian grape and wine sector; researchers and students; Australian grape and wine organisations' staff; members of the Australian and State governments; industry suppliers; and industry members from overseas countries. The CIS group members handled over 3,000 requests for information during the year.

The operations of the Communication and Information Services group complements and supports the communication activities of all AWRI staff in general, but particularly the activities of the Industry Development and Support group. Our specific activities include the following:

- Information and knowledge management
- Facilitating effective communication between the AWRI and its stakeholders
- Maintaining the collection held within the John Fornachon Memorial Library
- Management of the AWRI website, and web-accessible information databases
- Production of corporate publications, including *Technical Review* and the Annual Report
- Provision of an editorial service for AWRI staff
- Media and VIP visit coordination
- Management of the Australian Wine Industry Technical Conferences

Some of the highlights for the 2006/2007 financial year include:

- Response to more than 3,000 requests for information
- The establishment of the Information and Knowledge Manager position and appointment of Linda Bevin to the role in February 2007
- Appointment of Sean Boden as the Librarian in November 2006
- Launch of the AWRI Online Image Collection
- The completion of the industry-wide survey to assess the communication effectiveness of the AWRI
- Establishment of an agreement to provide library and information services to DrinkWise Australia Ltd.
- The web-accessible industry library database reached 50,000 records
- The re-development of the AWRI website (due for launch July 2007)
- The launch of the Information and Knowledge Management Review
- Publication of AWRI report: *The stone age didn't end because man ran out of stones: why innovation is critical for the Australian wine industry.*

Improvement of knowledge management, stakeholder communication and culture at The Australian Wine Research Institute

Stakeholder communication plan

An objective from our recently completed 10-year Business Plan was to improve our value to our stakeholders. A copy of the Executive Summary of the Business Plan can be accessed from our website: http://www.awri.com.au/about_us/Business_Plan/AWRI_Exec_Summary.pdf

To achieve this, we developed a plan; part of which involves interviewing identified stakeholders from a range of producer sizes and locations. During December 2006, 29 industry members (decision makers/senior technical management/operations, wine and grapes, large, medium- and small-producers) from NSW, Victoria, SA, WA and Tasmania were interviewed by telephone, with each interview lasting around an hour. These members were asked questions such as:

- Can you tell us about how you think of the AWRI and its role in the Australian wine industry and your experiences with AWRI?

- Apart from the drought, frost, pests and current over-supply matters, what are the key drivers of change going into 2007? How well is AWRI responding to those changes?
- Where are the new ideas coming from in the Australian wine industry? How does AWRI promote thought leadership to the innovation and/or knowledge process?
- How you learn about new technical developments?
- How well you think AWRI reaches its constituency?
- Should AWRI have more points of presence?

Other questions were asked, ad hoc, as the interview progressed to tease out important issues. From these interviews convergence and divergence of opinions were identified.

The outcome from these interviews formed the basis for an on-line survey which was emailed to AWRI's contacts database. Population of that database is 2,707. An overall response rate of 35.5% was achieved (959 responses), which would be considered 'high' when comparing to similar projects. Not all respondents answered every question.

With these activities, we hope to:

- understand better how AWRI is perceived by the Australian wine industry now;
- improve stakeholder understanding of how AWRI delivers value to the Australian wine industry;
- identify the 'what, when and how' (actions) for AWRI to improve its delivery of value to the industry and better meet the needs of industry participants; and
- develop a way of measuring stakeholder perception of value delivery.

During the second half of 2007, the data will be analysed and matrices constructed. These results will instruct the objectives and strategies of a Stakeholder Communication plan to be undertaken next year. The data provide an effective yardstick that can be used for comparison for future surveys, to establish how effectively we are disseminating information to, and communicating with, our important stakeholders.

Information and knowledge management

The AWRI Information and Knowledge Management Review commenced in April 2007. The purpose of the review is to identify current and future requirements in relation to the management and transfer of knowledge. The key drivers for an Information and Knowledge Management Strategy is to enhance the industry's technical capability through the application and adoption of research outcomes from the AWRI, supporting the industry to better respond to current and emerging issues, and enhancing the productivity and quality of research through the use of technologies.

Team reports

Table 5. Summary of information requests during 2006/2007

	Wine industry		Staff		Other ⁶		Total		% Change
	2007	2006	2007	2006	2007	2006	2007	2006	2007
Information requests	714	923	1089	920	1318	1451	3121	3294	(5%)
Interlibrary loans:									
• requests sent ¹	100	56	641	551			741	607	22%
• requests received ²							79	76	4%
Technical Review requests ³							96	110	(13%)
Technical Review articles forwarded ⁴							328	336	(2%)
Articles forwarded ⁵							417	455	(8%)
Number of AWRI publications forwarded							1395	618	126%
Articles photocopied in JFML	967		543		994		1318	1613	(18%)

¹ Request to another library for an article; ² Requests from another library for articles held in our collection; ³ Number of requests received for articles published in *Technical Review*; ⁴ Number of articles forwarded (usually more than one article is requested); ⁵ Number of articles forwarded from the library collection, excluding staff publications; ⁶ Requests from students, Government agencies, private companies and overseas customers.

The Information and Knowledge Management Strategy will be implemented in stages. The first stage, expected to commence in October 2007, will focus on extending the availability of information services and resources via the AWRI website.

Provision of scientific, technical and regulatory information

The John Fornachon Memorial Library

The John Fornachon Memorial Library holds the largest collection of grape and wine technical literature in the Southern Hemisphere, covering winemaking, viticulture, wine microbiology, flavour chemistry, phenolics, food chemistry, wine and health, wine and the environment, and more. The collection includes books, journals, article reprints, conference proceedings, reports, theses, standards and legislations, as well as a reference collection of foreign dictionaries and atlases.

The AWRI has an ever-growing knowledge base and technology is providing opportunities for the John Fornachon Memorial Library to evolve beyond the traditional concept of libraries and focus on the expansion of electronic information access and delivery. Printed publications will continue to be an important part of our collection, but a 'modernisation' program is under development to ensure our information services continue to be of value and relevance to our customers.

Industry online information databases

Three information databases, available via the AWRI website, can be accessed by all grape-growers and winemakers who pay the *Grape Research Levy* or *Winegrapes Levy*. The databases are a valuable information resource comprising books, journal articles, conference proceedings, reports, standards and legislation held in the AWRI collection, and users of the databases can also request items online.

Real progress has been made in the last quarter of 2006/2007 to expand the *Industry* information database. The addition of more than 17,000 records represents an increase of 47% and brings the total number of bibliographic records in the *Industry* information database to 54,908 (see Table 4 for a list of information databases). This database also contains abstracts from selected AWRI publications and journal articles where the AWRI was able to acquire copyright permissions.

There is strong demand for information access via the web, which is available 24 hours a day, 7 days a week. Customers continue to show support for the *Industry* information database, with an overall increase in usage compared to figures reported last year. Figure 13 provides a summary of database usage during 2006/2007.

Table 4. Description and size of online information databases and library catalogues

Web accessible information databases	
Industry (with searchable abstracts)	54,832
Environment	573
REGS: European Community wine legislation	412
Library catalogues databases	
AWRI_database (library catalogue)	52,798
Journals (journals, theses, statistics and annual reports)	412

John Fornachon Memorial Library catalogue databases

The Library holds over 54,000 books, conference proceedings, theses and scientific, technical and medical reprint articles. They are indexed in the Library's database catalogue which is accessible via the John Fornachon Memorial Library. Details of the Library's journal holdings including newsletters, statistics and annual reports are held in the *Journals* database. A summary of the size of the Library's catalogue and information databases is given in Table 4.

Database usage 1 July 2006 to 30 June 2007

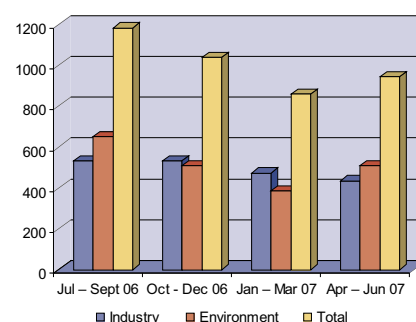


Figure 13. Summary of database usage during 2006/2007

Specialised information services

While the usage of the AWRI's *Industry* online information database is increasing and the database is available free of charge to all Australian grapegrowers and winemakers who pay the *Grape Research Levy* or *Winegrapes Levy*, customers are continuing to request the Library to conduct online searches using commercial databases on a fee-for-service basis.

Document delivery services

'Document delivery' supplies journal articles, books or other library items to customers upon request. This also includes sourcing items held by other Australian and overseas libraries if required (interlibrary loans are provided on a fee-for-service basis). The ability to order items online means that most interlibrary loan requests are able to be completed within five days.

The electronic ordering facility available from the AWRI website continues to be an efficient method for customers to request AWRI publications. This year, we serviced a 126% increase in publications requested over that reported in the previous year (Table 5). To put this figure into context, this increase is on top of the 124% increase registered last year over the 2004/2005 figures.

Copyright Services

In June 2007, the Copyright Agency Limited (CAL) released a new copyright licence allowing printed materials to be digitalised for internal use. Due to copyright restrictions, the AWRI currently does not have a full-text searchable database for its staff publications with the option to download the entire document electronically. The new licence will address this restriction and allow the Communication and Information Service (CIS) group to explore options to provide more electronic resources.

There is also a demand for electronic information services from the industry. While the licenses available from CAL do not extend to electronic delivery of information, the CIS group will continue to approach publishers for copyright permission to use abstracts of articles in *Technical Review* and to index these abstracts into our information databases. There are currently 8,855 records containing searchable abstracts in the *Industry* information database.

Library collection

A total of 150 monographs and 8 conference proceedings were added to the collection in the financial year of 2006/2007. The library subscribes to 52 journals and receives over 70 annual reports, newsletters and journals through exchange and donation. The collection also holds over 23,700 reprints of AWRI staff publications, articles featured in *Technical Review* and articles obtained via interlibrary loans.

Online Image Collection

The AWRI Online Image Collection was launched in March 2007 and holds in excess of 2,000 images. The collection of images, some of which are nearly sixty years old, range from wine microorganisms to grape harvesting technology, and will be a useful resource for industry members, researchers, academics and students.

The project was funded by Australia's grape-growers and winemakers through their investment body, the Grape and Wine Research and Development Corporation, with matching funding from the Australian government. The image collection was established with the donation of slides and photographs by the late Dr Peter May (formerly CSIRO), Dr Bryce Rankine (formerly AWRI) and Dr Bryan Coombe (formerly University of Adelaide), supplemented with the AWRI's own images collected since 1955. The collection will continue to be added to upon receipt of further donated images. Access to these images is via the AWRI website, and the database is free of charge to search.

Donations to the Library collection

The AWRI wishes to thank all individuals and companies who contribute to the collection through donations or exchange agreements. The support of the following persons and organisations who have donated books, journals or photographic material is acknowledged:

Australian Bureau of Agriculture and Research Economics, Australian Dried Fruits Corporation, Australian Wine and Brandy Corporation, Australian Wine and Brandy Producers' Association,

Commonwealth Scientific and Industrial Research Organisation, Dr B.G. Coombe, the late Dr P. May, Petaluma Australia, K.F. Pocock, Dr B.C. Rankine, Viticultural Publishing Inc., and the Winemakers' Federation of Australia Incorporated.

Provision and development of mechanisms for the efficient transfer of knowledge and technical information to the Australian grape and wine sector

AWRI website

A redevelopment of the AWRI website has been instigated to increase the ease of access of information by our stakeholders, and to improve the quantum of relevant information available. Working again with Michael Major Media, the new website will also enable Australian levy payers to create their own unique password to access the protected sections of the site. The new design is due to be launched in July 2007.

Technical Review

Technical Review is a bimonthly publication produced by the AWRI and provides progress reports to the industry on the AWRI's research, as well as updates on relevant conferences, regulatory amendments and medical issues. The 'Current Literature' section provides citation details and abstracts of recently published technical and scientific articles.

In the financial year of 2006/2007, more than 18,000 copies of *Technical Review* were distributed to Australian grapegrowers and winemakers who pay the *Grape Research Levy* or *Winegrapes Levy* and subscribers in Australia and overseas. Over 300 articles featured in *Technical Review* were requested and forwarded.

An electronic version of *Technical Review* is available to levy payers via a secured section of the AWRI website and the annual CD-ROM. The 2006/2007 edition of the *Technical Review* CD-ROM provides simple search capabilities,

offering fast access to technical notes, current literature abstracts and other matters of interests published in the last twelve months.

A format change introduced in the April 2007 issue of *Technical Review* has resulted in lower production costs. This saving has been re-directed to a larger print run to accommodate the annually expanding list of industry members who pay the *Grape Research Levy* or *Winegrapes Levy*.

Dr Barbara Hardy AO and her family continue to support the publication of *Technical Review* through regular generous financial contribution to the Thomas Walter Hardy Memorial Trust, and their ongoing support is gratefully acknowledged.

Email service

The Email Advice and Information on Technical Issues Bulletin service continues to be a fast and cost-efficient way of disseminating important technical information to interested members of the Australian wine industry. There are >3,500 email addresses recorded to receive the email bulletins, and interested members of the Australian wine industry should submit their email address (to infoservices@awri.com.au) should they wish to receive the email bulletins. Fifteen email bulletins were issued during the year and are shown in Table 6.

Editorial services

The Australian Wine Research Institute contributes a regular column in the *Australia and New Zealand Wine Industry Journal*. This journal is published bi-monthly and the Group Manager is responsible for the editing and delivery of the AWRI's contribution (details of the articles published are in Appendix 5). The Group Manager also contributes regular articles to the AWRI's bi-monthly publication *Technical Review* which include information on new staff joining the AWRI, staff accolades from external parties, and updated information on the Australian Wine Industry Technical Conference.

Table 6. Email bulletins sent during 2006/2007

Date	Bulletin topic
5/7/06	Updates made to AWRI's 2006/2007 Agrochemicals book
1/8/06	AWRI Clare seminar and workshop 3 & 4 August
1/8/06	Biological insecticide required for use in vineyards to control locusts and grasshoppers
9/8/06	AWRI wine instabilities workshop
21/8/06	AWRI seminar and workshop: Coonawarra 29 & 30 August
21/8/06	AWRI technical problem solving available in Coonawarra region
28/8/06	Invitation to AWRI's Victorian presentation of our new seven-year plan
4/9/06	AWRI roadshow in Bendigo, 12 September
1/12/06	World-leading science enhanced to the benefit of the Australian wine industry
15/12/06	Agrochemical update
20/12/06	AWRI information on smoke taint
14/2/07	Registrations now open for 13AWITC and 4AWIEC
14/2/07	Winemaking implications of drought
22/2/07	Wine industry benefits from \$0.5 m state government grant
14/3/07	AWRI Online Image Collection now available!

Team reports

Media liaison

Two media releases were prepared and distributed

- *Wine future is assisted by investment agreement*: a media release, announcing the new Seven-Year Investment Agreement between the AWRI and the GWRDC, distributed 7 November 2006.
- *Wine industry benefits from \$0.5 m state government grant*: a media release announcing the funding received for the South Australian branch of Metabolomics Australia, distributed 15 February 2007.

Australian Wine Industry Technical Conferences

The Australian Wine Industry Technical Conference is the major extension activity undertaken by The Australian Wine Research Institute, as has been the case since 1970. Since 1986, the AWRI has presented the AWITC in collaboration with the Australian Society of Viticulture and Oenology. The development and conduct of this event is a large undertaking for the AWRI, with much of this year spent in the planning phase. More details of the Conference can be found on the Conference website: www.awitc.com.au, and a full review of the event will be published in our 2007/2008 annual report. Whilst most AWRI staff will have some involvement in the conduct of the event, the key responsibilities are held by the following AWRI staff members:

AWRI's Managing Director	Professor Sakkie Pretorius	Chair of Conference Planning Committee
Group Manager – Communication and Information Services	Rae Blair	Conference Manager, Treasurer, Public Officer of AWITC Inc.
Group Manager – Research	A/Professor Markus Herderich	Program Sub-Committee Convenor
Manager – Industry Services	Con Simos	Program Sub-Committee Convenor
Group Manager – Industry Development and Support	Peter Godden	Workshop Coordinator
Research Microbiologist	Dr Eveline Bartowsky	Poster Coordinator

The workshop program is managed by AWRI staff: Peter Godden, Ella Robinson, Teegan Waples, Sarah Kobelt, Jean Macintyre and Jeremy Hack. The Poster program is supported by AWRI staff: Dr Sally-Jean Bell, Dr David Jeffrey and Jeff Eglinton. Conference management and registration process is supported by Kate Beames and Pauline Thornton.

General other activities

The Communication and Information Services group developed a proposal to provide library and information services to DrinkWise Australia Ltd. The proposal was accepted by DrinkWise and will provide an income stream in 2007/2008 which will be re-invested to expand the information and knowledge services offered by the AWRI to the Australian grape and wine sector.

Analytical Service

Staff

Mai Nygaard, Randell Taylor, Leanne Craddock, Teegan Waples, Matthew Cream, Oliver Lovat, Jelena Jovanovic, Melissa Nutt, Danielle Leedham, Nevil Shah, Slavko Bekavac, Daniel Tynan, Andrew Ferrell, Heather Brooks, David Boehm, Yvonne Staeffler, Stella Kassara (part-time)

Students

Patrick Dimanin, Danielle Butzbach, Katie Gerber, Darek Kutyna

The 2006/2007 year was very positive for the Analytical Service with solid growth in the number of analyses performed for the wine industry and successful completion of several significant milestones. During the year, the Analytical Service saw significant restructuring of its human resources and we underwent an important process of upgrading and streamlining the Analytical Service and its routine and trace laboratories to meet current and future industry demands.

Highlights for the 2006/2007 financial year were:

- Growth in Analytical Service revenue of 10% in a difficult financial year for the wine industry. The surplus made will be reinvested in new Analytical Service laboratory instrumentation.

- Staff changes. A new Analytical Laboratory Supervisor, Leanne Craddock, was recruited and commenced work in January 2007. Analytical Service also welcomed two new laboratory technicians and new staff in the Customer Service area with Teegan Waples taking up the position as Customer Service and Marketing Manager.
- LIMS (Laboratory Information Management System) fully implemented. The system uses barcode readings of samples and automated data transfer from instrumentation. It is also prepared for electronic notification and reporting to clients.
- Evaluation of two automated enzymatic analyzers to identify a suitable replacement for the obsolete Cobas Fara analyser.
- Independent contract studies and non-routine analytical work for the grape and wine sector increased. Analytical Service assisted clients in areas such as: closures, packaging materials, taint and sensory assessments and small-scale winemaking under GLP.
- Regular communication with customers through the Analytical Service's quarterly industry newsletter 'The Wine Analyst'
- An AWRI report on 'Quality Management in the laboratory' was published in the *Australian and New Zealand Wine Industry Journal's* Nov/Dec 2006 issue (AWRI publication # 953) and Analytical Service was also involved in an industry benchmark survey on analysis and technology, reported in June 2007

The Analytical Service conducts the widest range of tests of any wine specialised laboratory in Australia and currently we

are performing more than 100,000 individual analyses per year for the grape and wine sector and we offer more than 100 different analytical tests on grapes, juice and wines. The Analytical Service is committed to substantially contributing to the ongoing success of the Australian wine sector by delivering high quality analytical services and by using a unique business model where any potential surplus made from our operations are reinvested to directly support the Australian grape and wine sector, either through investment in the Analytical Service or to underpin other AWRI activities.

Analytical Service keeps an updated list of services offered to the wine sector on the AWRI web page www.awri.com.au/analytical_service

The Analytical Service laboratory is NATA accredited and operates in accordance with ISO 17025 - 2005, applying a strict quality management system. The laboratory is also GLP recognised in the field of analytical testing and grape processing for agrochemical residue studies. As part of our quality management, Analytical Service participates in a wide range of proficiency testing schemes (NATA, IWAG, DAPS, FAPAS) and we constantly strive towards excellence in quality control in order to secure all analytical results reported are reliable and accurate.

Table 7 Routine analyses provided by AWRI's Analytical Service throughout the grape to consumer value chain

Value chain	Decision-Control point	Desired analyses	Key parameters offered by Analytical Service
Vineyard/Grapes	Streaming and harvest decision Compliance (MRL)	Grape maturity and quality Agrochemical residues	Brix/Baume, pH, TA, Colour (anthocyanin)/phenolics, MCP tannin assay Multi residue assay (MRA) Smoke taints
Juice/Must	Meeting specifications, requirements for adjustments/ additives	Chemical composition, antioxidants	Juice panel: Brix/Baume, pH, TA, YAN, Malic, tartaric acid, FSO ₂ , TSO ₂ , ascorbic acid, turbidity MRA
Fermenting must	Fermentation control Optimisation of process to meet desired wine style	Follow fermentation progress and quality indicators	Brix/Baume, pH, TA, Red. sugar, density, alcohol, VA/ acetic acid, organic acids, FSO ₂ , TSO ₂ , ascorbic acid, colour, phenolics
Dry wine: Maturation Blending Bottling/ Quality Control	Meeting product specifications Malolactic Maturation Barrel ageing Stabilisation Blending Labelling Pre-bottling QC	Chemical composition Stability Quality control parameters Alcohol for labelling Screen for taints, residues	Alcohol, glucose/ fructose, SG, pH, TA, VA/acetic acid, malic acid, citric, lactic, ascorbic acid, FSO ₂ , TSO ₂ , Metals (e.g. Cu, Fe) Spectral profile, colour, phenolics, MCP tannins Oak aromas/profile Cold and heat stability Micro sterility 4 EP/4EG, TCA, MRA
Export of wine	Document wine compliance with AWBC/ export requirements	Certificates for the target export markets. Absence of taints, health concerns	AWBC, EU VI-1 (packaged, bulk, VBOT), Japanese, and other certificates for export markets TCA, Ochratoxin A, biogenic amines
Sensory evaluation	Quality assessment Taint investigations Consumer preference mapping	Independent assessment by trained sensory panels Consumer panels for preference/liking	Quality assessment Taint assessment Difference testing Descriptive analysis Consumer testing

Our services

The Analytical Service assists the grape and wine sector by delivering the necessary tools and data required for grape growers and wine producers to make informed decisions. Examples of various analyses offered to assist the wine producer at critical control points in the grape to consumer value chain are presented in Table 7.

Routine Analytical Laboratory

Leanne Craddock took over the Laboratory Supervisor role for the Analytical Routine Laboratory in January 2007 and initiated a comprehensive analytical method review and optimisation of work flows to ensure timely and accurate results are supplied to our customers.

A benchmark study of two enzymatic analysers was carried out to identify a replacement for an old obsolete Cobas Fara enzymatic analyser in the Routine Analytical Laboratory. The Analytical Service invested in a Randox Daytona instrument, which is now fully implemented and NATA accredited for routine enzymatic analysis.

The FTIR WineScan continues to play an essential part of the routine analysis of dry wines in the Routine Analytical Laboratory and during the 2007 vintage, part of the juice maturity samples

were analysed by FTIR using a grape juice calibration supplied by FOSS and validated by AWRI in 2006.

Trace Analytical Laboratory

Analytical Service also offers a wide range of trace analysis tailored for the grape and wine sector. These include screening for agrochemical residues, grape and wine aroma compounds, oak volatiles, and various taints like for example 4EP/4EG and TCA. These analyses are performed by the Trace Analytical Laboratory team headed up by Laboratory Supervisor, Randell Taylor. The laboratory also assists the wine sector with analysis in relation to specific taint problems and has during the last year provided emergency response for two important taint cases.

Examples of the provision of critical analytical service support to the grape and wine sector

Smoke taints during vintage 2007

The tainting of grapes and wine by bushfire smoke is a serious industry problem, highlighted by the events of 2007 in Victoria, NSW and Tasmania. Guaiacol and 4-methylguaiacol are emphasised as important compounds contributing to 'smoky' taints originating from bushfires. The Analytical Service has a rapid GC-MS method to measure accurately these compounds in

grapes, juice and wine, with sensitivity to levels less than the sensory threshold, and we analysed approximately 900 samples in three months. The service was an important contribution to assist the sector in coping with the bushfire related problems.

Halogenated phenols problems in 2006

Last year the wine industry experienced unexpected taint problems (described as 'plastic' 'paint', 'medicinal') related to a group of compounds, known as halogenated phenols. The AWRI's research teams developed analytical methods for the suspect compounds (including 2,4- and 2,6-DCP) and these were subsequently transferred and validated for high throughput application in the Analytical Service's Trace Analytical Laboratory and offered to the sector on a fee for service basis. The taints were shown to be associated with contaminated ingredients and the Analytical Service offered testing on both raw materials/ingredients and wine samples.

Team reports



(L to R from top row): Heather Brooks, Melinda Nutt, Nevil Shah, Teegan Waples, Patrick Dimian, Randell Taylor, Andrew Ferrell
(R to L from top of stairs): Stella Kassara, Yvonne Staeffler, Leanne Craddock, Mai Nygaard, Daniel Tynan, Suzana Cottram, Oliver Lovat, Slavko Bekavac

The 2nd AWRI closure trial – assisting suppliers with independent evaluation of the performance of wine bottle closures

Since the AWRI commenced the first independent wine closure trial in 1999, the AWRI was able to provide knowledge and understanding of the performance of different closures and their effect on final wine quality. Wine bottle closure performance has radically improved as a result, and wine producers have been better informed which has enabled them to reliably select closures that are fit for purpose. Recently, renewed interest from closure manufacturers and suppliers with respect to testing of new or improved products prompted the Analytical Service to offer another round of closure testing on a commercial basis using an 'in confidence' contract model.

The second AWRI closure trial builds on the experience from the previous closure trial and involves sampling of a statistically valid number of bottles at each testing point during the trial. All analytical testing is performed by the Analytical Service under ISO 17025/NATA accreditation and AWRI's experienced sensory panels will perform the sensory evaluations using descriptive analysis.

In May 2007, 4,000 litres of Clare Semillon wine were bottled under 15 different closures at a major contract bottling plant and the wine underwent comprehensive testing pre- and immediately post-bottling. Each participating closure supplier signed a two-year contract and they will receive regular reports on the results originating from their closure in comparison to selected reference closures. The closures represent natural/technical corks, synthetic closures and a screwcap closure.

Quality management in the laboratory NATA reassessment

The Analytical Service Group Manager, Mai Nygaard, is now the authorised NATA representative overseeing the internal quality management systems of the Analytical Service. During the year, documentation was updated in response to the change-over to a new LIMS in July 2006 and documents were submitted to NATA demonstrating that the Analytical Service is accredited according to the 2005 version of the ISO 17025 standard.

In April 2007, the Analytical Service underwent a NATA audit for re-accreditation to ISO/IEC 17025:2005. The Routine and the Trace Analytical Laboratories achieved re-accreditation along

with some requested variations to the scope of some existing methods and the acceptance of proposed signatories.

In routine analysis, we were granted expansion to the scope of two methods: to include sparkling wines in the determination of sulfur dioxide by Flow Injection Analysis; and the prediction of acetic acid using the FOSS WineScan in finished wines containing up to 10 g/L glucose/fructose. Overall, the laboratory performed extremely well and only a couple of minor housekeeping/documentation issues were found. The laboratory staff members were commended for their knowledge.

This year, the Analytical Service also underwent auditing for compliance according to the OECD guidelines for GLP. We successfully retained this recognition in the area of small-scale winemaking and related agrochemical testing.

Article published on quality management using practical tools and examples

In collaboration with Eric Wilkes from Foster's Wines, the Analytical Service published an article in the Nov/Dec 2006 issue of the *Australian and New Zealand Wine Industry Journal* offering an overview of some of the most common and accepted quality management tools in a wine laboratory. The aim was to provide inspiration

and practical examples of how to improve the quality of analytical results and to outline some of the benefits of having a well designed quality system in place.

An example of the use of inter-laboratory tests as a quality management tool is shown in Figure 14.

Figure 14 illustrates the z-Scores for Pyrimethanil (203 µg/kg) in Wine Test Material. FAPAS Proficiency test 1960, June-July 2006. Each bar represents a result reported from an analytical laboratory. The AWRI Analytical Service is laboratory no. 23. A Z score within +/- 2.0 is considered an acceptable result.

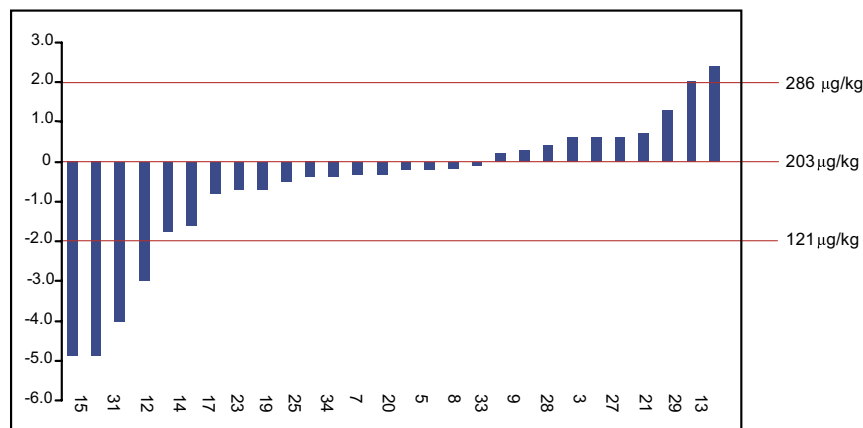


Figure 14. Proficiency testing results for Pyrimethanil, an agrochemical residue. Reproduced with permission from FAPAS, UK. Published in ANZWIJ Nov/Dec 2006, (AWRI publication #953)

LIMS

In July 2006, the Analytical Service implemented a new Laboratory Information Management System (LIMS), Labworks, from Perkin Elmer. After having overcome some initial 'teething problems' requiring further customisation of the software, the system is now providing real value to the Analytical Service. This has been achieved through increased automation of laboratory work flows, secure sample and data management through barcode reading and electronic data transfer from instrumentation to database, improved quality management and documentation, as well as offering full traceability in the Routine and Trace Analytical Laboratories.

The next important step is to finalise the implementation of customer service focused functionalities like electronic reporting and automated sample receipt notification, for clients to fully harvest the many benefits of the new LIMS.

Outlook

During the next year, the Analytical Service will continue to improve its services to the grape and wine sector. Important objectives are the implementation of electronic customer service and reporting systems, and the upgrade of the Trace Analytical Laboratory's capacity to perform fast, cost efficient analysis through the investment in new technology (LC-MS).

The AWRI's commercial closure trial also continues with close monitoring of the Semillon wine bottled under different closures by chemical and sensory evaluations at agreed time points.

Lastly, the next year will lead up to the final move into new laboratories in the Wine Innovation Cluster, providing the Analytical Service with state-of-the-art infrastructure to further build and expand our services according to the grape and wine sector's needs.



During the 2nd AWRI closure trial in May 2007, 4,000 litres of Clare Semillon wine were bottled under 15 different closures

Financial Report – Directors' report



Your Directors present their financial report for the year ended 30 June 2007.

Review of operations

The 2006-2007 year heralded the first year of operation of the new seven year Investment Agreement between The Australian Wine Research Institute Ltd (AWRI) and the Grape and Wine Research and Development Corporation (GWRDC). The level of goodwill and cooperation prevailing at quarterly Joint Agreement Committee (JAC) meetings, at which representatives of AWRI and GWRDC discuss progress in achieving research and extension outputs, will become invaluable in a funding environment which is destined to become more difficult.

The execution of the various agreements in relation to the construction of the Wine Innovation Cluster (WIC) Central building by the University of Adelaide has allowed the focus to shift from the legal aspects to planning the internal design and layout of AWRI's space in that building. The ever increasing demand for space in the interim has necessitated the acquisition of three transportable buildings to accommodate staff.

AWRI is very pleased to announce that a new Workplace Agreement was signed in November 2006. Importantly the Agreement was overwhelmingly endorsed by the staff and provides a range of progressive benefits that are consistent with an "Employer of Choice" ethos. This Agreement, together with implementation of a revamped performance appraisal system and a focus on nurturing professional development, are key strategic drivers in attracting and retaining high calibre staff.

During the year, the identification and isolation of various wine taint compounds, which arose out of the use of contaminated wine processing aids, are testament of AWRI's unique position to prioritise and apply the best of scientific rigour to solve industry problems. This capability relies not only on staff experienced in applied wine science who understand the industry, but also state of the art equipment.

The successes achieved by the various scientific teams culminated with the discovery of the compound responsible for the peppery aroma in Shiraz wines, and in significant progress in understanding the complex influence of yeasts in the aroma, flavour and colour of wine. This work has led to the development of novel yeast strains, hybrids and combination of strains, attracting keen interest from commercial yeast manufacturers.

AWRI has worked hard and is proud of its success in successfully tendering for \$2.5 million dollars of funding from a combination of the *National Collaborative Research Infrastructure Strategy* (NCRIS) initiative of the Federal Government and the *Premier's Science and Research Fund* (PSRF) of the South Australian State Government. This income, which will be received over five years in total, will provide much needed funding for specialised laboratory equipment and scientific expertise to maintain the momentum feeding research outcomes that are fuelling the innovation drive of the wine industry. This source of funding is particularly opportune given the growing strain the industry's financial capacity by environmental and climate change issues.

Results of operations

Revenue increased by just over 7% overall coming from both GWRDC funding and other commercial activities. The profit figure reflects the gain on redemption of the Endowment to the University of Adelaide for the Australian Wine Industry Chair of Oenology. The Deed was extinguished when the University chose to make alternative arrangements in respect of the Chair. The increased funding from the GWRDC was largely used to support greater staff and operating costs whilst many planned capital purchases were deferred given the uncertainty of the GWRDC's future levy income occasioned by the continuing drought. The figures show unspent funds this year of over \$600k which should give some flexibility if the 2008 vintage intake falls significantly below the 2007 level.

Significant changes in state of affairs

There are no significant changes in the state of affairs on the Institute.

PRINCIPAL ACTIVITIES

The three principal activities of the AWRI, of which there has been no significant change are:

- Undertaking research and communicating research outcomes into grape and wine composition, and grape and wine production,
- Information and knowledge transfer,
- Provision of commercial analytical and contract research services.

Information on Directors

Directors of The Australian Wine Research Institute Ltd in office at any time during or since the end of the year:

Name and Qualifications and Experience	Special responsibilities	No. of Director's meetings attended	No. of Audit meetings attended
Robin Elliott Day , BAgSc, BAppSc(Wine Science), Chairman of Council, Director of Domain Day, former Board Member, Australian Wine and Brandy Corporation, National and International wine show judge, 34 years of production and R&D experience in the Australian wine industry.	Chairman Member Executive Council	6	
James Frederick Brayne , BAppSc(Wine Science), Production Director/Chief Winemaker McWilliam's Wines Pty Ltd, National wine show judge, 34 years technical and winemaking experience in the Australian wine industry.		3	
Paul Conroy , LLB(Hons), Bcomm, Legal Affairs Director, Foster's Group Ltd, member of Chartered Secretaries of Australia, member of the Australian Corporate Lawyers Association, former Southcorp Limited's representative on the Executive Committee of the Winemakers' Federation of Australia, admitted as solicitor in the Supreme Courts of NSW, Victoria and the High Court of Australia, over 16 years legal and management experience working in Australia, Asia, United Kingdom and United States.		5	
Peter James Dawson , BSc, BAppSc(Wine Science), Group Chief Winemaker, Hardy Wine Company, Adjunct Professor, Faculty of Science and Technology, Deakin University, National wine show judge, Inspector, Australian Wine and Brandy Corporation Export Approval Panel, 29 years technical and winemaking experience in the Australian wine industry.	Member Audit Committee	2	1
Timothy Wickham Bevan James , AssDip(Wine Prod), Chief Executive, Wirra Wirra Vineyards, past President, SA Wine and Brandy Industry Association, past Deputy Chair, Grape and Wine Research and Development Corporation, Senior National Wine Judge, past Panel Chairman Sydney, McLaren Vale and Hunter Wine Shows, Deputy Chairman of the Adelaide Wine Show, past Chairman of the Barossa Valley Wine Show, past Chairman of the Canberra Wine Show, past Chairman of Cowra Wine Show, graduate of Melbourne University Advanced Management Program 1985, member of ASVO Publishing Committee, 31 years technical and winemaking experience in the Australian wine industry.	Member Executive Council Member Audit Committee	5	1
Geoffrey Raymond Linton , BAppSc(App Chem), Grad Dip(Systems Analysis), Technical Manager, Yalumba Wine Company, member of the Wine Industry Technical Advisory Committee WFA), member Strategic Directions Group (WFA), 34 years experience in the Australian wine industry.	Member Executive Council	6	
Stephen Brian Millar , BAAcc, CPA, former CEO, Constellations Wines and BRL Hardy Limited, Executive Member, Winemakers' Federation of Australia, Chair, Winemakers' Federation of Australia Audit Committee, Director, Drinkwise, former Deputy Chair, Australian Wine Export Council, former member, South Australian Wine Industry Council.	Chair Audit Committee	4	1
Jan Sheree O'Connor , BEd (Physical Education), Managing Director, O'Connor Harvesting, member, Robinvale & District Wine Grape Growers Association, Committee, Murray Valley Winegrowers Inc, member, Murray Valley Industry Development Committee, member, Phylloxera & Plant Health Technical Reference Group, member, Australian Wine & Brandy Corporation Knowledge Development Advisory Committee, 21 years experience in the Australian wine industry. (from 8 May 2007)		1	
Isak Stephanus Pretorius , BSc Agric(Hons) PhD, Managing Director, The Australian Wine Research Institute Ltd, Professor Extraordinary in Oenology, University of Stellenbosch, Affiliate Professor in Oenology, University of Adelaide, Board Member, Provisor Pty Ltd, member, Wine Industry Technical Advisory Committee (WFA/AWBC), Member, International Commission of Yeasts, Editorial Board Member, American Journal of Enology and Viticulture, Annals of Microbiology, FEMS Yeast Research, South African Journal of Enology and Viticulture, Yeast, 30 years experience in microbiology and biotechnology.	Member Executive Council	6	

Financial Report – Directors' report

Name and Qualifications and Experience	Special responsibilities	No. of Director's meetings attended	No. of Audit meetings attended
Alternate Directors			
Nigel Peter Blieschke , BAppSc, GradCertVit, Viticulturalist/Nursery Manager, Yalumba Wine Company.			
Leon Phillip Deans , BAppSc, Grad Dip (Business Administration), Innovations Manager, Pernod Ricard Pacific, member, Wine Industry Technical Advisory Committee, Board Member of Australian Wine and Brandy Corporation, 28 years winemaking experience in the Australian wine industry.			
James Northey , BSc, Grad Dip (BusAdmin), Management Systems Manager, Hardy Wine Company, member of the South Australian Wine Industry Association Environment Committee, 26 years experience in the Australian wine industry.		2	
Alan David Kennett , BSc, BAppSc (Wine Science), Chief Winemaker, Casella Wines Pty Ltd, member, WFA Technical and Packaging Committee, member, CSU Course Advisory Committee, 15 years experience in the Australian wine industry. (from 14 Nov 2006)		1	
Alexander Nikolai Sas , BSc Agric(Hons), Regional Viticulturalist, Hardy Wine Company, 18 years experience in viticultural R&D and grape supply management.			
Secretary			
Hans Englebert Muhlack BEc CPA			
Six Meetings of Council were convened during the year			

Share Options

No options to shares in the chief entity have been granted during the year and there were no options outstanding at the end of the year.

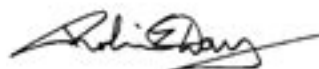
Auditor's independence declaration

The auditor's independence declaration under section 307C is attached.

Indemnification of officers and auditors

The company has not, during or since the end of the year, in respect of any person who is, or has been, an officer or auditor of the chief entity or a related body corporate indemnified, or made any relevant agreement for indemnifying, against a liability, including costs and expenses, in successfully defending legal proceedings, or paid, or agreed to pay, a premium in respect of a contract insuring against a liability for the costs or expenses to defend legal proceedings.

Signed in accordance with a resolution of the Board of Directors this 20th day of November 2007.



R.E. Day
Chairman



I.S. Pretorius
Managing Director

**INCOME STATEMENT
FOR THE YEAR ENDED 30 JUNE 2007**

	Notes	2007 \$	2006 \$
Revenue from operating activities			
Grape and Wine Research and Development Corporation			
Project funds		7,893,851	6,690,174
Equipment		420,814	724,375
CRCV project funds		0	666,210
Commercial research collaborations		238,206	60,155
Analytical Service		2,169,063	1,974,426
Interest income		346,743	242,868
Other revenue		576,532	499,591
Expenses from operating activities			
Employee benefit expenses		7,705,624	6,112,514
Analytical & project operating expenses		1,568,771	1,659,489
Administration & general services expenses		678,730	861,158
Depreciation and amortisation expenses	5	731,386	651,569
Travel expenses		237,184	175,753
Impairment Write-down of investment in Provisor		0	650,000
Profit from ordinary activities		<u>723,514</u>	<u>747,316</u>
Total changes in equity		<u><u>723,514</u></u>	<u><u>747,316</u></u>

The Income Statement should be read in conjunction with the accompanying notes.

**BALANCE SHEET
AS AT 30 JUNE 2007**

	Notes	2007 \$	2006 \$
Current assets			
Cash assets		5,188,344	3,198,469
Commercial bills		2,719,779	2,558,181
Receivables	3	2,225,774	641,997
Other current assets	4	184,298	183,597
Total current assets		<u>10,318,195</u>	<u>6,582,244</u>
Non current assets			
Leasehold buildings	5	1,373,750	1,410,850
Plant and equipment	5	2,055,146	2,377,352
Investment in Provisor Pty Ltd	6	0	0
Australian Wine Industry Chair of Oenology		0	840,000
Total non current assets		<u>3,428,896</u>	<u>4,628,202</u>
TOTAL ASSETS		<u><u>13,747,091</u></u>	<u><u>11,210,446</u></u>
Current liabilities			
Payables and accruals	7	2,926,429	1,988,180
Project funds not expended and repayable			
GWRDC		1,358,363	746,488
Provisions	8	1,074,476	898,333
Total current liabilities		<u>5,359,268</u>	<u>3,633,001</u>
Non current liabilities			
Payables and accruals	7	79,796	0
Provisions	8	200,416	193,348
Total non current liabilities		<u>280,212</u>	<u>193,348</u>
TOTAL LIABILITIES		<u><u>5,639,480</u></u>	<u><u>3,826,349</u></u>
NET ASSETS		<u><u>8,107,611</u></u>	<u><u>7,384,097</u></u>
EQUITY			
Reserves	9	700,000	700,000
Retained earnings	10	7,407,611	6,684,097
TOTAL EQUITY		<u><u>8,107,611</u></u>	<u><u>7,384,097</u></u>

The Balance Sheet should be read in conjunction with the accompanying notes.

**STATEMENT OF CHANGES IN EQUITY
FOR THE YEAR ENDED 30 JUNE 2007**

	Retained Earnings	Other Reserves	Total
	\$	\$	\$
As at 1 July 2005	5,936,781	700,000	6,636,781
Profit for the year	747,316	0	747,316
Total recognised income & expenses for the period	<u>747,316</u>	<u>0</u>	<u>747,316</u>
As at 30 June 2006	6,684,097	700,000	7,384,097
Profit for the year	723,514	0	723,514
Total recognised income & expenses for the period	<u>723,514</u>	<u>0</u>	<u>723,514</u>
As at 30 June 2007	<u>7,407,611</u>	<u>700,000</u>	<u>8,107,611</u>

**CASHFLOW STATEMENT
FOR THE YEAR ENDED 30 JUNE 2007**

	Notes	2007 \$	2006 \$
CASH FLOWS FROM OPERATING ACTIVITIES			
Grants and other income		10,658,936	10,642,864
Interest received		346,743	242,868
Payments to suppliers and employees		(8,552,876)	(7,884,027)
Net cash provided by operating activities	11	<u>2,452,803</u>	<u>3,001,705</u>
CASH FLOWS FROM INVESTING ACTIVITIES			
Payment for commercial bills		(161,598)	(145,259)
Lease repayments		(7,451)	0
Payments for plant and equipment		(328,497)	(1,166,524)
Proceeds from sale of plant and equipment		34,616	11,186
Net cash used in investing activities		<u>(462,930)</u>	<u>(1,301,597)</u>
Net increase in cash held		1,989,873	1,700,108
Cash at 1 July		<u>3,198,469</u>	<u>1,498,361</u>
Cash at 30 June		<u>5,188,342</u>	<u>3,198,469</u>

The Statement of Cash Flows should be read in conjunction with the accompanying notes.

Notes to and forming part of the Financial Report

1. Introduction

The Australian Wine Research Institute Ltd (AWRI) was incorporated in South Australia in 1955. It is a company limited by guarantee without a share capital.

Operations and principal activities

The principal activities of the AWRI are:

- Undertaking research and communicating research outcomes into grape and wine composition, and grape and wine production,
- Information and knowledge transfer,
- Provision of commercial analytical and contract research services.

Scope of financial statements

The financial statements cover the complete activities of AWRI. Notwithstanding that AWRI has approximately a 40% share of the equity of Provisor Pty Ltd, it has no right to receive any distribution of income as a member and accordingly does not account for any interest in Provisor Pty Ltd in its financial statements.

Authorisation of financial report

The financial report was authorised for issue by the Directors on 20 November 2007.

2. Statement of accounting policies

The financial report is a general purpose report and has been prepared in accordance with Australian Accounting Standards including Australian Accounting Interpretations, other authoritative pronouncements of the Australian Accounting Standards Board and the *Corporations Act 2001*. The financial report has also been prepared on the basis of historical costs and does not take into account changing money values. Where necessary, comparative information has been reclassified to achieve consistency in disclosure with current financial year amounts and disclosures.

Australian Accounting Standards include Australian equivalents to International Financial Reporting Standards (IFRS). Compliance with the Australian equivalents to IFRS (AIFRS) ensures that the financial report complies with IFRS. No new Standards or Interpretations that have been issued but not adopted have been used in the preparation of this financial report.

The following is a summary of the significant accounting policies adopted by the Institute in the preparation of the financial report.

(a) Receivables and revenue recognition

Sales are recorded when goods or services have been provided to a customer. Trade debtors are recognised at the amount receivable and are due for settlement within 30 days from the date of the invoice.

(b) Non-current assets

The cost method of accounting is used for the acquisition of assets. The acquisition of assets must be initiated by a purchase order.

The carrying amounts of non-current assets are reviewed at balance date to ensure that they are not valued in excess of their recoverable amount.

Plant and equipment is depreciated on a straight line basis to write off the net cost of each item of plant and equipment over its expected useful life. The expected useful lives are between 3 and 10 years.

Buildings and improvements are amortised over the useful life of the buildings of 50 years.

(c) Payables and expenditure recognition

Purchases are recorded when a supplier has supplied goods or services. Trade creditors are unsecured and are usually paid within each supplier's trading terms.

d) Employee entitlements

(i) Wages, salaries and annual leave

Wages and salaries and annual leave and other employee benefits expected to be settled within twelve months of the reporting date are measured at their nominal amounts, including related on-costs.

(ii) Long service leave

Long service leave liabilities expected to be settled more than twelve months after the reporting date are measured such that the liability is not materially different from the estimate determined by using the present value of the estimated future cash outflows in respect of services provided up to the reporting date.

(e) Leases

Leases of fixed assets, where substantially all the risks and benefits incidental to the ownership of the asset, but not the legal ownership, are transferred to the entity are classified as finance leases.

Finance leases are capitalised, recording an asset and a liability equal to the present value of the minimum lease payments, including any guaranteed residual values.

Leased assets are depreciated on a straight line basis over their estimated useful lives where it is likely that the entity will obtain ownership of the asset. Lease payments are allocated between the reduction of the lease liability and the lease interest expense for the period.

Lease payments for operating leases, where substantially all the risks and benefits remain with the lessor, are charged as expenses in the period in which they are incurred.

Lease incentives under operating leases are recognised as a liability and amortised on a straight-line basis over the life of the lease term.

(f) Impairment

At each reporting date, the entity reviews the carrying values of its tangible and intangible assets to determine whether there is any indication that those assets have been impaired. If such an indication exists, the recoverable amount of the asset, being the higher of the asset's fair value less costs to sell and value in use, is compared to the asset's carrying value. Any excess of the asset's carrying value over its recoverable amount is expensed to the Income Statement.

Where the future economic benefits of the asset are not primarily dependent upon on the assets ability to generate net cash inflows and when the entity would, if deprived of the asset, replace its remaining future economic benefits, value in use is depreciated replacement cost of an asset.

Where it is not possible to estimate the recoverable amount of an assets class, the entity estimates the recoverable amount of the cash-generating unit to which the class of assets belong.

(g) Cash and Cash Equivalents

Cash and cash equivalents include cash on hand, deposits held at-call with banks, other short-term highly liquid investments with original maturities of three months or less, and bank overdrafts.

Notes to and forming part of the Financial Report

(h) Goods and Service Tax (GST)

Revenues, expenses and assets are recognised net of the amount of GST, except where the amount of GST incurred is not recoverable from the Australian Taxation Office. In these circumstances the GST is recognised as part of the cost of acquisition of the asset or as part of an item of expense. Receivables and payables in the Balance Sheet are shown inclusive of GST.

Cash flows are presented in the Cash Flow Statement on a gross basis, except for the GST component of investing and financing activities, which are disclosed as operating cash flows.

(i) Critical Accounting Estimates and Judgements

The directors evaluate estimates and judgments incorporated into the financial report based on historical knowledge and best available current information. Estimates assume a reasonable expectation of future events and are based on current trends and economic data, obtained both externally and within the group.

Key estimates — Impairment

The entity assesses impairment at each reporting date by evaluating conditions specific to the entity that may lead to impairment of assets. Where an impairment trigger exists, the recoverable amount of the asset is determined. Fair value less costs to sell or current replacement cost calculations performed in assessing recoverable amounts incorporate a number of key estimates.

	2007	2006
	\$	\$
3. Receivables		
Trade debtors	841,263	440,530
Other debtors	1,384,511	201,467
	<u>2,225,774</u>	<u>641,997</u>

4. Other current assets

Course materials	57,648	53,912
Prepayments	126,650	129,685
	<u>184,298</u>	<u>183,597</u>

5. Non current assets: amortisation and depreciation

	Leasehold buildings	Plant and equipment
Written down value		
Balance 30/06/2006	1,410,850	2,377,352
Additions	0	385,942
Disposals	0	13,862
Depreciation expense	37,100	694,286
Balance 30/06/2007	<u>1,373,750</u>	<u>2,055,146</u>

Proceeds on disposal of plant and equipment were \$34,616 in 2007 and \$11,186 in 2006.

6. Provisor Pty. Ltd.

AWRI owns approximately 40% of the equity in Provisor Pty Ltd, which was incorporated following a successful submission to the Commonwealth Government under its Major National Research Facilities Program. The other shareholders of Provisor Pty Ltd are CSIRO, SARDI, and The University of Adelaide.

In addition to AWRI's own cash contributions of \$650,000, the South Australian State Government contributed a further \$700,000 through the Institute. AWRI has completed its obligation to provide in kind support this year.

This investment was entirely impaired at 30 June 2006 as the Institute is unable to receive any distribution from Provisor Pty Ltd in the near future.

	2007	2006
	\$	\$
7. Payables and accruals		
Current		
Trade creditors	1,016,393	1,569,229
PAYG and GST	457,616	191,449
Other creditors and accruals	1,444,221	227,502
Lease Liability	8,199	0
	<u>2,926,429</u>	<u>1,988,180</u>
Non Current		
Other creditors and accruals	38,000	0
Lease liability	41,796	0
	<u>79,796</u>	<u>0</u>

8. Provisions

Current		
Employee entitlements	1,074,476	898,333
Non current		
Employee entitlements	200,416	193,348
Number of Employees (F.T.E.)	89.1	84.3

9. Reserves

Capital Reserve - established when the balance of the Wine Research Trust Fund was transferred by the Commonwealth to AWRI.

Balance at the beginning of the year	700,000	700,000
Transferred to retained earnings	0	0
Balance at the end of the year	<u>700,000</u>	<u>700,000</u>

10. Retained earnings

Balance at the beginning of the year	6,684,097	5,936,781
Transferred from capital reserve	0	0
Profit from ordinary activities	723,514	747,316
Retained earnings at the end of the year	<u>7,407,611</u>	<u>6,684,097</u>

	2007 \$	2006 \$
11. Reconciliation of net cash provided by ordinary activities with ordinary profit		
Profit from ordinary activities	723,515	747,316
Non cash flows in operating profit		
Amortisation and depreciation	731,386	651,569
(Profit) loss on the sale of plant and equipment	(360,305)	2,823
Impairment of Provisor	0	650,000
Charges to (reduction in) provisions	183,212	156,132
Changes in assets and liabilities		
(Increase) decrease in inventories	(3,736)	1,415
(Increase) decrease in receivables and other current assets	(401,193)	25,110
Increase (decrease) in payables and accruals	1,579,925	767,341
Net cash provided by ordinary activities	<u>2,452,803</u>	<u>3,001,705</u>

12. Remuneration of key management personnel

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

Short-term employee benefits	1,077,056	782,271
Post-employment benefits	128,739	100,837
Total	<u>1,205,795</u>	<u>883,108</u>

13. Remuneration of auditors

(a) For auditing the financial report	15,750	15,750
(b) For other services	3,410	17,309
	<u>19,160</u>	<u>33,059</u>

14. Directors holding office

The following directors held office during the year:

Directors	Alternate Directors
Robin Elliott Day	Leon Phillip Deans
Jan Sheree O'Connor	
Paul David Conroy	
Stephen Brian Millar	
Timothy Wickham Bevan James	James Northey
Geoffrey Raymond Linton	Nigel Peter Blieschke
James Frederick Brayne	Alan David Kennett
Peter James Dawson	Alexander Nikolai Sas
Isak Stephanus Pretorius	

Remuneration of directors is disclosed in Note 12 to the accounts.

15. Related Parties

Australian Wine Industry Technical Conference Incorporated (AWITC)

Australian Society of Viticulture & Oenology Incorporated (ASVO)

Viticultural Publishing Incorporated

Provisor Pty Ltd

Drinkwise Australia

Hardy Wine Company

Domain Day Wines

Wirra Wirra Vineyards

McWilliam's Wines

Foster's Group Ltd

The Institute acts as an unrewarded trustee for The H.R. Haselgrove Memorial Trust Fund, The John Fornachon Memorial Library Endowment Fund, The Stephen Hickinbotham Memorial Research Trust and The Thomas Walter Hardy Memorial Trust Fund.

	2007 \$	2006 \$
Transactions with Related Entities:		
Administrative services charged to:		
- ASVO	0	6,860
- AWITC	45,973	41,009
Funding received from the CRCV	0	666,210
Amount still to be paid by CRCV	0	15,475
Services received from AWITC	50,195	707
Services received from Provisor Pty Ltd	13,083	33,404
Services provided to Provisor Pty Ltd	13,084	35,432
Services provided to Drinkwise Australia	5,200	0
Services provided to Hardy Wine Company	63,594	91,904
Services provided by Hardy Wine Company	11,910	2,519
Services provided by Domain Day Wines	110	975
Services provided to Wirra Wirra Vineyards	3,934	6,842
Services provided by Wirra Wirra Vineyards	0	1,533
Services provided to McWilliam's Wines	4,922	6,829
Services provided by McWilliam's Wines	0	925
Services provided to Foster's Group Ltd	50,555	97,279

Notes to and forming part of the Financial Report

16. Financial reporting by segments

The AWRI operates predominantly in one industry. The principal activities in the course of the financial year were conducting and promoting research and other scientific work in connection with winemaking and viticulture. The AWRI operates predominantly in one geographical area, being Adelaide, South Australia.

17. Limited liability

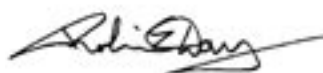
The company is limited by guarantee. In the event of the company being wound up, the liability of each member (both during the time he or she is a member and within one year afterwards) is limited to two dollars.

Director's Declaration

In the opinion of the directors:

- (a) the accompanying financial report and notes set out on pages 40 to 51 are in accordance with the Corporations Act 2001, comply with the accounting standards and give a true and fair view of the company's financial position as at 30 June 2007 and of its performance for the year ended on that date; and
- (b) at the date of this declaration there are reasonable grounds to believe that the company will be able to pay its debts as and when they become due and payable.

Signed in accordance with a resolution of the directors



R.E. Day
Chairman



I.S. Pretorius
Managing Director

At Adelaide this 20th day of November 2007.

Auditor Independence Declaration

To the Directors of the Australian Wine Research Institute Ltd

As lead engagement partner for the audit of The Australian Wine Research Institute Ltd for the year ended 30 June 2007, I declare that, to the best of my knowledge and belief, there have been:

- (a) no contraventions of the auditor independence requirements of the Corporations Act 2001 in relation to the audit; and
- (b) no contraventions of any applicable code of professional conduct in relation to the audit.

PKF

Chartered Accountants



I.J. Painter
Partner

Signed at Adelaide, this 20th day of November 2007.

Independent Audit Report

TO MEMBERS OF THE AUSTRALIAN WINE RESEARCH INSTITUTE LTD

We have audited the accompanying financial report of the Australian Wine Research Institute Ltd, which comprises the balance sheet as at 30 June 2007, and the income statement, statement of changes in equity and cash flow statement for the year ended on that date, a summary of significant accounting policies, other explanatory notes and the directors' declaration.

Directors' Responsibility for the Financial Report

The directors of the company are responsible for the preparation and fair presentation of the financial report in accordance with Australian Accounting Standards (including the Australian Accounting Interpretations) and the *Corporations Act 2001*. This responsibility includes establishing and maintaining internal controls relevant to the preparation and fair presentation of the financial report that is free from material misstatement, whether due to fraud or error; selecting and applying appropriate accounting policies; and making accounting estimates that are reasonable in the circumstances. In Note 1, the directors also state, in accordance with Accounting Standard AASB 101 *Presentation of Financial Statements*, that compliance with the Australian equivalents to International Financial Reporting Standards ensures that the financial report, comprising the financial statements and notes, complies with International Financial Reporting Standards.

Auditor's Responsibility

Our responsibility is to express an opinion on the financial report based on our audit. We conducted our audit in accordance with Australian Auditing Standards. These Auditing Standards require that we comply with relevant ethical requirements relating to audit engagements and plan and perform the audit to obtain reasonable assurance whether the financial report is free from material misstatement. Our responsibility is to also express an opinion on the remuneration disclosures contained in the directors' report based on our audit.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial report. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial report, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the entity's preparation and fair presentation of the financial report in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by the directors, as well as evaluating the overall presentation of the financial report and the remuneration disclosures in the directors' report.

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

Independence

In conducting our audit, we have complied with the independence requirements of the *Corporations Act 2001*.

Auditor's Opinion

In our opinion the financial report of the Australian Wine Research Institute Ltd is in accordance with the *Corporations Act 2001*, including:

- (a) giving a true and fair view of the company's financial position as at 30 June 2007 and of its performance for the year ended on that date; and
- (b) complying with Australian Accounting Standards (including the Australian Accounting Interpretations) and the *Corporations Regulations 2001*.

PKF

A South Australian Partnership
Chartered Accountants



I.J. Painter
Partner

Signed at Adelaide this 20th day of November 2007.

Memorial Funds

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 TRUST FUND

Statement by Directors of the trustee company

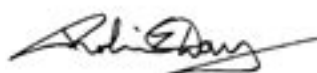
As detailed in note 2 to the accounts, the Trusts are not reporting entities because, in the Trustee's opinion, it is unlikely that users exist who are unable to command the preparation of reports tailored so as to satisfy, specifically, all of their information needs. This is a special purpose financial 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 Ltd:

1. (a) the Income Statements give a true and fair view of each Trust's surplus for the year ended 30 June 2007;

(b) the Balance Sheets give a true and fair view of each Trust's state of affairs as at 30 June 2007.
2. 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 Board of Directors of the trustee company and is signed for and on behalf of the directors by:



R.E. Day
Chairman

Dated this 20th day of November 2007.

Trusts administered by the AWRI

INCOME STATEMENTS	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 Fund	
For the year ended 30 June 2007	2007 \$	2006 \$	2007 \$	2006 \$	2007 \$	2006 \$	2007 \$	2006 \$
Income								
Interest	5,645	4,985	5,412	4,641	3,679	3,258	5,463	4,903
Donations	-	-	5,000	5,000	-	-	-	-
	5,645	4,985	10,412	9,641	3,679	3,258	5,463	4,903
Expenditure								
Advertising	-	-	-	-	-	-	-	-
Audit fees	550	500	540	500	540	500	540	500
Bank charges	-	-	-	-	-	-	-	-
Sponsorship	-	-	-	-	-	-	-	2,890
	550	500	540	500	540	500	540	3,390
SURPLUS FOR THE YEAR	5,095	4,485	9,872	9,141	3,139	2,758	4,923	1,513

BALANCE SHEETS	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 Fund	
As at 30 June 2007	2007 \$	2006 \$	2007 \$	2006 \$	2007 \$	2006 \$	2007 \$	2006 \$
Current Assets								
Cash at Bank	1	2	7	1	-	-	-	-
Receivables	-	-	-	-	-	-	-	-
Total Current Assets	1	2	7	1	-	-	-	-
Non-Current Assets								
Investments	98,855	94,149	104,645	90,179	64,260	61,521	95,644	91,120
TOTAL ASSETS	98,856	94,151	104,652	90,180	64,260	61,521	95,644	91,121
Current Liabilities								
Sundry creditors	550	940	5,550	950	550	950	550	950
NET ASSETS	98,306	93,211	99,102	89,230	63,710	60,571	95,094	90,171
TRUST FUNDS								
Settled Sum	12,785	12,785	50	50	20,000	20,000	50	50
Founder's Donation	-	-	25,000	25,000	-	-	-	-
	12,785	12,785	25,050	25,050	20,000	20,000	50	50
ACCUMULATED SURPLUS								
Opening balance	80,426	75,941	64,180	55,039	40,571	37,814	90,121	88,608
Surplus for the year	5,095	4,485	9,872	9,141	3,139	2,758	4,923	1,513
Closing balance	85,521	80,426	74,052	64,180	43,710	40,571	95,044	90,121
TOTAL TRUST FUNDS	98,306	93,211	99,102	89,230	63,710	60,571	95,094	90,171

The accompanying notes form part of the accounts.

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 TRUST FUND

1. Notes to and forming part of the accounts

- (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 Ltd 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 Ltd 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 Ltd 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 a 'Special Purpose Financial Report' which has 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:

AAS22 Related Party Disclosures

AAS28 Statement of Cash Flows

AAS33 Presentation and Disclosure of Financial Instruments

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 comprise money on deposit, and are recorded at their nominal value. Interest is brought to account as earned, with accrued interest at balance date being included in the balance sheet as receivables.

3. Commitments

The Thomas Walter Hardy Memorial Trust Fund has committed \$11,000 for sponsorship of a session dealing with climate change at the 13th Australian Wine Industry Technical Conference.

The Stephen Hickinbotham Memorial Research Trust Fund has committed \$5,500 to sponsor Cornelis van Leeuwen at the 13th Australian Wine Industry Technical Conference.

Auditor's report to the trustee of

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 TRUST FUND

Scope

We have audited the financial statements, being special purpose financial reports, of The John Fornachon Memorial Library Endowment Fund, The Thomas Walter Hardy Memorial Trust Fund, The H. R. Haselgrove Memorial Trust Fund and The Stephen Hickinbotham Memorial Trust Fund for the year ended 30 June 2007, as set out on pages 49 to 51. The Trustee is responsible for the preparation and presentation of the financial statements and the information they contain and has determined that the accounting policies used and described in Note 2 to the accounts are appropriate to meet the needs of the members. We have conducted an independent audit of these financial statements in order to express an opinion on them to the members on their preparation and presentation.

Our audit has been conducted in accordance with Australian auditing standards. Our procedures included examination, on a test basis, of evidence supporting the amounts and other disclosures in the financial statements and significant accounting estimates. These procedures have been undertaken to form an opinion as to whether, in all material respects, the financial statements are presented fairly in accordance with the accounting policies described in Note 2 to the accounts. These policies do not require the application of all accounting standards and mandatory professional reporting requirements.

The audit opinion expressed in this report has been formed on the above basis.

Audit Opinion

In our opinion, the financial statements of The John Fornachon Memorial Library Endowment Fund, The Thomas Walter Hardy Memorial Trust Fund, The H. R. Haselgrove Memorial Trust Fund and The Stephen Hickinbotham Memorial Trust Fund for the year ended 30 June 2007 are properly drawn up in accordance with applicable Australian accounting standards. As the Trustee has determined that the Trusts are non-reporting entities, accounting standards and other mandatory professional reporting requirements have only been applied to the extent described in Note 2 to the accounts.

PKF

A South Australian Partnership
Chartered Accountants



I.J. Painter
Partner

Signed at Adelaide this 20th day of November 2007.

Appendix 1. External presentations and talks

Staff	Title of talk	Presented to and where	Date
P.J. Chambers	Tailoring yeasts to make wines for a diverse market	2 nd FEMS Congress of European Microbiologists, Madrid, Spain	4–8 Jul 06
P.A. Henschke, J. Bellon, F.M. Carrau ¹ , J.M. Eglinton, K. Howell ² , T. Siebert, A. Soden ³ , J.H. Swiegers, D. Torrea ⁴ , M. Ugliano, C. Varela, M. Vilanova ⁵ , G.H. Fleet ² , I.L. Francis, P.J. Chambers, M. de Barros Lopes ⁶ , M. Herderich, I.S. Pretorius	Advances in wine fermentation biotechnology	39 th annual AIFST Convention, Adelaide, SA	10-13 Jul 06
C.S. Stockley	Alcohol, wine and health	AWRI Roadshow Seminar, Pettavel Winery, Geelong, VIC	13 Jul 06
A.P. Pollnitz, G.A. Ruediger, K.H. Pardon, A.N. Sas ⁷ , C. Curtin, P.W. Godden	The fate of agrochemical residues during the winemaking process		
E.J. Bartowsky, P.A. Henschke	Microbiological induced oxidative spoilage of bottled red wine – role of acetic acid bacteria		
P.A. Henschke, P.J. Costello, P.R. Grbin ⁸ , P.W. Godden	Causes and control of mousy off-flavour in wine		
E.J. Bartowsky, P.A. Henschke	Flavour aspects of MLF – control of the 'buttery' diacetyl character in wine		
P.A. Henschke, P.J. Costello, H. Gockowiak, E.J. Bartowsky	Strategies for successful induction of malolactic fermentation		
P.W. Godden	Strategies for the control of <i>Dekkera</i> / <i>Brettanomyces</i> during winemaking		
R.G. Damberg	An industry survey of grape colour, tannin, TSS (Brix) and crop yield – with some implications for winemaking		
R.G. Damberg	Grape and wine tannins, red wine colour and mouth-feel – an overview on current research, emerging applications and future challenges		
P.J. Chambers, P.A. Henschke	Development of low alcohol yeast – progress report	AWRI Roadshow Seminar, Clare Showgrounds, Clare, SA	3 Aug 06
C.D. Curtin	Results of the AWRI <i>Brettanomyces</i> research project		
P.A. Henschke, P.J. Costello, H. Gockowiak, E.J. Bartowsky	Strategies for successful induction of malolactic fermentation		
P.J. Chambers, P.A. Henschke	Development of low alcohol yeast – progress report		
P.A. Henschke	Natural fermentation: potential of alternative inoculation strategies		
P.A. Henschke, P.J. Costello, H. Gockowiak, E.J. Bartowsky	Strategies for successful induction of malolactic fermentation		
C.S. Stockley	Is allergen labelling necessary for Australian wine? Results of a clinical study undertaken at The Alfred/Monash University.		
S-J. Bell	Agrochemicals – selling quality wine Management of pesticide residues during winemaking		
P.W. Godden	Strategies for the control of <i>Dekkera</i> / <i>Brettanomyces</i> during winemaking		
P.W. Godden	Understanding and avoiding sub-optimal fermentation		
C. Varela	The Australian Wine Research Institute – an overview	Pontificia Universidad Católica de Chile, Santiago, Chile	9 Aug 06
C. Varela	Biosciences at The Australian Wine Research Institute		10 Aug 06

¹ Universidad del la Republica, Uruguay; ² University of New South Wales; ³ Fosters Group; ⁴ IDIFARMA, Pamplona, Spain; ⁵ Consejo Superior de Investigaciones Científicas, Spain; ⁶ University of South Australia; ⁷ Hardy Wine Company; ⁸ School of Agriculture and Wine, University of Adelaide

Staff	Title of talk	Presented to and where	Date
C. Simos	Overview of taints	Griffith tasting/Seminar, TAFE Griffith, Griffith NSW	21 Aug 06
	Tasting – tainted wines		
S-J.Bell	‘Off-label’ use of ethephon Agrochemicals – selling quality wine Oops I got the withholding period wrong!	E.E. Muir and Sons Grower Meeting Chardonnay Lodge – Coonawarra, SA	28 Aug 06
C.D. Curtin	Incidence of ‘Brett’ in Australian wines and characterisation of <i>Dekkera/Brettanomyces</i> isolates	AWRI Roadshow Seminar, Coonawarra Hall, Coonawarra, SA	29 Aug 06
P.W. Godden	Strategies for the control of <i>Dekkera/Brettanomyces</i> during winemaking		
I.L. Francis	Consumer preferences for Shiraz and Cabernet Sauvignon wines		
S-J. Bell	Agrochemicals – selling quality wine Salty wine		
A.D. Coulter	AWBC taint presentation	AWRI, Adelaide, SA	2 Sept 06
T.E. Siebert, M.J. Herderich, A.P. Pollnitz,	Influence of different winemaking conditions on fermentation-derived aroma compounds in a Cabernet Sauvignon wine	AWRI Roadshow Seminar, Bendigo TAFE, Bendigo, Vic	12 Sept 06
A. Pollnitz, D. Capone, M. Caldersmith ⁹ , M.A. Sefton	The ability of various wine bottle closures and fining agents to remove flavour and aroma compounds from wine		
I.L. Francis	Consumer preferences for Australian Riesling wines of different styles and ages Grape and wine tannins: an overview on current research, emerging applications and future challenges		
R.G. Dambergs	Red grape colour – why is it important and how can it be measured		
R.G. Dambergs	Developments of new technologies for the prevention of protein haze formation in white wine		
P.W. Godden	Strategies for the control of <i>Dekkera/Brettanomyces</i> during winemaking		
H.E. Holt	Manipulation of phenolic profiles in red grapes and wine by viticultural management		
H.E. Holt	Grape maturity and tannins: the impact of viticultural treatments on grape and wine tannins		
D. Cozzolino	Introduction to chemometrics	Hardy Wine Company – Reynella, SA	13 Sep 06
R.G. Dambergs	Applications of chemometrics in grape and wine analysis		
D.W. Jeffery	Development of new methods for the analysis of condensed tannins in red wine	5 th Tannin Conference, San Francisco, USA	14 Sept 06
M.J. Herderich	Analysis of tannins in grape and wine samples: Development of analytical tools for style and quality specifications based on objective tannin measures		
M.J. Herderich	The Australian Wine Research Institute: Innovative RD&E and solutions for the wine industry	HortResearch, Auckland, NZ	18 Sept 06
C.S. Stockley	Better wine for better health?	The Cool Climate Oenology and Viticulture Institute (CCOVI), Brock University, Ontario, Canada	26 Sep 06
C.S. Stockley	Recommendations on alcohol consumption: an international comparison	Kettil Bruun Society Thematic Symposium, Population studies on alcohol consumption and harm, Toronto, Canada	5 Oct 06
E.J. Waters	Protein haze in white wines: new solutions to an old problem	ASVO Oenology seminar, ‘Maximising the value’ Sebel Playford Hotel, Adelaide, SA	12 Oct 06
I.L. Francis	Understanding consumer preferences of Cabernet Sauvignon and Shiraz wines		

⁹ Currently Hollick Wines

Appendix 1. External presentations and talks

Staff	Title of talk	Presented to and where	Date
I.L. Francis	Consumer preferences for Shiraz and Cabernet Sauvignon wines	Hardy Wine Company marketing and technical personnel, Hardy Wine Company, Reynella, SA	24 Oct 06
R.G. Dambergs	Vis-NIR discrimination of powdery mildew infection	Presentation to Hardy Wine Company and University of Adelaide Fungal Pathology Group, held at Waite Library, Urrbrae, SA	31 Oct 06
H.E. Holt	AWRI/Leasingham Clare Valley Cabernet Sauvignon Trial; Outcomes and Overview	Hardy Wine Company Internal Technical Conference, Conference Room, Reynella, SA	8 Nov 06
M. Mercurio	MCP Tannin Assay: Quantitation of tannins in HWC wine and grape samples		
S-J. Bell	Phosphorous acid in grapes and wine	Yarra Valley Winegrower's Association in Yarra Valley, Vic	10 Nov 06
I.S. Pretorius	The Australian Wine Research Institute	Chilean Business Delegation, Plant Research Centre, Waite Campus, Urrbrae, SA	11 Nov 06
I.S. Pretorius	The AWRI 7-Year Research Development and Extension Plan	NSW Wine Industry Planning Forum, Ron Potter Centre, Charles Sturt University, Wagga Wagga, NSW	13 Nov 06
I.S. Pretorius	The AWRI 7-Year Research Development and Extension Plan	Members of Griffith Wine Industry, Westend Estate Winery, Griffith, NSW	14 Nov 06
I.S. Pretorius	AWRI Research capabilities and priorities	WFA Strategic Directions Group, National Wine Centre, Adelaide, SA	20 Nov 06
I.L. Francis	AWRI consumer research	WFA Strategic Directions Group, Majestic Hotel, Adelaide, SA	21 Nov 06
I.S. Pretorius	The AWRI Annual Report and 7-Year RD&E Plan	The South Australian Wine Industry Association, National Wine Centre, Adelaide, SA	24 Nov 06
I.L. Francis	Yeast modulation of Sauvignon Blanc wine aroma	Winemakers involved in the Sauvignon yeast strain project, Waite Campus, Urrbrae, SA	1 and 29 Nov 06
A. Coulter	Wine hazes and deposits	Technical Staff, Pernod Ricard Pacific, Rowland Flat, SA	4 Dec 06
I.L. Francis	Wine sensory descriptive terminology	Advanced Wine Assessment Course, Waite Campus, Urrbrae, SA	5 Dec 06
D.W. Jeffery	Red wine tannins: from analytical challenges to consumer preference	Australian and New Zealand Forensic Science Society, SA Branch, Adelaide, SA	6 Dec 06
P.J. Chambers	Biodiversity and natural transfer for improved fermentations: developing novel, non-GMO yeast strains for the wine industry	Wageningen Centre for Food Sciences, Food Summit 2006: Harvesting Microbial Diversity – Mining, Methods and Metagenomes. The Netherlands.	12 Dec 06
P.J. Chambers	Generating novel yeast strains for the wine industry	VTT, Helsinki, Finland	14 Dec 06
C.S. Stockley	Better wine for better health?	AWRI Roadshow Seminars, University of New England, Armidale, NSW	16 Jan 07
	Consumer preferences for Australian unwooded Chardonnay wines		
A. Pollnitz, D. Capone, M. Caldersmith ⁹ , M.A. Sefton	The ability of various wine bottle closures and fining agents to remove flavour and aroma compounds from wine		
K.F. Pocock, Y. Hayasaka, R. Muhlack ¹⁰ , S. Nordestgaard ¹¹ , B.K. O'Neill ¹¹ , C.B. Colby ¹¹ , E.J. Waters, A.P. Pollnitz	Development of new technologies for the prevention of protein haze formation in white wine – a progress report		
P.A. Henschke, P.J. Costello, H. Gockowiak, E.J. Bartowsky	Strategies for successful induction of malolactic fermentation		
P.A. Henschke	Natural fermentation: potential of alternative inoculation strategies		

⁹ Currently Hollick Wines; ¹⁰ Currently Hardy Wine Company; ¹¹ School of Chemical Engineering, University of Adelaide

Staff	Title of talk	Presented to and where	Date
S-J Bell	Manipulation of phenolic profiles in red grapes and wine by viticultural management	AWRI Roadshow Seminars, University of New England, Armidale, NSW	16 Jan 07
	Agrochemical issues for grapegrowers and winemakers		
S-J Bell, M. Essling	Botrytis management		
R.G. Dambergs	Quality management systems		
	Industry survey of grape colour, tannin TSS and crop yield		
P.W. Godden	Strategies for the control of <i>Dekkera/Brettanomyces</i> during winemaking		
C.S. Stockley	Australian case study – allergen labelling	Regulator's forum of the World Wine Trade Group, Canberra, ACT	22 Jan 06
Y. Hayasaka, K. Wilkinson ¹² , G.M. Elsey, M. Raunkjaer ¹³ , M.A. Sefton	Screening of oak lactone precursors using LC-MS/MS combined with information dependent acquisition	21 st Australian and New Zealand Society for Mass Spectrometry, Christchurch, New Zealand	22 -25 Jan 07
I.L. Francis	Consumer preferences for Shiraz and Cabernet Sauvignon wines	New Zealand/Australia Sensory Network Symposium, Auckland, New Zealand	31 Jan 07
I.S. Pretorius	Principle centred leadership	University of Adelaide MBA students, Ayers House, Adelaide, SA	2 Feb 07
A. P. Pollnitz	Aroma compounds in wine: analysis and applications	University of Adelaide staff and students, Charles Hawker Conference Centre, Waite Campus, Urrbrae, SA	5 Mar 07
I.S. Pretorius	AWRI and innovation in the Australian wine industry	Russian business delegation, Waite Campus, Urrbrae, SA	6 Mar 07
C.S. Stockley	Australian wine and health research directions 2007	OIV Consumption, Nutrition and Health expert group meeting, Paris, France	13 Mar 07
	Consumer health and safety issues related to the dietary intake of sodium – putting consumption into perspective	OIV Commission IV Safety and Health meeting, Paris, France	14 Mar 07
S.M. Boden	AWRI Online Image Collection Launch	AWRI staff and wine industry, Charles Hawker Auditorium, Waite Campus, Adelaide, SA	14 Mar 07
C.S. Stockley	Analysis of protein-fined wines for detection of residual food proteins in wine	OIV Commission IV Safety and Health meeting, Paris, France	15 Mar 07
Y. Hayasaka, I.S. Pretorius	A knowledge-based and innovative wine industry: How can the AWRI close the gap between the science and its application?	Japanese wine educators and journalists, AWBC, Adelaide	21 Mar 07
D.L. Johnson	Introduction to Intellectual Property	Licencing Executives Society Networking Forum, Adelaide, SA	4 April 07
		Student workshop, Adelaide, SA	13 and 20 April 07
C.S. Stockley	Review of NHMRC Australian Alcohol Guidelines 2001	National Alcohol Beverage Industry Council Board meeting, Sydney, NSW	23 Apr 07
I.S. Pretorius	The Australian Wine Research Institute: delivering value to the Australian wine industry	Wine Australia overseas managers, AWBC, Adelaide, SA	27 Apr 07
D.L. Johnson	Overview of The Australian Wine Research Institute	Chilean researchers, Santiago, Chile	3 May 07
M.J. Herderich	Research and innovation at The Australian Wine Research Institute		
C.S. Stockley	Review of NHMRC Australian Alcohol Guidelines 2001	Distilled Spirits Industry Council of Australia Board Meeting, Katoomba, NSW	17 May 07
S-J. Bell	Does grapevine nutrition have an impact on wine quality?	Tasmanian Vineyard of the Year Field Day, Tamar Ridge Estates, Tas	24 May 07
J.H. Swiegers	Yeast modulation of wine flavour: Genesis and metabolism of sulfur compounds	Agrovin Technical Seminar, Barcelona, Spain	5 Jun 07
J.H. Swiegers	Yeast modulation of wine flavour: Genesis and metabolism of sulfur compounds	Agrovin Technical Seminar, Alava, Rioja, Spain	6 Jun 07
J.H. Swiegers	Yeast modulation of wine flavour: Genesis and metabolism of sulfur compounds	Agrovin Technical Seminar, Tordesillas, Valladolid, Spain	8 Jun 07

Appendix 1. External presentations and talks

Staff	Title of talk	Presented to and where	Date
I.S. Pretorius	Creating a successful wine industry: role of innovations and discoveries	Bacchus at Brock Conference, St. Catharines, Canada	6-9 Jun 07
M. Parker	My career	Flinders University 2nd year chemistry students, Flinders University, Bedford Park, SA	8 Jun 07
A. Borneman	Comparative genome sequencing of a wine yeast strain	Roche Genomic Systems Symposium 2007, Adelaide, SA	12 Jun 07
I.S. Pretorius, P.J. Chambers, D.L. Johnson	Not all wine yeasts are equal: how to really add value to wine	Oenology section session, OIV World Congress, Budapest, Hungary	12 Jun 07
I.S. Pretorius, D.L. Johnson	Wine quality: setting the pace in a race without a finish line	Joint section session, OIV World Congress, Budapest, Hungary	13 Jun 07
P.J. Costello	Comparison of inoculated and wild malolactic fermentation on wine composition and sensory properties	ASEV Conference (Symposium on Managing Wild Bacterial Flora), Reno, USA	18 Jun 07
C.S. Stockley	An introduction to The Australian Wine Research Institute	Wine Ambassador Shop Group, AWBC, Adelaide, SA	18 Jun 07
I.L. Francis	Descriptive terminology	Advance Wine Assessment Course, Waite Campus, Urrbrae, SA	19 Jun 07
E.J. Waters	The shared future of the AWRI, the NWGIC and the Australian Wine Industry	National Wine and Grape Industry Centre ten year anniversary celebration, Wagga Wagga, NSW	20 Jun 07
M. Ugliano, F.M. Carrau, L. Moio, P.A. Henschke	Formation of monoterpene alcohols during alcoholic fermentation occurs through at least five different pathways	8 th International Enology Symposium of Bordeaux, France	25 -27 Jun 07

Workshops

Conducted by	Title of workshop/Presentations	Held	Date
P.W. Godden	Trouble free winemaking – the identification, management and avoidance of common wine instabilities	AWRI Workshop Roadshow, Pettavel Winery, Geelong, Vic	14 Jul 06
A.D. Coulter	A tasting of wines with simulated faults and taints		
G.D. Cowey	Laboratory analysis and Quality Management		
M.G. Holdstock	Introduction to AWRI Solutions Website		
G.D. Cowey, A.D. Coulter, M.G. Holdstock	Use of a microscope and isolation of hazes/ deposits – Theory and practical exercises		
A.D. Coulter, M.G. Holdstock	What bug is that? Identifying common wine microflora – Theory and practical demonstration		
A.D. Coulter	Taints and their occurrence in wines	AWRI Workshop Roadshow, Clare Showgrounds, Clare, SA	4 Aug 06
G.D. Cowey	Quality Management Systems		
A.D. Coulter	A tasting of wines with simulated taints and faults	AWRI Workshop Roadshow, Clare Showgrounds, Clare, SA	4 Aug 06
M.G. Holdstock	Using the AWRI Website		
	Methods to assess taints in winemaking additives		
A.D. Coulter	Instabilities from wine additives	Langhorne Creek Workshop Roadshow, Football Clubrooms, Langhorne Creek, SA	17 Aug 06
C. Simos	Trouble free winemaking – the identification, management and avoidance of common wine instabilities		
A.D. Coulter	A tasting of wines with simulated faults and taints		
G.D. Cowey	Laboratory analysis and Quality Management		
M.G. Holdstock	Introduction to AWRI Solutions Website		
G.D. Cowey, A.D. Coulter, M.G. Holdstock	Use of a microscope and isolation of hazes/ deposits – Theory and practical exercises	Langhorne Creek Workshop Roadshow, Football Clubrooms, Langhorne Creek, SA	17 Aug 06
A.D. Coulter, M.G. Holdstock	What bug is that? Identifying wine microflora – Theory and practical demonstration		

Conducted by	Title of workshop/Presentations	Held	Date
C. Simos	A current overview of contamination and taints in winemaking	Coonawarra Workshop Roadshow, Pipers of Penola, Penola, SA	30 Aug 06
A.D. Coulter	Taints and their occurrence in wines		
	A tasting of wines with simulated taints and faults		
G.D. Cowey	Quality management systems		
M.G. Holdstock	Using the AWRI Website		
	Methods to assess taints in winemaking additives		
A.D. Coulter	Instabilities from wine additives	Bendigo Workshop Roadshow, BRIT Chemistry Labs, Bendigo, Vic	13 - 14 Sep 06
P.W. Godden	Trouble free winemaking – the identification, management and avoidance of common wine instabilities		
A.D. Coulter	A tasting of wines with simulated faults and taints		
C. Simos	Laboratory analysis and Quality Management		
	Introduction to AWRI Solution Website		
A.D. Coulter	Use of a microscope and isolation of hazes/deposits		
	What bug is that? Identifying common wine microflora		
R.G. Dambergs	From grapes to glass – predicting wine quality in the vineyard	‘Some like it hot’ Conference, Renmark, SA	12 Oct 06
C. Simos	Taints – part program	Margaret River, WA	9 Nov 06
C. Simos, A. Coulter, M. Holdstock, G. Cowey	Taints	Angaston, Barossa Valley, SA	16 Nov 06
J.H. Swiegers I.L. Francis	Yeast modulation of Sauvignon Blanc wine aroma	Tastings for winemakers, Waite Campus, Urrbrae, SA	1 and 29 Nov 06
P. Godden, M. Holdstock, G. Cowey, B. Travis, C. Cynkar, L. Francis, A. Coulter	Advanced Wine Assessment Course	Waite Campus, Urrbrae, SA	4 Dec – 8 Dec 06
P.W. Godden	Trouble free winemaking – the identification, management and avoidance of common wine instabilities	AWRI Roadshow Workshops, University of New England, Armidale, NSW	17-18 Jan 07
C. Simos	A current overview of contamination and taints in winemaking		
M.G. Holdstock	Practical exercise – identification of taints in winemaking additives		
A.D. Coulter	Examples of wine taints and faults and how they can occur in wines (tasting and discussion)		
R.G. Dambergs	Tannin and red grape colour – What’s it all about?		
R.G. Dambergs, M.G. Holdstock	Red grape colour and tannin analysis demonstration		
C. Simos, A.D. Coulter	Taints – Supply Chain (The avoidance and management of taints during the winemaking supply process)	Swinburne University, Lillydale, Vic	16 Mar 07
I.L. Francis	White wine phenolics	Orlando Wines, Rowland Flat, SA	4 Apr 07
E.J. Bartowsky	Winemaking and microbiology of wine	High school students workshop, Glenunga International High School, Glenunga, SA	17 & 18 Apr 07
L. Janik, D. Cozzolino	Chemometrics and calibration development	Yalumba Technical Staff, Waite Campus, Adelaide, SA	19 Apr 07
L. Janik, D. Cozzolino	Introduction to chemometrics, grams and the unscrambler	CSIRO Land and Water – Adelaide, SA	May 07
P. Godden, C. Simos, E. Robinson, S. Kobelt, T. Waples, M. Holdstock, C. Rodriguez, L. Francis, A. Coulter	Advanced Wine Assessment Course	Waite Campus, Urrbrae, SA	19 – 22 Jun 07

Appendix 1. External presentations and talks

Posters

Author(s)	Title of poster	Presented at	Date
C. Varela, J.H. Swiegers, R.L. Willmott, L. Francis, M. Sefton, I. S. Pretorius	The genetics of volatile thiol release and modulation during wine fermentation: Tracking and manipulating the expression of key flavour-enhancing genes	Yeast Genetics and Molecular Biology Meeting, Princeton, USA	25-30 Jul 06
C. Varela, D.F. Malherbe ¹⁴ , J.H. Swiegers, P.J. Chambers, P. van Rensburg ¹⁴ , I.S. Pretorius	Creating wine yeasts for the production of low alcohol wines	Yeast Genetics and Molecular Biology Meeting, to be held in Princeton, New Jersey, USA	25-30 Jul 06
C.S. Stockley	Could moderate wine consumption provide significant health benefits?	(ISBRA) 2006 World Congress on Alcohol Research in Sydney, NSW, Australia	10 Sept 06
A.M. Molina ¹⁵ , J.H. Swiegers, I.S. Pretorius, E. Agosin ¹⁵	Synthesis of aromatic compounds and related gene expression in <i>Saccharomyces cerevisiae</i> EC1118 strain during wine fermentations at 15°C and 28°C	232 nd American Chemical Society's National Meeting, San Francisco, USA	10-14 Sept 06
K.A. Lattey, B.R. Bramley, I.L. Francis	Sensory properties, consumer acceptability and expert quality judgements of Australian red wines	2 nd European Conference on Sensory Consumer Science of Food and Beverages The Hague, The Netherlands	26-29 Sept 06
R.C. Brown, D.L. Capone, M.A. Sefton, G.M. Elsey	Synthesis of standards for the quantification and chiral distribution of γ -lactones in wine	RACI Organic and Physical Chemistry Conference, Adelaide, SA	28 Jan – 2 Feb 07
R.C. Brown, D.L. Capone, M.A. Sefton, G.M. Elsey	The quantification and chiral distribution of γ -lactones in Australian red wines	8 th Wartburg Flavour Symposium, Eisenach, Germany	27 Feb – 2 Mar 07
M. Ugliano, T. Siebert, D. Capone, P. A. Henschke	Production of volatile compounds by yeast during the fermentation of shiraz musts with different initial nitrogen concentrations	8 th International Enology Symposium of Bordeaux, France	25-27 Jun 07
M. Ugliano, L. Moio ¹⁶	Changes in the concentrations of yeast- and grape-derived volatile compounds of red wine during malolactic fermentation with four different commercial strains of <i>Oenococcus oeni</i>	8 th International Enology Symposium of Bordeaux, France	25-27 Jun 07

¹⁴ University of Stellenbosh, South Africa; ¹⁵ Pontificia Universidad Católica de Chile; ¹⁶ Università degli Studi di Napoli Federico II, Italy

Appendix 2. Teaching responsibilities of AWRI staff during 2006/2007

Subject	No. of Lectures	AWRI Staff
2006 — Semester 2		
Adelaide University		
Sensory Studies lectures	2	I.L. Francis
3045WT/7048WT Advances in Oenology	1	J.H. Swiegers
	5	P.A. Henschke
	3	E.J. Bartowsky
	2	I.L. Francis
	1	P.W. Godden
3005WT Grape Industry Practice Policy and Communication	Approx. 50 hours	C.S. Stockley
	1	I.S. Pretorius
University of South Australia		
Food Science Course	1	D. Cozzolino
Flinders University		
BTEC 3630 Medical and Molecular Biology	1	P.J. Chambers
BTEC 9670 Bioprocessing and Industrial Biotechnology	2	P.A. Henschke

Appendix 2. Teaching responsibilities of AWRI staff during 2006/2007

Subject	No. of Lectures	AWRI Staff
2007 — Semester 1		
The University of Adelaide		
WT3047, WA3047 and WT7047 Winemaking at Vintage	6	P.W. Godden
	2	P.A. Henschke
Stabilisation and Clarification	3	E.J. Waters
Oenology and Post-Graduate Oenology students	2	A.D. Coulter
3002WT (Bachelor of Agriculture)	1	P.J. Chambers
2001WT & 7030WT Wine in society	2	C.S. Stockley
Flinders University		
Honours Course SoCPES	10	G.M. Elsey
University of South Australia		
Advanced wine marketing	1	C.S. Stockley
OIV Master of science in wine management	1	C.S. Stockley

Appendix 3. Graduate and Honours student supervision responsibilities of AWRI staff for 2006/2007

Student	Supervisor/s	Source of funds
PhD		
A. Bandara	G. Stanley ¹⁷ , S. Fraser ¹⁷ , P.J. Chambers	Victoria University
R.C. Brown	G.M. Elsey, M.A. Sefton	GWRDC/APA
E. Dennis	P.A. Smith, M.V. Perkins ¹⁸	GWRDC/ARC
E.S.A. King	S. Bastian ⁸ , J.H. Swiegers, I.L. Francis, I.S. Pretorius	APA/GWRDC/University of Adelaide
D.R. Kutyna	P.J. Chambers, P.A. Henschke, C. Varela, G. Stanley ¹⁷	AWRI
N.D.R. Lloyd	G.M. Elsey, M.A. Sefton, M. Ugliano	GWRDC
O.J. Macintyre	I.S. Pretorius, E.J. Waters, C.B. Colby ¹¹ , B.K. O'Neill ¹¹	GWRDC/APA
I. Mohammed	G. Stanley ¹⁷ , P.J. Chambers	ARC
S. Nordestgaard	E.J. Waters, C.B. Colby ¹¹ , B.K. O'Neill ¹¹ , G.P. Jones ⁸	University of Adelaide/GWRDC
D. Stanley	G. Stanley ¹⁷ , P.J. Chambers	ARC
T. Tran	P.J. Chambers, G. Stanley ¹⁷ , M.A. de Barros Lopes ⁶	Victoria University/AWRI
S.C. van Sluyter	E.J. Waters, A. Bacic ¹⁹ , F. Pettolino ¹⁹	University of Melbourne
C. Wood (Hiatus 30 January to 1 July 2007)	A.P. Pollnitz, J.A. Alcalde ¹⁵ , E. Bordeu ¹⁵	VRAID, Vicerrectoría Adjunta de Investigación y Doctorado/AWRI/GWRDC
Hons		
A. Anderson	D. Cozzolino, C. Bevin ⁷ , B. Kaiser ⁸	University of Adelaide
A. Fudge	G.M. Elsey, Y. Hayasaka	Flinders University
J. Giaccio	G.M. Elsey	Flinders University
H. Heading	G.M. Elsey, D. Capone	Flinders University
J. Smith	S. Schmidt, E.J. Waters, P. Anderson ¹⁸	Flinders University
Masters		
P. Kneknopulos	Y. Hayasaka and G.K. Skouroumounis, D. Taylor ⁸	University of Adelaide

⁶ University of South Australia; ⁷ Hardy Wine Company; ⁸ School of Agriculture and Wine, University of Adelaide; ¹¹ School of Chemical Engineering, University of Adelaide; ¹⁵ Pontificia Universidad Católica de Chile; ¹⁷ Victoria University; ¹⁸ Flinders University; ¹⁹ University of Melbourne

Appendix 3. Graduate and Honours student supervision responsibilities of AWRI staff for 2006/2007

Theses completed

Honours/PhD

Student	Hon/PhD	Title of thesis	Supervisors
M.J. Birse	PhD	The colour of red wine	M.J. Herderich, A.P. Pollnitz, I.L. Francis
R.A. Muhlack	PhD	Development of alternative bentonite treatments for heat-unstable white wine	C.B. Colby ¹¹ , B.K. O'Neill ¹¹ , P.B. Hoj ²⁰ , A. Lim, E.J. Waters
U. Nastution	Mas	Expression and analysis of <i>Pichia</i> derived HPF2	S. Schmidt, E.J. Waters, P. Anderson ¹⁸
E.S.A. King	Hon	Co-inoculated fermentations: their impact on the aromatic profile of L. cv. Sauvignon Blanc	J.H. Swiegers, I.S. Pretorius
N. Lloyd	Hon	New routes to damascenone: formation under fermentation conditions	G.M. Elosey, M. Ugliano
J. Hixson	Hon	An investigation into the origin of off-flavours produced by <i>Brettanomyces</i> yeasts	G.M. Elosey, C. Curtin
N. Warnock	Hon	Expression of Botrytis proteases in <i>Pichia pastoris</i>	S. Schmidt, E.J. Waters, P. Anderson ¹⁸

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Appendix 4. Media Interviews

Date	Staff member	Discussed	Media
03 Jul 06	P.W. Godden	<i>Diam</i> closures	Jamie Goode, <i>Harpers UK</i>
10 Jul 06	P.W. Godden	Closures	Fionnuala Synnott, <i>The Drinks Business</i> magazine, UK
04 Aug 06	P.W. Godden	Possible sources of chlorophenols in wine	Tim White, Freelance
18 Aug 06	C.S. Stockley	Adverse reactions to wine	ABC radio (Alison Buchanan)
05 Sep 06	P.W. Godden	Closures	Tyson Stelzer, Freelance
09 Sep 06	P.W. Godden	Screwcaps	Lauren Corsey, <i>Australian and New Zealand Wine Industry Journal</i>
09 Sep 06	P.W. Godden	Closures, particularly oxygen ingress	Tim White, Freelance
13 Sep 06	A.P. Pollnitz	Use of oak chips	Henri Laurent Arnould, <i>Revue des Oenologues</i> (France)
13 Sep 06	P.W. Godden	AWRI Roadshows	Gemma McCarthy, <i>WBM</i>
20 Sep 06	P.W. Godden	Closures	Goerge Taber, Freelance
21 Sep 06	P.W. Godden	<i>Procork</i> closures	Jodie Blewett, <i>Channel 10</i> , Adelaide
11 Oct 06	P.W. Godden	Implications of climate change for the grape and wine industry	Simon Wallace, <i>ABC Radio</i> , Riverina
23 Oct 06	P.W. Godden	Closures	George Taber, Freelance
25 Oct 06	P.W. Godden	Trends in composition of Australian wine, especially alcohol concentrations	Simon Evans, <i>Australian Financial Review</i>
17 Nov 06	P.W. Godden	Wine faults	Joelle Thompson, Freelance (New Zealand)
17 Nov 06	I.L. Francis	Wine flavour and sensory evaluation	Felicity Carter, freelance writer
21 Nov 06	P.W. Godden	Nebbiolo	Jane Faulkner, <i>Melbourne Age</i>
Nov 06	P.J. Chambers	Article entitled <i>Search for yeast that produces less alcohol without compromising quality</i>	<i>Australian and New Zealand Grapegrower and Winemaker</i>
Nov 06	J.H. Swiegers	Article entitled <i>Selecting best yeast gives competitive advantage says AWRI</i>	<i>Australian and New Zealand Wine Industry Journal</i>
7 Dec 06	C.S. Stockley	Physiological effects of alcohol consumption	<i>Sunday Herald Sun</i> (Derek Ballantine)
11 Dec 06	P.W. Godden	New Zealand controversy concerning provenance of wine show entries	Paul Tudor, Freelance (New Zealand)
14 Dec 06	C.S. Stockley	Physiological and psychological effects of alcohol consumption	<i>Sunday Herald Sun</i> (Derek Ballantine)

Date	Staff member	Discussed	Media
19 Dec 06	C.S. Stockley	Potential adverse and beneficial effects of wine consumption	Singapore radio 938LIVE – Gets You Talking (Deborah de Souza), <i>Body & Soul</i> health talkshow
15 Jan 07	G.M. Elsey and N. Lloyd	Natoiya Lloyd's forthcoming project	GWRDC's <i>R&D at work</i> publication
17 Jan 07	P.W. Godden	Regarding article in London <i>Telegraph</i> 'screwcaps cause wine to smell of rotten eggs'	Trixy Oldfield, <i>The Australian</i>
17 Jan 07	P.W. Godden	Screwcaps and reduction	Geoff Hutchinson, <i>ABC Radio</i> , W.A.
18 Jan 07	P.W. Godden	Screwcaps and reduction – London <i>Telegraph</i> article	Angela Gregory, <i>New Zealand Herald</i>
30 Jan 07	P.W. Godden	General discussion of sensory properties of wine and differences in perception amongst individuals	Yoshiji Sato, Freelance, (Japan)
8 Feb 09	P.W. Godden	Peter Godden's presentation on Pinot Noir and <i>Brettanomyces</i> at Pinot Noir 2007, Wellington.	Paul Tudor, Freelance (New Zealand)
22 Feb 07	C.S. Stockley	Health and nutrition claims for alcoholic beverages	Graham Dixon, freelance journalist
26 Feb 07	P.W. Godden	Peter Godden's presentation on Pinot Noir and <i>Brettanomyces</i> at Pinot Noir 2007, Wellington	Geoff Kelly, Freelance (New Zealand)
12 Mar 07	I.L. Francis	Red wine mouth-feel influences	Karen Harries-Rees, Royal Society of Chemistry, Chemistry World
19 Mar 07	P.W. Godden	Closures, smoke taint	Sally Easton, Freelance, (UK)
		Smoke taint	Tim White, Freelance
23 Mar 07	I.L. Francis	Alcohol in cola drink incident	Tony Love, <i>The Advertiser</i>
5 Apr 07	P.W. Godden	Smoke taint	Sally Easton, Freelance, (UK)
25 May 07	C.S. Stockley	Pollution and potential impacts on grapes, wine and consumers	Felicity Ogilvy (ABC Hobart)
Jun 07	P.J. Chambers	GM use in US sets stage for Australian debate	Eric Cummins (<i>Grape Growers and Vignerons</i>) published in June 2007 edition
14 Jun 07	C.S. Stockley	Screwcaps and cancer claims	Huon Hooke (Freelance journalist)
15 Jun 07	C.S. Stockley	Diabetics and wine consumption for cardioprotection	Deborah Cameron (<i>Sydney Morning Herald</i>)
19 Jun 07	I.L. Francis	Consumer preferences	Tony Love, <i>The Advertiser</i>
21 Jun 07	A.D. Coulter	Closures and VSC's	Sally Easton, <i>Wine Wisdom</i> (UK)
10 Jul 07	I.L. Francis	Wine flavour and temperature	Tim White, wine columnist: <i>Australian Financial Review</i> , wine writer: <i>The Age</i> (Melbourne), magazine columnist: <i>Australian and New Zealand Grapegrower and Winemaker</i>

Appendix 5. AWRI Publications

- 923** Swiegers, J.H.; Willmott, R.; Hill-Ling, A.; Capone, D.L.; Pardon, K.H.; Elsey, G.M.; Howell, K.S.; de Barros Lopes, M.A.; Sefton, M.A.; Lilly, M.; Pretorius, I.S. Modulation of volatile thiol and ester aromas by modified wine yeast. Bredie, W.L.P.; Petersen, M.A., eds. *Flavour Science: recent advances and trends. Proceedings of the 11th Weurman Flavour Research Symposium*; held 21-24 June, 2005, Roskilde, Denmark. Amsterdam, The Netherlands: Elsevier; 2006: 113–116.
- 924** Francis, L. Wine bottle closures-natural corks, synthetic closures and screw caps. Tsantalis, G.; Trogus, H.; Gafner, J. eds. 14th International enology symposium; held 8-12 May, 2005, Porto Carras, Chalkidiki, Greece. Breisach, Germany: Internationale Vereinigung für Oenologie, Betriebsführung und Weinmarketing e.V.; 2005: 353–365.
- 925** Bayly, J.C.; Douglas, L.M.; Pretorius, I.S.; Bauer, F.F.; Dranginis, A.M. Characteristics of Flo11-dependent flocculation in *Saccharomyces cerevisiae*. *FEMS Yeast Res.* 5: 1151–1156; 2005.
- 926** Stockley, C.; O'Hehir, R.; Rolland, J. Is allergen labelling necessary for Australian wine? *Aust. N.Z. Wine Ind. J.* 21 (3): 17–21; 2006.
- 927** Ugliano, M.; Bartowsky, E.J.; McCarthy, J.; Moio, L.; Henschke, P.A. Hydrolysis and transformation of grape glycosidically bound volatile compounds during fermentation with three *Saccharomyces* yeast strains. *J. Agric. Food Chem.* 54: 6322–6331; 2006.
- 928** Lilly, M.; Bauer, F.F.; Lambrechts, M.G.; Swiegers, J.H.; Cozzolino, D.; Pretorius, I.S. The effect of increased yeast alcohol acetyltransferase and esterase activity on the flavour profiles of wine and distillates. *Yeast* 23: 641–659; 2006.
- 929** Lilly, M.; Bauer, F.F.; Styger, G.; Lambrechts, M.G.; Pretorius, I.S. The effect of increased branched-chain amino acid transaminase activity in yeast on the production of higher alcohols and on the flavour profiles of wine and distillates. *FEMS Yeast Res.* 6: 726–743; 2006.
- 930** Muhlack, R.A.; Waters, E.J.; O'Neill, B.K.; Lim, A.; Colby, C.B. New insights into the adsorption of haze-forming proteins by bentonite during winemaking. *Chemeca 2004: sustainable processes: proceedings of the 32nd Australasian Chemical Engineering Conference*; 27–29 September 2004; Sydney, NSW: Institute of Engineers, Australia; 2004.
- 931** Lloyd, F.K.; Colby, C.B.; O'Neill, B.K.; Waters, E. Combined heat/proteolytic enzyme treatment for the removal of protein haze in wine. *Chemeca 2005: smart solutions – doing more with less: proceedings of the 33rd Australasian Chemical Engineering Conference*; 25–28 September 2005; Brisbane, Queensland: Institute of Engineers, Australia; 2005.
- 932** Gundllapalli, S.B.; Cordero Otero, R.R.; Pretorius, I.S. Development of a screening method for the identification of a novel *Saccharomyces cerevisiae* mutant over-expressing *Trichoderma reesei* cellobiohydrolase II. *Ann. Microbiol.* 56(2): 143–150; 2006.
- 933** Holt, H.E.; Iland, P.; Ristic, R. A method for mini-lot fermentation for use in research and commercial viticultural and winemaking trials. *Aust. N.Z. Grapegrower Winemaker* (509a): 74–81; 2006.
- 934** Colby, C.B.; Nordestgaard, S.; Waters, E.; O'Neill, B.K. Bentonite fining: can we improve performance and efficiency and decrease value losses? *Aust. N.Z. Grapegrower Winemaker* (509a): 82–88; 2006.
- 935** Cozzolino, D.; Cynkar, W.U.; Damberg, R.G.; Janik, L.; Gishen, M. How to select a scanning near infrared spectrophotometer instrument. *Aust. N.Z. Grapegrower Winemaker* (510): 52–54; 2006.
- 936** Brown, R.C.; Sefton, M.A.; Taylor, D.K.; Elsey, G.M. An odour detection threshold determination of all four possible stereoisomers of oak lactone in a white and a red wine. *Aust. J. Grape Wine Res.* 12: 115–118; 2006.
- 937** du Toit, W.J.; Marais, J.; Pretorius, I.S.; du Toit, M. Oxygen in must and wine: A review. *S. Afr. J. Enol. Vitic.* 27(1): 76–94; 2006.
- 938** Rolland, J.M.; Apostolou, E.; Deckert, K.; de Leon, M.P.; Douglass, J.A.; Glaspole, I.N.; Bailey, M.; Stockley, C.S.; O'Hehir, R.E. Potential food allergens in wine: Double-blind, placebo-controlled trial and basophil activation analysis. *Nutrition* 22: 882–888; 2006.
- 939** Jolly, N.P.; Augustyn, O.P.H.; Pretorius, I.S. The role and use of non-*Saccharomyces* yeasts in wine production. *S. Afr. J. Enol. Vitic.* 27(1): 15–39; 2006.
- 940** Liu, L.; Cozzolino, D.; Cynkar, W.U.; Gishen, M.; Colby, C.B. Geographic classification of Spanish and Australian Tempranillo red wines by visible and near-infrared spectroscopy combined with multivariate analysis. *J. Sci. Food Agric.* 54(18), 6754–6759; 2006.
- 941** Campbell, J.I.; Pollnitz, A.P.; Sefton, M.A.; Herderich, M.J.; Pretorius, I.S. Factors affecting the influence of oak chips on wine flavour. *Aust. N.Z. Wine Ind. J.* 21 (4), 38–42; 2006.
- 942** Cynkar, W.; Damberg, R.; Janik, L.; Gishen, M.; Cozzolino, D. Application of electronic nose devices in the Australian wine industry. *Aust. N.Z. Grapegrower Winemaker* (513): 66–68; 2006.
- 943** Pocock, K.F.; Waters, E.J. Protein haze in bottled white wines: How well do stability tests and bentonite fining trials predict haze formation during storage and transport? *Aust. J. Grape Wine Res.* 12: 212–220, 2006.
- 944** Muhlack, R.; Nordestgaard, S.; Waters, E.J.; O'Neill, B.K.; Lim, A.; Colby, C.B. In-line dosing for bentonite fining of wine or juice: Contact time, clarification, product recovery and sensory effects. *Aust. J. Grape Wine Res.* 12: 221–234; 2006.
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- 946** Ugliano, M.; Bartowsky, E.J.; McCarthy, J.; Moio, L.; Henschke, P. Hydrolysis and transformation of grape glycosidically bound volatile compounds during fermentation with three *Saccharomyces* yeast strains. *J. Agric. Food Chem.* 54: 6322–6331; 2006.
- 947** Stockley, C.S. Could moderate wine consumption provide significant health benefits? *Aust. N.Z. Grapegrower Winemaker* (514): 83–86, 2006.
- 948** Swiegers, J.H.; Pretorius, I.S.; Bauer, F.F. Regulation of respiratory growth by Ras: the glyoxylate cycle mutant, *cit2^Δ*, is suppressed by *RAS2*. *Curr. Genet.* 50: 161–171; 2006.
- 949** Nieuwoudt, H.H.; Pretorius, I.S.; Bauer, F.F.; Nel, D.G.; Prior, B.A. Rapid screening of the fermentation profiles of wine yeasts by Fourier transform infrared spectroscopy. *J. Microbiol. Meth.* 67: 248–256; 2006.
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- 953** Nygaard, M.; Cream, M.; Taylor, R.; Wilkes, E. Quality management in the laboratory – practical tools and examples from a NATA accredited wine laboratory. *Aust. N.Z. Wine Ind. J.* 21(6): 31–36; 2006.
- 954** Malig, R.; Varela, C.; Agosin, E.; Melo, F. Accurate and unambiguous tag-to-gene mapping in serial analysis of gene expression. *BMC Bioinformatics* 7(487); 2006.
- 955** Bevin, C.J.; Fergusson, A.J.; Perry, W.B.; Janik, L.J.; Cozzolino, D. Development of a rapid 'fingerprinting' system for wine authenticity by mid-infrared spectroscopy. *J. Agric. Food Chem.* 54(26): 9713–9718; 2006.

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